Proceedings

of the

23rd Annual Northwest Turfgrass Conference

September 24, 25, 26, 1969

Hayden Lake Golf &
Country Club

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PRESIDENT'S MESSAGE

GEORGE HARRISON

Welcome to Hayden Lake.

Again we expect to have an informative and educational conference for this, our 23rd annual meeting of the Northwest Turfgrass Association. We should all express our thanks to the committee which has made this conference possible. This group, which is listed below, has put in many long hours preparing for the Conference and they, along with the Board members of the Association, have performed yeomen services.

It is a great pleasure to be at Hayden Lake Golf and Country Club again, and we wish to thank the management and, of course, the superintendent, John Harrison, for their courtesy in providing these facilities.

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Dr. Roy Goss	Executive Secretary
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Art Eliot & Al Blair	Social Hour
Cliff Everhart	Golf Tournament
Lucille Everhart	Women's Activities
John Harrison	Banquet Entertainment
Max Kamp & John Harrison	Menus and Facilities

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John Zoller	Eugene Country Club 255 Country Club Rd. Eugene, Oregon
Roy L. Goss	Western Wa. Research & Extension Center, Puyallup, Wa.

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"Tartan" Surfacing Material Expands From Horse Tracks To Football Fields in 10 Years[1]

William P. Whitehead[2]

When John Nerud suggested that the greatest thing that could happen to horse racing would be a synthetic track, little did he know he was opening the door to a brand new era of synthetic surfaces for everything from tracks to football fields.

In the space of just under 10 years, the horse trainer for 3M Company executive William L. McKnight has seen his dream become a reality and has watched the results of his idea spread into numerous fields completely unrelated to horse racing.

Nerud voiced his inspiration on many different occasions, but it wasn't until a rainy winter afternoon in 1959 that someone heeded his advice. McKnight, then chairman of the board of 3M, felt that the idea wasn't as foolish as it sounded. So, he put 3M researchers to work on the project.

In 1961, the company introduced its first batch of surfacing material under the brand name of "Tartan". It was installed outside of Max Hempt's farm in Mechanicsburg, Pa., where horses trained on it.

Installation of test strip, however, is a long way from having a full track operating under competitive conditions. The cost was prohibitive and the material really was untested.

But, as in any other field, there was a far-sighted individual who was willing to take a chance on a new product and install it on his track. That man was Del Miller, harness driver par excellence who was building a trotter track in Washington, Pa.

When the Meadows opened in June 1963, it boasted the first full oval covered completely with "Tartan" Surfacing Material. The five-eighths mile track has been operating on

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[1]Paper presented at the 23rd N. W. Turfgrass Conference, Hayden Lake, Idaho. September 24-26, 1969.

[2]Sales Representative, "Tartan" Surfacing & Turf. 3M Co.

the plastic surface ever since, without requiring major patching of the durable material. This material is the same material which goes into the base for the football fields.

The company has installed one horse race track each year since that time -- Laurel, Md., Raceway in 1964, Windsor, Ont., Raceway in 1965 and Tropical Park in 1966. The latter was the first thoroughbred track installed.

Sale of one horse track a year could not come close to justifying existence of a product, however, so 3M sought new markets for its all-weather surfacing material.

Since horses found the new surfacing a boon to their longevity and racing times, the natural place to look for new markets was in the field of human racing.

Again, a gambler had to be found who was willing to give the material a fair test. This time, he was a man closer to home. Ralph Lundeen, athletic director at Macalester College in St. Paul, okayed the installation of a full 440-yard, eight-lane running track.

Since that track was installed in 1963, every track and field record on both a high school and college level has been broken. In one state high school track meet in the rain, five records fell, proving the material truly is non-slip under any and all conditions.

Lundeen was so enamored of the track, he had "Tartan" Surfacing Material put down in his fieldhouse in 1966. By installing the plastic over the old dirt surface, Lundeen turned his fieldhouse into an all-purpose facility capable of being used for varsity and intra-mural sports such as basketball, tennis, volleyball, badminton, handball, indoor track and even indoor football. In addition, student convocations and dances can be held on the floor without danger of marring the surface, something completely impossible with the old wood floors.

The track and fieldhouse applications have expanded greatly since the first installations. The University of Tennessee has installed both surfaces in its new athletic compound. Track power San Jose State and Penn Relay host University of Penn. are among other major schools to have tracks either installed or on the agenda.

Mexican officials decided the plastic surface would be ideal for the 1968 Olympic Games in Mexico City. A contract was drawn up and approved which provided that the main Olympic track and five tracks would be covered with "Tartan" Surfacing Material. The Olympic Games provided the opportunity for every top track and field athlete in the world to test the surface.

Chief characteristics emerging from the first uses of the product were its non-slip capabilities, its resilience, its uniformity even under the most adverse weather conditions and its durability.

With credentials like that, it was obvious numerous other uses for the product would be found.

The New York City Park Board led the way in the playground area by installing some material on one of its play areas. Other parks and playgrounds followed suit, providing a safe surface on which children could play.

Portland State College, under pressure to provide additional recreational space in an urban area, became the first to turn a roof-top into an all-purpose recreational area by surfacing it with "Tartan". The previously unusable roof of the physical education building now houses four full-size tennis courts, a running track and a large area for other activities.

A number of golf courses around the country have installed the material in pro shops, in restaurant areas, on walkways to tees, on bridges and on other hard wear areas previously worn out by heavy traffic.

Veterinarians have found "Tartan" ideal for animal stalls and operating areas where a nice soft surface makes it more comfortable for the horses and a resilient surface aids healing.

Many schools have surfaced locker rooms, weight rooms, hallways, hockey rink runways and other heavy traffic areas with the plastic surface.

Several ocean liners have eliminated problems caused by water sloshing over the deck area by installing "Tartan" Surfacing Material. The non-slip characteristics of the product make it much safer to walk the ship deck during rough or wet weather.

Yes, athletics has been undergoing many changes over the years in rules, equipment and facilities, but few have been so significant as the one which is beginning to roll this year.

When two major universities -- Tennessee and Wisconsin -- installed a grass-like synthetic playing surface on their football fields, it marked the start of a major revolution not only in this sport, but also in many events held on grass areas.

First Tennessee and then Wisconsin put in 3M Company's new product, just named "Tartan" Turf, in time for the 1968 season. Other schools and even some professional teams have been interested enough to send delegations to both installations and to St. Paul, Minnesota, home of 3M, to talk about the possibility of having a field of their own.

For many years, experts have been citing advantages of a synthetic surface for football, but, until last year, there has not been a surface produced which met the specifications of a majority of the decision-makers.

One of the greatest benefits listed by these men is the probable reduction in injuries. Because cleats cannot dig into the 3M surface, there is less chance of knees and ankles being wrenched because cleats have been anchored in the ground.

The base of "Tartan" Turf, an offshoot of a product currently being used in fieldhouses, on running tracks, on playgrounds and in other areas, already has shown it is a factor in reducing injuries such as shin splints, heel bruises and ankle injuries because of its resilience.

Another major advantage is the consistency of the surface under all weather and wear conditions. It will not get hard in the cold weather or soft in warm weather; it will remain constant at all times. The field is not worn out by heavy use meaning numerous activities can be conducted on it.

Reduction in maintenance is another factor which swayed the two schools to go to a synthetic surface. No more re-sodding, re-liming or covering the field during a rain-storm is necessary. The turf will drain by itself, although footing is not affected by water, and permanent lines can be painted on the surface in a variety of colors.

The inch-thick 3M product has no grain or direction, resulting in very little abrasion and little chance for unnatural bounces of the ball. It appears to contain all the advantages of grass with none of the disadvantages.

When the field at the Portland Civic Stadium was installed it became the first outdoor synthetic surface in the world to be used for both baseball and football.

When Pittsburgh follows a year later, it will become the first major league synthetic facility to be used for both sports. The baseball Pirates will open the 1970 season on the turf, followed by the football Steelers that fall.

Multi-purpose use of the stadiums is made possible because of a technical innovation by 3M. Nylon "Hedlok" fasteners are used as a connection between the permanent part of the field and the skinned portion of the infield.

During initial construction of the new field, the entire area outside of the infield is covered with a layer of asphalt. Over the asphalt, the permanent installation of "Tartan" Turf is laid.

Around the infield, under the turf, is a stretch of concrete curbing 12 inches wide and sunk eight inches into the ground. The curbing is placed on both the inside and outside of the skinned area of the field.

On the dirt edge of the concrete is a niche into which the fasteners are adhered. During a baseball game, the fasteners and exposed concrete are covered with a layer of dirt raked in from the rest of the infield area.

When it is time to convert to a football field, the dirt is raked back to the skinned portion of the infield and the fasteners are cleaned out with an air gun. The dirt portion is rolled with a ride-on roller to provide a firm base.

The turf then is rolled out with a lift track containing a special 3M-designed attachment. The 10-foot wide rolls are held in place by the fasteners, which firmly interlock when their multiple pattern of identical nylon stems are snapped together.

Converting from a baseball to football field will take about four hours, while switching back to a baseball playing area consumes only two hours.

Portland's facility is to be used in the fall by the Portland State University football team and the area's high schools.

To date, most of the uses found for "Tartan" are in the athletic or recreational fields. Although sports is an obvious benefactor of the advantages the 3M material has to offer, business and industry also may have applications in which a plastic-type surface could be used.

In fact, "Tartan" could be considered for use in any area where grass, dirt, concrete, wood, or any other surface currently is being used.

The Value of Turf in the State of Washington— A Turgrass Survey[1]

Roy L. Goss[2]

INTRODUCTION

The Turfgrass industry encompasses the development, production, and management of specialized grasses for utility, beautification, and recreational facilities. It involves turfgrass science, manpower development, and the production, distribution, and sale of turfgrass products and services. This industry has undergone immense growth within the last decade. The vast urban build-up is responsible for most of the growth and the associated recreational areas, including parks, golf courses and playfields, are an integral part of this urban growth.

The value of the turfgrass industry has not been easy to assess for a number of reasons. Except for seed and sod, the value in turfgrass is not derived from an immediately marketable commodity. Therefore, no market information has been available in terms of production units, commonly expressed in the agricultural industry. Since this industry has not been concerned directly with the production of food, feed, or fiber, many agricultural leaders have not considered it a part of the total agricultural picture. This attitude has changed somewhat today, and according to estimates made in 1965, the value of the turfgrass industry in the United States was placed at four billion dollars.[1/]

Urban, recreational, institutional, and other turfgrass areas have been growing rapidly in Washington.

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[1]Paper presented at the 23rd N. W. Turfgrass Conference, Hayden Lake, Idaho. September 24-26, 1969.

[2]Associate Agronomist and Extension Specialist in Agronomy, W.W.R.E.C., Washington State University, Puyallup, Washington.

[1/]Dr. G. C. Nutter, Turfgrass Times, October 1965

In addition to growth, there is a general trend toward better management programs by all people in the industry, hence, a growing need for professional, skilled, and semi-skilled persons to service this industry. In order to provide skilled workers in this field tomorrow, we must know more about the size of the industry and its needs today.

To assign an accurate value to the industry, and not rely upon guesses and unfounded estimates, it was necessary to conduct an intensive statewide survey. The information resulting from this survey can be of value in the following ways:

1. Determine training programs necessary and desirable for professional and semi-professional persons to serve as pesticide applicators, golf course, park, cemetery, and institutional grounds superintendents, consultants, design specialists, etc.

2. To serve as a guide for allied industrial development in the areas of equipment and supplies used.

3. To determine University research and Extension programs necessary to serve the industry and provide information to areas in greatest need.

4. To be able to provide more accurate information to avoid over-saturation within the industry.

This survey was conducted under a joint agreement between the Washington State University Cooperative Extension Service and the Statistical Reporting Service of the United States Department of Agriculture.

VALUE OF HOME LAWNS

Home lawns in Washington, covering an area of 96,600 acres, make-up 61% of the total turf area. The average lawn size is 4,770 square feet and there are presently over 881,700 units in this classification. Less than 2.5% of the homes use commercial lawn services for managing their lawns. Over 87% of the people in Washington have established their own lawns. The average cost of establishment of new lawns (grading, fertilizer, seed, drainage, etc.) in 1967 was $6,891. per acre. Value of owner-labor is not included in this figure.

Various problems are encountered in the seeding and management of home lawns. A survey revealed that weeds, poor soil, insects and diseases are the three most serious problems. These are associated with intensity of management of lawns. Less than 51% of the home owners fertilize their lawns and an even lower percent used pest control practices. In Western Washington, one third of the lawns are not irrigated. Renters are particularly lax in these high intensity management practices.

The cost of materials for management of home lawns amounted to $97.35 per acre. This figure includes fertilizers, weed, disease and insect control and soil conditioners and is about 34% of the total budget for maintenance. Total equipment costs averaged $139.60 per acre with a total expenditure for maintenance cost of $300. per acre in 1967.

At the time of this survey there was a total investment in equipment of over 134 million dollars. The total home lawn expenses, excluding paid and unpaid family labor for 1967 was $58,455,900. Since 87% of the labor involved in lawn care is unpaid family labor this item is not reflected in the above figures. In 1967, the value of unpaid family labor was about 99 million dollars.

Good quality, pre-grown sod will cost the individual over 8¢ per square foot. If the lawn is being replaced due to loss by insects, disease, neglect or other causes, the old sod must first be removed, the surface repaired and the new sod laid. The very minimum planting costs for lawns is about 4.4¢ per square foot. However, no consideration is given for the pesticides, fertilizer and other cost items necessary to produce a mature sod in the lawn.

UTILITY TURF OR GENERAL-TYPE LAWNS

In order to avoid too many categories of turfgrass areas, the church, motel, industrial site, parks, and other miscellaneous areas were grouped under utility turf. Some are for aesthetic purposes only, while others, such as parks, are used for recreation.

There are in this category 16,000 units with 6,900 acres of turf, an average of 0.43 acres per unit, about four times the size of the average home lawn. Five percent of the utility turf owners use lawn service at an average rate of $1,666. per unit, as compared to 2.4% for home lawns with an average of $117.70 per unit. This indicates that the general category uses more complete service at a higher total cost per unit area than does the home lawn operator.

Problems in utility lawns ranked in order of importance show weeds and poor soil heading the list, which is the same for home lawns. An important difference, however, is the occurrence of compaction as the third greatest problem in this area compared to a ranking of fifth on home lawns. This, no doubt, reflects the foot traffic effects in parks.

The cost of maintaining turfgrass in this category, presents an entirely different picture from home lawns. In this area, hired labor and lawn service each, are over twice as costly as total equipment. Other than labor, fertilizer and weed control are the largest expenditures in the maintenance budget. Multi-purpose products, being combination materials used for weed, disease, and insect control account for the third greatest expense for maintenance materials. The degree of lawn care in this category, indicates about the same as for home lawns. The total expenses for general-type or utility-type lawns in 1967, was $5,559,000.

GOLF COURSES

Golf course turf in Washington ranks second in size and total value only to home lawns of all intensively managed turfgrass. Golf course turf in Washington rank second in size and total value of all intensively managed turfgrass. An independent survey in 1967 showed a total of 153 golf courses. Thus there has probably been a greater growth in golf courses than in any other turfgrass classification in Washington. This is due to a rapidly expanding recreational need in the state, as well as a rapidly expanding urban residential development.

The presence of a large number of lakes, streams, and scenic vistas in Washington, and the broad diversity of climate, recreational development, including golf courses, has soared in recent years. The recreation developer can offer a complete recreation package for the family usually within easy driving distance from his home. A single development can offer swimming, boating, horses, fishing, hiking, golfing, and limitless quantities of fresh smog-free air.

The survey revealed 99 golf courses in Western Washington, made up of 55 nine-hole courses and 44 with 18-holes or more. Eastern Washington showed 54 courses of which 21 are 18-holes or over. The total of 153 golf courses have a combined area of 12,172 acres, with an estimated value of $50,647,000. based upon the replacement cost of the total acreage but not including land values or buildings.

The survey revealed a total of 3,843,800 rounds of golf played in 1967 with about two thirds of this total being played in Western Washington. This is a function of population and climatic differences between the two geographic areas. Golf can be played all year with only a minimum number of closure days in Western Washington, but snow and cold weather restricts winter golf in portions of Eastern Washington.

As would be expected, Eastern Washington fairways showed a preponderance of bluegrass and Western Washington revealed more bentgrass. However, over 30% of all eastern Washington fairways contained some bentgrass. Bentgrass is not desirable in this region on fairways and indicates a need for more investigation for better ways to maintain pure bluegrass stands. Bentgrasses become heavily diseased during the winter and permit damaged areas to be taken over by weeds.

A greater number of management problems besiege the golf course than any other turfgrass area, due to the high level of perfection required. Better-than-average knowledge and ability is required of the golf superintendent to cope with these problems. Poor drainage, compaction, wear, weeds, and disease are the chief problems on putting greens on 18-hole courses in Western Washington. In Eastern Washington, however, wear, disease and poor soil are indicated to be the chief problems on greens. Diseases rank fifth on Western Washington putting greens and reflects the fact that more golf courses are practicing disease control programs.

Weeds head the list of common problems on fairways in both Western and Eastern Washington. Although wear, poor drainage and poor soils are also important.

Out of $3,338,700. spent for maintenance in 1967 on Washington's golf courses, $2,481,500. was spent for labor. This represents a whopping 74% of the total budget, far exceeding that spent for materials or equipment. Most golf courses are faced with the labor dilemma today. Many jobs have to be left undone at the risk of poor appearance, reduced playability, and additional equipment becomes necessary to partially replace labor. The total equipment cost for 1967 was $503,500. At one time a 3-gang power-driven greens mower was in use on golf courses, but single-gang power-driven mowers resulted in a more desirable turf appearance and were easier to manage with low-cost labor. Today, after being off the market for many years, the 3-gang greens mower is making a comeback, representing another step to reduce labor costs. Golf courses spend nearly one-third as much for disease control as home lawns. This is most significant when we consider that most golf course fungicides are applied only to greens, making up about 220 acres.

No attempt was made to assess the cost of irrigation water to the maintenance program. This is a real cost where municipal water is used. Most irrigation systems on golf courses are of the manual-type rather than semi-automatic and automatic. Automatic systems are being used on many of the new courses and will become more important in the future.

The 44 Western Washington 18-hole golf courses employ 160 full-time employees for an average of 3.6 men, and Eastern Washington's 21 18-hole courses employ 87 men, for an average of 4 full-time employees. Eastern Washington hired about 60% more part-time help.

It is interesting to note that it cost $1.25 in maintenance costs for each round of golf played on 18-hole courses in Western Washington, and $1.10 for Eastern Washington. It cost slightly less per round on nine-hole courses than on 18-hole courses in both areas. This probably is due to a slightly lower level of maintenance and somewhat more traffic on public nine-hole courses as compared to private 18-hole courses.

SCHOOL LAWNS

Washington school systems, public and private, maintain 10,400 acres in turfgrasses. Nearly 45% of this turf is on playgrounds, 19.7% on athletic fields, and 35.6% is general purpose turf, such as lawns. The cost of establishing these lawns is lower than any other turfgrass category in this survey. Schools spent only $726. per acre, or a little less than 2¢ per square foot for turf establishment. At this cost refinements such as the replacement of topsoil, adequate drainage, good irrigation systems, etc., are not possible.

Weeds, poor soil, wear and compaction are the most serious turfgrass problems.

Schools spent an average of $11.45 per acre on fertilizer. Golf courses spent over $16. per acre and are applying only about one-half enough. This is one reason for such serious weed problems on school turf. Wear would be reduced if compaction could be corrected. Schools spend only 45¢ per acre for aerification, which is one of the few means of loosening a compacted soil. Labor for maintaining 10.400 acres of grass on school turfgrass areas is $1,186,200. or about 68% of the total budget. When the 1967 cost of equipment, $243,000. was removed from the total maintenance budget, a mere 11% was left to cover all cost of maintenance.

Washington's schools have an inventory of $7,279,200. worth of turfgrass maintenance equipment. When depreciation of equipment, over a period of six years, and new lawns were added to the 1967 maintenance budget, the total expenditure for all schools was $3,154,700.

The pressure for more classrooms and teaching facilities is always a burden on the schools. The grounds, which includes physical education and athletic facilities, are the items most often cut from tight budgets. Most schools at this time are not able to apply the better management practices that we know today, and until such a time as reasonable budgets can be provided for this area, little progress can be expected.

CEMETERIES

Cemeteries in Washington account for 2,000 acres or slightly more than 1% of the total turfgrass area in the state. The nature of a cemetery, however, makes management quite expensive. Many of our older cemeteries with above-ground stones and monuments increase the cost of maintenance. These markers also restrict the use of conventional maintenance equipment and demand the use of specialized trimmers. The modern endowment-type cemetery has adopted flush markers, and the increased usage of mausoleums have materially reduced maintenance costs.

Labor still makes up as much as 69% of the maintenance budget on cemeteries. Maintenance equipment cost about 31% more in 1967 than all materials added together. Cemeteries, in an effort to present a neat and beautiful appearance, fertilized the grass 2.1 times as compared to 1.6 times for general-type lawns and 2.1 times for home lawns. In general, an increased usage of fertilizer would improve the appearance and lessen the weed problem.

All cemeteries had an inventory of $1,455,200. in equipment. Annual depreciation of this equipment, based on a six year average life, adds an additional $242,500. to turf maintenance for a total expense for 1967 of $1,139.100.

Campus Turf Maintenance[1]

George O. Woods[2]

The Seattle School District, with which this discussion "Campus Turf Maintenance" is concerned, comprises a very large acreage. It includes twelve High Schools, seventeen Junior High Schools, ninety elementary schools and about six other building areas containing turf or lawns. It is difficult to visualize the magnitude of these areas with which we are concerned.

Of the total schools mentioned, only four of them have no lawns to maintain. The areas set aside for landscaping have always been in the plan for each school. The grassed areas may be just a few thousand square feet up to as much as four acres for one school. It is not at all unusual to have a couple of acres of grass plus the shrubbed areas and rockeries to maintain.

The lawns are cut or mowed by the Operating Department (custodians) as it has always been done; however, when the area to be mowed amounts to an acre or more, it is done by a traveling crew of two or three men operating a small Triplex. We have two or three of these in operation during the mowing season. Otherwise, the custodians maintain their own lawns. Acreages considered here for mowing are

High schools	17 acres
Junior high schools	33 acres
Elementary schools	33 acres

The Triplex mowers take care of approximately 50 acres of this total.

In addition to the Class "A" turfs, or those adjoining each school, we have several athletic fields that are maintained regularly, but not as "well groomed" as the Class "A" turfs. Our budget for this year - 1969-70, totals $304,000. This

[1]Paper presented at the 23rd N. W. Turfgrass Conference, Hayden Lake, Idaho. September 24 - 26, 1969.

[2]Landscape and Grounds Superintendent, Seattle School District #1, Seattle, Washington

includes $69,000 for landscaping; $200,000 for grounds upkeep and $35,000 for general playground maintenance. The amount allocated for landscaping is used for newly-constructed schools or for the renovation of older ones. The seemingly large amount for grounds upkeep ($200,000) is really quite conservative when it is divided among the approximately 124 sites to clean up, fertilize, thatch, perforate, weed, spray, etc. Man hour labor and supplies are charged against any one or all of these three categories.

To do a completely satisfactory and complete maintenance job, more manpower is needed. By this I mean our cleanup crews would be better able to maintain lawn and shrub areas if we could schedule them at each school more often than two or three times each year as is now done. However, our present budget is not sufficient to hire more than thirty regulars, with up to forty-five college boys for the three summer months. Some seasons we are unable to treat all lawns to the fringe benefits necessary such as thatching, perforating, weed spraying and fertilizing. Ideally, the lawns should be fertilized at least four times; however, most are fertilized a minimum of two times, some receive three applications and in some cases, four times. We use the 3-1-2 mixture or 12-4-8. The results from these are really outstanding. Last winter, in spite of the extreme cold, our lawns weathered it magnificently with a very good green color throughout. The late fertilizing paid off.

As you all know, a lack of good, experienced personnel is the greatest hurdle to be overcome by anyone managing, supervising or operating a program maintenance plan. This lack of qualified gardeners with a real gardening ability results in work which does not meet our desired high standards.

Another difficulty is maintaining the power equipment - mowers, edgers, thatchers, perforators, sicklebars, to name a few. They may not be made for such rigorous work or for the abuse they get possibly by inexperienced operators. This keeps two of our mechanics busy just overhauling this power equipment, to keep it in good working condition.

Cutting or mowing the lawns less than the required one and one-half inches regularly specified is not uncommon; in fact, scalping seems to be the habit with some of the operators of the Triplex machines used on the larger lawn areas. We are now endeavoring to correct this situation in our Machine Shop by setting the reels so that it will be impossible to go below an inch and one-half cut.

We also have a problem with our sicklebar mowers - plugging of the air intake - this we are correcting by installing a cover with a smaller screen. A number of Jari motors burned out due to the plugging up from tall grass cutting off the air.

The slides which I have brought with me show many of the problems we have been experiencing and how we are coping with them. These show various turfs, with varying fescue, Kentucky blue, and creeping bent mixtures, straight tall fescue playground areas and possibly a Merion bluegrass-sown football field.

Converting our Memorial Stadium from a dirt field to ASTROTURF was a great accomplishment by our Director of Athletics, Harvey Lanman. It is not difficult to realize the benefits derived by playing football or soccer despite inclement weather conditions. The wear and tear on uniforms is minimized - they formerly would not last out a season on the regular field.

Astroturf, however, does have its limitations and disadvantages in regard to maintenance in the cleaning up of all the debris and paper that seems to drift from the stands during a game. The cleanup operation takes several hours and sometimes the job is barely done before another event is scheduled - sometimes the same day. It would be safe to say that about one-half the time is needed to maintain the Astroturf as was necessary with the former dirt field. The big job of dragging, lining and wetting down before every event has been eliminated.

The lines for football as well as for soccer are painted different colors (white for football and yellow for soccer) thus the lining job is simplified.

Also, in order to use the area for other events other than sports, the surface is protected by laying a plywood flooring over the Astroturf.

Even though the Astroturf is fastened or anchored down like any carpet, it tends to stretch making it necessary to take up the slack each year so far. This also makes the painted lines obsolete, thus necessitating removing the lines and repainting as before.

Promising New Fungicides for Control of Fusarium Patch[1]

Charles J. Gould[2]

Both new and standard fungicides were included in the 1968/69 tests for control of Fusarium Patch (F. nivale), the most important turfgrass disease in the Pacific Northwest. The principle test was conducted on Highland bentgrass at the Western Washington Research and Extension Center, Puyallup, Wash. Applications were started August 30, 1968 and repeated at three week intervals until May 28, 1969 for most compounds. Mertect and Benlate were also used at one rate at 6, 9, and 12 week intervals. All products were applied in 10 gallons of water per 1000 sq. ft. A supplementary test was run at an outlying farm with applications beginning on February 13, 1969 and continuing at three week intervals until May 29. Data were obtained at intervals on number of Fusarium spots, density, color and general quality of turf at both locations.

Fusarium did not become epiphytotic at any time during these trials. It did start to develop a few times but was suppressed by unfavorable weather. The most severe attack occurred between July 2 and 10, 1969, about six weeks after the last application. This late attack yielded information on the residual effectiveness of the fungicides. Although Fusarium did not cause much typical spotting during these trials, it remained sufficiently active to produce thin turf in unprotected and poorly protected plots. Therefore, a rating of general quality was used to supplement counts of the numbers of Fusarium spots for an indication of the relative value of fungicides.

All fungicides tested in 1968/69 gave some control of Fusarium Patch. Fore (8 oz.) produced the darkest and densest turf and gave good control of the fungus as long as it was applied regularly. PMA (3/4 oz.) and Calo-Clor (2 oz.) were effective during most of the year but occasionally failed to control the fungus. The April 15, 1969 application of Calo-Clor burned the grass. Daconil, which was effective in the 1967/68 tests, injured the grass in the 1968/69 trials. This

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[1]Paper presented at the 23rd N. W. Turfgrass Conference, Hayden Lake, Idaho. September 24-26, 1969.

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

injury was pronounced at the 5 oz. rate and noticeable at 3 oz. Two new experimental products, MF-344 (Koban) and Cleary Exp. #81, partially controlled Fusarium.

Three of the most interesting new fungicides tested were the benzimidazoles: Merck's Mertect, DuPont's Benlate and Chemagro's BAY 33172. All of the benzimidazole treatments reduced the incidence of Fusarium Patch. Good control was still evident six weeks after the last (May 28) application of Benlate and Mertect. Benlate at the 2 oz. rate every three weeks produced turf which was as high in quality as that produced by Fore and provided the additional value of longer residual protection. The benzimidazoles are somewhat systemic and this characteristic should aid in the control of Fusarium. These fungicides also control several other turf pathogens.

Corticium Red Thread invaded the plots described above, although not uniformly. Red Thread appeared least in plots treated with: PMA, Calo-Clor, Daconil (5 oz.) and Benlate (2 and 3 oz.).

Ophiobolus Patch began developing in late June and was seen least in those plots treated with PMA, Calo-Clor, Fore, Daconil (5 oz.), Mertect (1.5 oz.), Benlate (1, 2 & 3 oz.) and Cleary Exp. #81.

Algae were controlled by Fore in these plots. This and certain other promising algacidal materials will be discussed by Dr. Goss.

My deep appreciation goes to my fellow cooperators: Dr. Roy L. Goss and Mr. V. L. Miller for their assistance in this research. For financial and other support I am grateful to the Northwest Turfgrass Association, Evergreen Chapter, Golf Course Superintendents Association of America and to the various chemical companies involved.

Turf Costs in Spokane Park System[1]

Charlie Thurman[2]

Probably few people outside of turfgrass managers have any concept of the cost of maintaining grass in any given area be it a home lawn or a golf green. We often hear folks say that they want low maintenance landscaping so they want mostly lawns but perhaps if the facts were known their lawn areas would shrink considerably. In preparing this report, I must admit that my own eyes have been opened even though much of my work is directly concerned with grass in several distinctly separate areas and intensity of uses.

In a City Park Department, such as ours, there are some factors that probably many of you do not have in private courses and other situations from which you may come such as Administration costs, varying pay scales due to longevity of tenure for the same work and the above mentioned wide diversity of turf areas and uses. Then too, diversities of soils, exposures, tree cover, and many other factors inherent in the individual park and its location effect its maintenance cost to a marked degree. We also have the problem of tree and shrub maintenance costs being charged to the park areas on an individual basis which is hard to segregate from the actual turf maintenance costs. It is therefore necessary for me to single out as fairly a representative area as possible to arrive at actual costs for us.

In order to arrive at the following figures, I have chosen Franklin Park on Spokane's North side which is 42 acres in extent all in grass area outside of its Ball Diamonds, and a few shrub beds. The soil is an extremely well drained sand and gravel and could use at least twice the fertilizer it receives even for a park area. The grass is mowed on an average of a 10 to 12 day interval through the mowing season from early April to late October. Our mowers are 7 unit hydraulic Jacobsens of which we have two, one for the North side of town and one for the South side. Each of these mowers has a trailer carrying two Toro 30" park special mowers for

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[1]Paper presented at the 23rd N. W. Turfgrass Conference, Hayden Lake, Idaho. September 24-26, 1969.

[2]Horticulture Supervisor, City of Spokane, Spokane, Washington.

trimming around trees and shrub beds, etc. The large mowers are rented from the Central Motor Pool on an hourly basis and operated by our men. The small mowers are our own equipment and are maintained by our shop and since this shop maintains all of the small equipment for 50 parks, 3 golf courses, The Albi Stadium and the Finch Arboretum it is almost impossible to determine some of these costs and pro-rate them accurately to a given Park area.

The fertilizing of park areas is fairly new to us since two years ago, it is doubtful if many of our parks ever saw more than a few dog and bird droppings in the way of fertilizer. We now apply one annual application of about 50 pounds per acre, of 20-7-14 Fairway Fertilizer, with a Lely broadcaster, about the middle of June when the grass begins to get that badly starved look. This is applied by our tree trimming crew of two men who also do all our spraying, sodding and planting operations in the Parks System. We make one application of herbicides in the fall, with spot applications in spring and summer, of badly infested areas as necessary, using 2,4D and/or Silvex and others as the need requires.

Our parks are maintained by park caretakers who are permanent men in the larger parks and seasonal men in the smaller ones. These men do the watering, hand trimming, and edging, pickup of trash, etc., but we have charged their full time as grass maintenance.

Our water is purchased on a metered basis so here again costs vary considerably, but we have used the figure arrived at for Franklin Park mentioned above as average in all park areas.

In all areas mentioned in this report, it will be necessary to note that Administration costs are listed at $40.00 per acre, since all those listed are only for the work done below the supervision level. This cost is arrived at by dividing the total land acreage under the jurisdiction of the park board into administration costs and would be low for developed areas since this acreage includes several undeveloped areas, as well as several highly developed areas requiring high levels of supervision so an actual cost would be almost impossible to arrive at.

Listed below are two park areas, one which we will call a low maintenance general park area and the other extreme, a high maintenance garden area and their respective turf maintenance costs.

A. General Park area (Franklin Park-42 Acres)	Per acre seasonal cost
1. Park caretaker - watering-trimming-pickup	$155.00
2. Water	52.23
3. Mowing - 10 to 12 day interval	33.57
4. Fertilizing - material @$2.00/acre-equipment @26¢ - labor @$1.37/acre	3.63
5. Weed spraying - Material $1.00/acre equipment 18¢/acre - labor/application 73¢/acre	1.91
6. Administration	40.00
Cost/acre/season	$286.34

B. Garden area (Manito Park-Duncan Gardens)	
1. Watering	184.00
2. Water	52.23
3. Mowing - (once weekly, April-Oct.) (dethatch once)	352.00
4. Edging - (one man 3 1/2 months @$2.00/hr)	300.00
5. Fertilizing	4.25
6. Weed spray	1.91
7. Administration (Gardens foreman added)	60.00
Cost/acre/season	$955.39

The Joe Albi Stadium is our responsibility with an advisory committee from Washington State University supplying cultural recommendations for its turf management. We have 70,000 square feet of turf in the football field and a 60,000 square foot sod nursery for replacement sod. From September through November last fall, 29 games were played on this field. Needless to say, most of the sod required replacement this spring, but with our first year with Cougar bluegrass the areas from the 30 yard line to the goal line did not need to be replaced. All the rest of the field was replaced so we now have Cougar on all of the field except a small area outside the sidelines which is Merion bluegrass. Here again, actual costs of field turf are a problem because three distinct areas are cared for by the same man and we have actual costs of the whole, but segregating the actual field cost is difficult to determine accurately. We have arrived at the following cost per acre as nearly as we can compute time spent in the various phases of maintenance work. (it should be noted that these costs do not include re-sodding which was 3 1/3 cents per square foot.)

Stadium field costs per acre per season.

1.	Park caretaker - watering, trimming & weeding	$435.00/acre
2.	Water	52.23
3.	Fertilization - material-$110.06/ acre, labor $61.00	171.06/acre
4.	Weed spraying	1.91/acre
5.	Mowing - twice weekly	170.52/acre
6.	Verticutting and rolling, etc.	40.00/acre
7.	Administration	40.00/acre
	Cost/acre/season	$978.22

Figuring costs of our Golf Courses is a little simpler since we merely divided the acres of grass area into total costs for the individual course to find the per acre cost but this, of course, does not give us costs of greens, tees, and fairways which I did not try to arrive at but would suppose that these figures would be comparable to those of courses generally which I am sure are readily available elsewhere. The three courses are listed below with their respective per acre costs.

	Total cost for 1968
Esmeralda - 90 acres @$857.48/acre	$79,635.96
Downriver - 85 acres @$862.67/acre	73,358.34
Indian Canyon - 87 acres @$812.35/acre	70,259.50

(These figures include administration costs at $40.00/acre.)

In arriving at these figures it might be noted that labor costs amount to approximately two-thirds of turf maintenance costs on our golf courses and the maintenance and operations expenses account for the remaining one-third with capital outlay running on an average of $6,000.00 per year per course.

In conclusion, we could say then that our general turf costs us about $300.00 an acre per season, gardens, turf, and football fields about equal at about $1,000.00 per acre, and our golf areas about $850.00 per acre for the grass areas.

Golf Course Budgeting[1]

Henry Land, Jr.[2]

Those of us involved in the Golf Course Profession know that a well run course requires careful budgeting. To discuss this budgeting, it will be necessary to bring out two schools of thought; one being the budgeting of present finances, and the other is the financing of an adequate budget.

Budgeting existing finances is an age old problem in golf courses. It involves only the current financial state of the club, with no other revenue available. This becomes a burden to the Superintendent if finances are not adequate for the ever-increasing cost of labor and material.

Financing a sufficient budget is a more feasible way of devising the needed capital for the essential care and upkeep of a golf course that today's golfers demand. Financing such a budget can be accomplished by a dues increase, assessment or other means, without the usual cutback in a once adequate budget.

The specific items allowed for in a maintenance budget will vary greatly from one club to another, thus not allowing for accurate comparisons that are often made by club officials. Some courses will capitalize any item that does not pertain to the upkeep of the course in it's present state (such as recontouring, planting trees, installing drain tile, etc.), whereas other courses will not. Part of the difference lies in the two facts that each course has it's own unique problems that will vary the upkeep cost, and the different accounting systems.

If all golf courses were flatly constructed, well-drained, with an adequate irrigation system, large greens, tees, and the best known turf available, then maybe golf clubs could compare costs; that is if a uniform accounting system between clubs was adopted.

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[1]Paper presented at the 23rd N. W. Turfgrass Conference, Hayden Lake, Idaho. September 24-26, 1969

[2]Superintendent, Sand Point Golf and Country Club, Seattle, Washington

At Sand Point Country Club, the cost of general upkeep has doubled over the past 15 years. This increase is probably exemplary of most courses in the Northwest. In our case, the increase was caused by a greater demand for better playing conditions. To meet this demand, we are presently moving fairways, greens, tees, banks, and completely raking sand traps six times per week. Accomplishing this takes a large crew and a considerable amount of equipment, along with a maintenance budget of some $92,000. not including capital items or equipment replacement.

The labor factor is becoming more of a problem in our area every year. When a man of average intelligence can earn between $4.00 to $6.00 per hour in other skilled jobs, we have little hope of attaining such skilled help at our present wage scale and limited budget.

In other trades, unions have a training program, which includes night school two nights a week for four years, while working as an apprentice. Because of this type of program, employers in other fields can hire trained journeymen.

Possibly the Golf Course Superintendent's Association could form a special committee to re-evaluate these problems, including a better bargaining position for their employees. Then, and only then, can we hope to keep up with today's rapid growth and advancements in other industries.

Facts About Automation in Irrigation[1]

Bjorn N. deBough[2]

The history of irrigation had many superstitions and oddities, so even to get involved in it's past would create a confusion with no end. Even today, some concepts do carry their oddities, and to a certain extent still have the fragrance of the rainmakers and raindancers of long time past.

As time goes by and the population increases, and the area for agricultural development becomes smaller and smaller, a perfect understanding of irrigation will be developed as a necessity. As these agricultural areas may be difficult to maintain due to their location and construction, automation has to be their answer. Strangely enough, automation has been very successful in all our industries from bean-picking to newsprinting, and from fish-packing to computers. However, in the field of irrigation I repeatedly have heard from people who are directly involved in the maintenance and operation of automatic irrigation systems, that they would have preferred to have a manual system, because of the amount of trouble arising in the automatic sprinkling systems.

I think it should be obvious that there must be some discrepancies in the concept or it's application. Today we can place man on the moon, send space-probes around Mars and other planets, and take pictures from there and send them back home to earth, and all of this due to automation and electronic control systems. It must then be obvious that there is something basically wrong with the concept of automatic irrigation.

The answer is fairly simple. Here in the United States we have a multitude of foundries and companies making sprinklers and valves for the irrigation industry, and most of their products are of a very high quality. Manual systems using these components have been known to have been working reliably for over twenty years. However, when the automation in irrigation became a demand, all these various companies started to solve these requirements on their own, thereby creating a

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[1]Paper presented at the 23rd N. W. Turfgrass Conference, Hayden Lake, Idaho. September 24-26, 1969.

[2]Electronic Engineer, Sound Engineering and Equipment Co., Seattle, Washington

variety of ways and methods for application of water to the soil by some mechanical means.

As the research and the development had to be paid for, and the equipment developed became more and more sophisticated, the expense placed the automatic equipment out of reach for the broad market. The reason for this is without doubt, that the people involved in the manufacture of sprinklers and valves, also became involved in the manufacturing of automatic controls, and their object was to be able to produce some sort of device that could be sold for an acceptable price. Quality and reliability became a secondary factor, and as long as each of these companies had a different answer to the problem, each company could only manufacture and sell a limited number of controls.

Production of electronic control equipment can become very reasonable when you are talking of quantity and mass-production, and the answer would naturally be to have some electronic company develop and supply a controller for all the sprinkling industry. This immediately would create competition, and after quality and reliability has been established, the competition would be in production techniques, thereby to lower the prices of the equipment, and yet keeping the reliability. As an example, you can take the radios and T. V's today, the methods of mass-production is the factor in price.

Enough on the control. The second problem in automation is in the installation of a system. The labor required can be unskilled when it comes to digging the trenches, but when it comes to the actual pipe-laying and valve-installation and the installation of swing-joints etc., a rigid requirement has to be enforced. People involved in an installation should study the materials in advance, and be instructed as to how to apply joint-cement, cleaning and roughing of pipe before the application, and how to put swing-joints together, and should always know the "reason why". Equally important is the installation of the valves. The wiring from the valve to the controller is also of great importance. To achieve high reliability, no splices should be permitted.

Naturally, without even mentioning it, the most important issue is the design of the system, and the selection of materials. The most important thing in a design is the knowledge of the seasonal water-pressure, and the reliability of the selected materials. It has happened too often, that a design has been made during the winter months and the water-pressure at that time showed 80 lbs. of pressure, when after installation, in the summer, it was established a pressure of only 40 lbs. So in conclusion I can only state that the initial expense of an irrigation system should be a little higher than expected, deduct from the difference a five year maintenance cost and you will be ahead, because automation in irrigation can be very successful as long as the requirements for success have been followed.

Turfgrasses for the North[1]

J. Drew Smith[2]

Summary

In regions with long, cold, snowy winters much damage to turfgrasses is caused by those fungal pathogens which are particularly active under a snow cover. When the snow insulation is absent cold injuries are prevalent; these may be aggravated by antecedent fungal damage. Cold injuries may also condition turfgrasses for fungal attack. However, it is probably more important in many areas to select for resistance to disease than to cold injuries. In the prairies some native and introduced forage grasses show considerable resistance to the low-temperature basidiomycete which is the principal snow mold pathogen, but these do not seem suitable for fine turf. Resistance to other pschycrophilic pathogens is considered.

The only grasses which are of much use in fine turf of golf greens where the low-temperature basidiomycete is prevalent are *Poa annua*, which establishes itself from seed every year and a locally selected strain of *Agrostis*. For the domestic lawns and turf of intermediate mowing height local ecotypes of *Poa pratensis* with disease resistance or high disease recovery vigor are sought for regional use. These are being screened for resistance to seed crop diseases and other agronomic defects before being retested in mown turf for resistance to the low-temperature basidiomycete. A world collection of *Poa* species is also being screened in the row for seed crop diseases before testing in turf. It is hoped to examine the resistance towards the snow mold pathogens of selected *Festuca* and *Agrostis* spp. and some of our finer native grasses.

Where the winters are long, cold and snowy, turfgrasses may be protected by snow from cold damage but this cover may

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[1]Paper presented at the 23rd N. W. Turfgrass Conference, Hayden Lake, Idaho. September 24-26, 1969.

[2]Plant Pathologist, Grasses, Research Station, Research Branch, Canada Agriculture, University Campus, Saskatoon, Saskatchewan.

also provide the conditions under which snow mold damage can occur. These have been dealt with in another paper at this conference. Winter is a very difficult time for turfgrasses because, after having suffered all sorts of abuse from humans in the growing season, they are exposed to many severe winter conditions. Death at this time of the year, or "winter killing", usually results from the combined effects of many factors. Cold injury can be the immediate cause of death and a frequent pre-condition for the subsequent lethal effect of other factors. The nature of freezing injuries on plants will not be discussed here but some of its effects will be considered.

Since cold injuries in winter occur when there is an absence or shortage of snow cover, they may be of considerable importance in Chinook areas, e. g. near the Rocky Mountains where the plants may be deprived of their protective snow blanket for a time when it melts. Cold injuries may then result to uncovered turf when normal cold winter weather resumes. Damage may be increased by antecedent fungal infection. In mild winters considerable damage can result from suffocating injuries, mostly to root systems, such as may occur in late fall or early spring if the soil is water-logged and then becomes snow covered. This is accentuated by poor drainage or soil acidity (possibly alkalinity too). Again fungal infection predisposes the plants to damage. Another type of suffocation which is referred to as ice suffocation occurs when soil moisture reserves are high in fall. Alternate freezing and thawing covers the ground with a continuous ice sheet. Damage results from a combination of freezing and suffocation. Another type of injury, frost heaving, results from repeated freezing and thawing and is particularly severe on seedling turf on moisture-retentive soils. Freezing and thawing tears off the fine roots of the seedlings. When temperatures reach the freezing point plants find it difficult to absorb water. If the soil water is frozen absorption may cease. If at the same time plants are exposed to a dry sub-zero wind and bright sun they become dehydrated with gradual lethal effect. This is referred to as winter drought damage. It shows as yellowish-brown grass - very much the same as in summer after a drought period. Probably killing of that ubiquitous annual grass Poa annua in our golf greens is caused by frost and subsequent winter drought. Frost injury and drought early in a sunny spring may also cause considerable turf damage.

As if it wasn't enough that turfgrasses had to hang on to life in a dormant state during a long, cold, snowy winter, and resist fungal attack, in much of the interior of the continent in the growing season they do not receive enough moisture in the form of snow and rain to permit the sort of vigorous growth required to make up for wear and tear on turf playing surfaces. So, if turf is to be maintained without artificial watering, the grasses composing it must have good drought resistance. Fortunately there seems to be a broad relationship in the grasses between cold resistance and resistance to drought. In any case, it is often possible to relieve the drought by artificial watering on the finer turf areas. (In fact one of the main differences noticed when comparing park areas and domestic lawns in a city in Britain or New Zealand and in the Prairies is the amount of wealth and time expended in watering the grass in the Prairie region.)

The basic species of grasses used in irrigated domestic lawns in the Prairies are bluegrass (Poa pratensis L.) and red fescue (Festuca rubra L. subsp. rubra). Sometimes some redtop (Agrostis álba L.) is included. Probably these components were arrived at by a process of trial and error. However, if you examine turf originally sown with a mixture of these three species after several years of snow mold injury you will not find much red fescue. The redtop goes out in the first year or two; it merely acts as a filler while the other two species establish. Dr. M. W. Cormack at the C.D.A. Lethbridge Research Station (1) compared the field resistance to the low-temperature basidiomycete of these three species, among others, over a 4-year period Kentucky bluegrass was moderately resistant and creeping red fescue moderately susceptible. Crested wheatgrass used extensively for dryland turf was very resistant. Cormack also made further tests on winter crown rot resistance of native and introduced grasses. Four Bromus spp., eight Agropyron spp. and four Elymus spp. were resistant but only two of these, crested wheatgrass and streambank wheatgrass are used to any extent as turfgrasses and then only in coarser turf. Of four bluegrass species tested, Poa pratensis L. was considerably more resistant than P. ampla Merr., P. bulbosa L. and P. trivialis L. Of the fescues, meadow fescue was most resistant; red fescue, Chewings' fescue and sheep's fescue were susceptible. In the turfgrass regions where the low-temperature basidiomycete is king only the fairly resistant Poa pratensis is left for general use. This species can be mown moderately short for domestic lawns and parks but will not suffer repeated short mowing. Under such conditions it is gradually replaced by P. annua. Other than Poa pratensis we have Northland bent which according to Lebeau (2) is resistant to the low-temperature basidiomycete.

In places where *Typhula* spp. are the prevalent winter pathogens there is a much wider selection of possible fine turf species and varieties. Wernham (3) in Pennsylvania found three strains of Washington creeping bent (*Agrostis palustris*). Boyce (4) at the Central Expt. Farm, of the Canada Department of Agriculture at Ottawa found that in general, Colonial bents (*Agrostis tenuis*) and velvet bents (*A. canina*) were more resistant to snow mold (*Typhula* and *F. nivale* probably) than the creeping bents (*A. stolonifera*). More recently Streu (5) in N. J. has found several resistant strains in *A. palustris*. There is little information on the resistance of *Poa pratensis*, *F. rubra*, *F. ovina* or *F. duriuscula* varieties to *Typhula*.

Smith and Jackson (6) found *Poa annua*, *Agrostis tenuis* and *A. stolonifera* varieties generally, and *Festuca rubra* subsp. *rubra* all susceptible to *F. nivale*; *Lolium perenne* was resistant, but resistance could break down under a prolonged snow cover. Couch (7) found Penncross creeping bent (*A. palustris*) highly resistant to *F. Nivale*. Dahl (8) found Washington and Metropolitan strains of creeping bent resistant. Howard, Rowell and Keil (9) reported *A. tenuis* and the *A. palustris* varieties Washington and Metropolitan to be more resistant than others. Both Tyson (10) and Jackson (11) found good resistance in some *A. tenuis* strains toward *F. nivale*. In Finland Jamalainen (12) found *A. canina* and *A. stolonifera* resistant to *Sclerotinia borealis* and the Finnish strain of *F. rubra* only slightly infected with this pathogen (13). He found N. American *F. rubra* severely attacked.

Breeding turfgrasses for the prairies

Ekstrand (14) suggested that for regions with severe winter climates the primary concern in plant breeding in the Gramineae should be towards developing resistance to the various winter fungi. Resistance to cold, drought, water-logging and high humidity should also be given high priority. He also considered it necessary that the breeding or selection should take place in the region where the crop was to be used. Now this latter point has been so very well pursued by breeders of fruit trees, lillies, and cereals that they have developed varieties for main regions and even for sub-regions with slightly different climates. In the turf world, breeders have not been so particular in tailoring varieties to fit local conditions - especially to local diseases. Take Merion bluegrass as an example. This was selected and developed in Pennsylvania. In the east it can make a turf of high quality. If you pour on the nitrogen and the water it produces a deep thick carpet of grass fairly resistant to Helminthosporium leaf spot. Seed of this variety is produced extensively in Europe. In Britain, Merion turf usually does well for a few years and then problems develop due to the foot rot phase of infection with Helminthosporium vagans. You should see it after it has been hit by snow mold in Brandon, Manitoba, Swift Current, Saskatoon and Prince Albert, Saskatchewan.

At Saskatoon, we started three years ago to select new Poa pratensis varieties specifically for the region. Emphasis was placed on selecting for resistance to or rapidity of recovery from disease caused by the low-temperature basidiomycete. We have collected plants of ecotypes from many points in Saskatchewan surviving in infected patches or recovering from snow mold infection on lawns. We hope that we have picked up resistant or at least highly vigorous material. Some promise of success appears from row studies. About 90% of the clones collected have been rejected in the rows for susceptibility to powdery mildew, rust, insect damage or poor agronomic features. It is not of much practical use to have a good turfgrass if seed is uneconomic to produce. The remaining lines will be increased for replicated turf tests in which they will be inoculated with the pathogen. We are also approaching the problem from another direction. A world collection of Poa pratensis and Poa species is being screened in the row for resistance to seed crop diseases. Subsequently we will look at their performance in turf. In addition similar programs have been started with Festuca and Agrostis spp. and with some of our finer native grasses.

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Effects of Three Nitrogen Sources and Three pH Modifiers on Turf Quality[1]

Wilbur L. Bluhm and Norman R. Goetze[2]

Earlier English and recent Washington State University research reported significant reductions of Ophiobolus graminis in turf by lowering soil pH. Some reports have indicated that Ophiobolus organism directly metabolizes urea.

OPHIOBOLUS PATCH is a turf disease of concern in Western Oregon as well as Western Washington and England. To learn more about the control of the disease, plots were established to (1) test the preceding research results under Western Oregon conditions, and (2) demonstrate control methods for the benefit of turf managers.

Very little Ophiobolus infection appeared during the life of the plots; however, interesting effects of different nitrogen sources were observed and recorded. This report is essentially limited to a discussion of the effects of three nitrogen sources on turf quality. Two lime sources and aluminum sulfate were used to modify soil pH, and their effects are also presented here.

Procedure

Two main plots of lime and four sub-plots of nitrogen carriers, with six replications, were established in April 1967 on an established golf course tee of Highland bentgrass in a silt loam soil. Two sub-plots of aluminum sulfate, each replicated twice, were included in the plot layout.

Main plots of pH modifiers were applied on April 28,

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[2]County Extension Agent and Farm Crops Specialist, respectively, Oregon State University.

This work was conducted at Illahe Hills Country Club, Salem, Oregon. The assistance of Andrew W. Hoiland, Greens Superintendent, is gratefully ackowledged. The authors are also indebted to E. Hugh Gardner, Soils Specialist, Oregon State University, for his assistance in establishing plot plan and analysis of results.

1967. Treatments included calcium carbonate ground limestone (90 percent $CaCO_3$ equivalant) at 162 pounds per 1,000 square feet (7050 pounds per acre), dolomite limestone (104 percent $CaCO_3$ equivalent) at the same rate as calcium carbonate, aluminum sulfate at 100 pounds per 1,000 square feet, and a check.

Sub plots of nitrogen fertilizers at equal rates of nitrogen were applied to each of the main plots of pH modifier. Urea, ammonium sulfate, and ferrous ammonium sulfate were compared at a uniform 1 pound of nitrogen per 1,000 square feet rate. Dates of application were April 28, June 19, July 31, September 5 and October 11, 1967, and April 10, May 15, July 1, August 28 and October 16, 1968. Five pounds of nitrogen per 1,000 square feet were applied annually through these applications. No phosphorus or potassium was applied during the two year period.

Results and Discussion

Noticeable differences, related to different nitrogen carriers, appeared in grass performance during the 2 years of treatment. After fertilization, ammonium sulfate plots possessed uniformity of color and growth quality, superior to urea plots as a whole, and possibly superior to ferrous ammonium sulfate plots. The latter were of lower quality because of "burn" injury resulting from hydrophylic nature of the ferrous ammonium sulfate. Color of ferrous ammonium sulfate plots after fertilization was a very deep green, and tended to carry through from one application to the next. Except for the burn injury, ferrous ammonium sulfate produced the best quality turf. Urea plots were of lowest quality.

Turf quality of plots, just prior to each fertilizer application, was in the order of the following treatments: ferrous ammonium sulfate, ammonium sulfate, and urea. Ferrous ammonium sulfate treated plots did, after the time lapse between applications, recover from injury sufficiently that grass texture, color, and density were excellent. Ammonium sulfate treated plots were still of high quality, but had lost relatively more color and were of lower overall quality than ferrous ammonium sulfate plots.

Thickness of thatch layer varied consistently with nitrogen source. Thatch layer thickness, after two growing seasons averaged as follows (measured in inches):

	Nitrogen Carrier			
pH Modifier	Urea	Ammonium Sulfate	Ferrous Ammonium Sulfate	pH Modifier Average
Check	0.83	1.00	1.33	1.06
Aluminum Sulfate	1.08	1.42	1.50	1.33
Dolomite Lime	0.98	0.98	1.30	1.08
Nitrogen Average	0.97	1.10	1.36	

Ten months after the last fertilizer treatments, the thatch layer thickness measured as follows (in inches):

	Nitrogen Carrier			
pH Modifier	Urea	Ammonium Sulfate	Ferrous Ammonium Sulfate	pH Modifier Average
Check	1.08	1.16	1.39	1.21
Aluminum Sulfate	1.17	1.33	1.70	1.41
Dolomite Lime	1.06	0.91	1.08	0.99
Calcite Lime	0.93	0.85	1.03	0.94
Nitrogen Average	1.03	1.13	1.38	

Ferrous ammonium sulfate generally produced heaviest thatch layer, followed by ammonium sulfate, and urea having the least. Aluminum sulfate treatment resulted in heavier thatch layers. Lime seemingly had little effect on thickness of thatch layer until during third season after application.

Turf density, measured by visual observation, was greatest with ferrous ammonium sulfate treated plots, followed by ammonium sulfate and then urea treatments. Greater density tended to result in a finer texture, and simultaneously in greater uniformity of overall appearance.

Poa annua population, at end of two-year period, was dramatically related to nitrogen source. Urea plots had a considerably higher annual bluegrass population than other treatments. Ammonium sulfate applications resulted in considerably lower amounts of *Poa annua*. Ferrous ammonium sulfate plots, except where divots were removed, had low annual bluegrass populations, and were remarkably free of it where traffic was low. Ferrous ammonium sulfate treated plots were essentially free of annual bluegrass where aluminum sulfate treatments were made.

Ferrous ammonium sulfate fertilization had another advantage when related to the *Poa annua* problem. The small amounts of *Poa annua* were less noticeable because of the color masking effects of ferrous ammonium sulfate.

Aluminum sulfate treatments also tended to hide color of *Poa annua*, especially in ferrous ammonium sulfate and ammonium sulfate treated plots. In combination with urea, aluminum sulfate aggravated a yellow spotting condition, perhaps resulting from *Fusarium nivale* infection. Urea treatments, regardless of pH modifier, generally promoted this yellowing.

Nitrogen sources affected all aspects of turf quality (color, density, uniformity, texture, disease incidence, *Poa annua* population, color of *Poa annua* and thatch accumulation).

The effect of nitrogen carriers and pH modifiers on soil and thatch fertility values was determined by routine soil analysis. Results are summarized in the following tables:

EFFECTS OF NITROGEN CARRIERS AND pH MODIFIERS ON pH

Nitrogen Carrier	Check	Aluminum Sulfate 10 lbs/100	Dolomite Lime 162 lbs/1000	$CaCo_3$ Lime 162 lbs/1000	Nitrogen Carrier Average
Ammonium Sulfate					
Thatch Layer	5.3	5.0	5.6	6.4	5.6
Soil Layer	5.9	5.6	5.9	6.4	5.8
Urea					
Thatch Layer	6.0	5.5	6.2	6.7	6.1
Soil Layer	6.1	5.7	6.0	6.7	6.1
Ferrous Ammonium Sulfate					
Thatch Layer	4.7	4.4	5.3	6.4	5.2
Soil Layer	5.5	5.1	5.8	6.4	5.7
Modifier Average					
Thatch	5.4	5.1	5.8	6.5	
Soil	5.8	5.5	5.9	6.5	

Original Soil Test 5.9

EFFECTS OF NITROGEN CARRIERS AND pH MODIFIERS ON PHOSPHORUS (ppm)

Nitrogen Carrier	Check	Aluminum Sulfate 10 lbs/100	Dolomite Lime 162 lbs/1000	$CaCo_3$ Lime 162 lbs/1000	Nitrogen Carrier Average
Ammonium Sulfate					
Thatch Layer	46	40	60	84	58
Soil Layer	28	22	20	21	23
Urea					
Thatch Layer	49	44	72	78	61
Soil Layer	24	22	24	19	22
Ferrous Ammonium Sulfate					
Thatch Layer	24	27	30	58	35
Soil Layer	19	19	23	24	21
Modifier Average					
Thatch	41	38	59	84	
Soil	23	21	23	21	
Original Soil Test	25				

EFFECTS OF NITROGEN CARRIERS AND pH MODIFIERS ON POTASSIUM (me/100g)

Nitrogen Carrier	Check	Aluminum Sulfate 10 lbs/100	Dolomite Lime 162 lbs/1000	$CaCo_3$ Lime 162 lbs/1000	Nitrogen Carrier Average
Ammonium Sulfate					
Thatch Layer	0.89	0.78	0.63	0.94	.81
Soil Layer	0.16	0.16	0.20	0.16	.17
Urea					
Thatch Layer	0.87	0.80	0.94	0.61	.81
Soil Layer	0.17	0.18	0.18	0.12	.16
Ferrous Ammonium Sulfate					
Thatch Layer	0.69	0.71	1.06	0.71	.79
Soil Layer	0.15	0.17	0.18	0.18	.17
Modifier Average					
Thatch	.82	.79	.85	.82	
Soil	.16	.17	.19	.15	
Original Soil Test	0.28				

EFFECTS OF NITROGEN CARRIERS AND pH MODIFIERS ON CALCIUM (me/100g)

Nitrogen Carrier	Check	Aluminum Sulfate 10 lbs/100	Dolomite Lime 162 lbs/1000	$CaCo_3$ Lime 162 lbs/1000	Nitrogen Carrier Average
Ammonium Sulfate					
Thatch Layer	14.2	10.4	13.3	36.0	13.5
Soil Layer	12.2	13.3	14.0	14.0	13.4
Urea					
Thatch Layer	17.0	11.8	19.6	22.4	15.2
Soil Layer	11.6	13.7	15.6	13.0	13.5
Ferrous Ammomium Sulfate					
Thatch Layer	10.1	6.4	16.9	39.2	13.2
Soil Layer	11.3	10.2	13.0	16.2	12.7
Modifier Average					
Thatch	14.0	10.2	16.4	34.0	
Soil	12.1	12.5	13.9	13.7	
Original Soil Test	12.4				

EFFECTS OF NITROGEN CARRIERS AND pH MODIFIERS ON MAGNESIUM (me/100g)

Nitrogen Carrier	Check	Aluminum Sulfate 10 lbs/100	Dolomite Lime 162 lbs/1000	$CaCO_3$ Lime 162 lbs/1000	Nitrogen Carrier Average
Ammonium Sulfate					
Thatch Layer	8.2	5.7	6.4	3.6	6.0
Soil Layer	5.5	5.9	6.4	4.3	5.5
Urea					
Thatch Layer	8.4	6.4	8.8	3.2	6.7
Soil Layer	4.9	6.0	7.5	3.6	5.5
Ferrous Ammonium Sulfate					
Thatch Layer	5.1	3.3	9.2	3.0	5.2
Soil Layer	5.1	4.7	5.6	4.3	4.9
Modifier Average					
Thatch	7.3	5.5	7.9	3.5	
Soil	5.3	5.6	6.4	4.0	

Original Soil Test 5.0

These results tend to support the following observations:

1. Thatch layers consistently contained higher phosphorous and potassium levels than the underlying surface soil because of accumulation of fertilizers there.

2. Thatch had higher magnesium level than soil when urea was nitrogen source, except where the application of calcium carbonate lime depressed the magnesium level.

3. Aluminum sulfate applications lowered pH in both thatch and underlying soil, but did not lower it as much as anticipated. It reduced thatch pH below 5.0 only where either ammonium sulfate or ferrous ammonium sulfate contributed to acid accumulation.

4. Calcium carbonate lime application, appreciably increased soil and thatch pH. The less soluble dolomite lime required more time to influence soil pH than calcium carbonate lime, and did not appreciably affect soil pH within two years of application.

5. Raising low pH values through application of calcium carbonate lime increased phosphorus availability in the thatch layer within two years of application, but not in the soil layer. The lime apparently did not move through the tatch. Dolomite applications gave generally same results, but increase in phosphorus availability was less than with calcium carbonate lime because of lower solubility of dolomite.

6. Soil and thatch potassium levels did not seem to be affected by different sources or by amendments to alter pH. Potassium level of soil was consistently below the original soil test reflecting a net consumptive turf usage.

7. Calcium carbonate lime nearly tripled thatch calcium level, whereas dolomite increased it only slightly. Both lime sources increased soil calcium levels slightly and about equally. Thatch intercepted and held applications.

8. Dolomite lime application tended to raise thatch magnesium level and consistently increased soil magnesium levels.

9. The acid forming fertilizers, ammonium sulfate and ferrous ammonium sulfate, through their lowering of soil and/or thatch pH decreased calcium and phosphorus levels. Urea fertilized plots had higher levels of calcium, phosphorus, and magnesium in both soil and thatch than ammonium sulfate and ferrous ammonium sulfate plots.

10. Ferrous ammonium sulfate plots averaged lowest in calcium phosphorus, and magnesium in both thatch and soil. Ferrous ammonium sulfate plots were consistently lowest in that pH and soil pH. The iron of ferrous ammonium sulfate apparently became tied up in thatch layer, forming insoluble iron phosphates, and resulting in consistently lower thatch phosphorus levels than with other forms of nitrogen. The slightly lower soil phosphorus values in ferrous ammonium sulfate plots are probably related to correspondingly lower soil pH values. Increases in soil phosphorus where lime was used was likewise due to higher pH values which increased phosphorus solubility.

11. Different nitrogen sources vary in ability to acidify thatch and soil. Ferrous ammonium sulfate consistently resulted in lower thatch pH and soil pH, unless lime was added. Ammonium sulfate plots generally were lower in pH than the urea treated plots at the end of two years.

12. Soil pH, after two years of treatments, was as low or lower than the original soil test indicated, except where calcium carbonate lime was applied.

13. Soil phosphorus levels tended to be only slightly lower after two years. This is logical since (a) no phosphorus fertilizer was applied during this time, (b) turf grass is not a heavy phosphorus user, and (c) some soil phosphorus may have been released during this time.

14. Soil potassium levels ranged from 43 to 71 percent of their values two years earlier. This is also logical since (a) no potassium fertilizer was used during this time and (b) turf grass is a relatively heavy user of potassium, using it at luxury rates when possible.

SUMMARY

Nitrogen sources and pH modifiers influenced bentgrass turf quality under Western Oregon conditions. Ferrous ammonium sulfate produced better quality turf than ammonium sulfate or urea, but its formulation caused some turf injury. Even though pH modifiers influenced many soil fertility characteristics, no consistent effects on turf quality were obtained. Thatch accumulation was accelerated in direct proportion to the pH lowering ability of nitrogen source and pH modifier.

Contract Maintenance Discussion for Northwest Turfgrass Association 1969 Conference[1]

George Harrison[2]

Contract maintenance of grounds has increased rapidly over the last ten years. Larger groups of units in apartment housing, small golf courses, business buildings and commercial installations of all kinds are finding it necessary to have regular skilled help to accomplish upkeep of grounds.

Malmo Landscapers Northwest employs up to 35 people for contract maintenance jobs. Herewith is a breakdown of costs involved in contract maintenance. There are many problems concerning items covered in these costs.

BREAKDOWN OF COSTS FOR A TYPICAL CONTRACT MAINTENANCE OPERATION:

Sales	100%	$100,000.
Costs direct		
Labor	50%	
Material	9%	
Equipment	7%	
Costs, indirect		
Supervision	3%	
Payroll, Taxes, Ins.		
Advertising & supplies	12%	
Administrative		
Utilities	2%	
Taxes	1%	
Office & shop supplies	5%	
Miscellaneous	2%	
Profit	9%	
	100%	
Investment		$50,000.

The first category labeled "Direct expense" covers labor, equipment, material and subcontract

[1]Paper presented at the 23rd N. W. Turfgrass Conference, Hayden Lake, Idaho. September 24-26, 1969.

[2]Manager, Malmo Landscapers Northwest, Inc.

cost. As you can see, the labor item is by far the greatest. The percentage, roughly 50% of the total sale seems to hold fairly constant. Probably the largest problem involved with labor is the fact that we have a seasonal business. It is mandatory that skilled foremen be carried through the winter season and that the new personnel hired in the spring be supplied with adequate training.

For our operation we have found that the military bases near our location provide us with a great many people who are eager for part-time or short-term work. This is an advantage that many other firms do not enjoy.

We have also found that within two weeks of hiring it is necessary to screen out nearly one half of those we hire due to inability of these people to give a fair day's work for a fair day's pay. Our supervisors endeavor to pick out persons with a fairly good probability of being able to make the grade. They must lay out their work in such a manner that people with short-term training can understand the task and adequately accomplish it.

Minimum labor rates on government contract jobs are now $2.55 per hour. Our regular full-time people are on a minimum of $3.00 per hour for labor. We have found that using one leadman and one new trainee has worked out to be a fairly good procedure. Our foremen take pride in their work and seem to have little or no difficulty in training the newly hired additions.

The jobs that we subcontract are street sweeping and spraying when our own rather minimal spray crew becomes overloaded.

The materials involved are the spray items and fertilizers and make up a fairly small percentage of the total direct cost.

Maintenance equipment is the bane of our existence. We do not find mowing equipment made substantial enough to take the beating that our rather inadequately trained crews can give. We find that our full-time mechanics are swamped almost all summer long. We feel that the sales personnel of the maintenance equipment manufacturers either are not able to or are not willing to help sufficiently with our training. As a result the casualty rates for equipment is much too high in most cases.

INDIRECT EXPENSES

This second category of expenses are those which do not depend entirely on the volume of business that we do. This includes the salaries of the department supervisors, advertising, office expenses, and the rather large item of payroll taxes and insurance. Of these the only item worthy of discussion at this point is insurance. We find that a policy with a $250 deductible feature is necessary in order to keep this cost under control. Liability risk is rather high in that we are dealing with rather dangerous chemicals and driving a great many vehicles. Many of our contracts specify the amount of coverage necessary.

Mechanization of every job possible is most important. On each of the large maintenance jobs such as Ft. Lewis or Madigan, we provide a pick-up truck, a Cushman truckster and the necessary mowing and watering equipment. We own a John Bean self-propelled sprayer which is rotated from job to job as needed.

For estate or commercial building maintenance we use a pick-up truck with mowing and clean-up equipment aboard and have a spray truck which does home-owner spraying as well as covering our contract maintenance accounts. Each truck carries a 21" reel mower, edger, rotary mower and hand tools.

This discussion will be concluded with a few slides showing some of the equipment that we have and the conditions under which it is operated. I will be open to any questions from the group upon conclusion.

Effects of Cultural Practices in Relation To Microclimate and Thatch[1]

J. R. Watson[2]

Turfgrass is judged by the standards established for its beauty, its use or playability and by its density, its freedom from pests and its uniformity of growth and color. A given turfgrass area is the product of the climate, the grass, the soil and the cultural practices required to maintain it in a manner suitable to the use for which it is grown. All of these factors, plus more, interact to produce the total environment of the grass plant. The microclimate of this environment is dynamic and ever-changing. All climatic factors -- temperature, light, water, wind movement and humidity -- exert direct and interacting effects upon the growth response of the turfgrass. For this reason, it is difficult to separate the individual response produced by any one factor. However, there may be an opportunity to alter the microclimate through the application of properly timed cultural practices. And, by so doing have important effects on thatch development and control.

CLIMATE

Climate, especially temperature, is the basic factor that determines the broad adaptation of turfgrasses. Growth response to temperature is generally used to classify the turfgrasses as either "cool" or "warm" season. And, when either group is grown under marginal conditions, soil environment and cultural practices become more critical for satisfactory turf growth. Both soil and cultural practices may be modified or adjusted to compensate partially for marginal adaptation and growth, of a turfgrass. However, neither will alter the broad impact of climate. Thus, cool season grass growth will slow down and frequently cease when soil temperatures approach 90° F.

Brown, at Missouri, reports that Kentucky bluegrass makes little top growth until the average soil temperature at one-half inch depth rises above 50° F. According to

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[1]Paper presented at the 23rd N. W. Turfgrass Conference, Hayden Lake, Idaho. September 24-26, 1969.

[2]Director of Marketing - Turf Products - Toro Manufacturing Corporation, Minneapolis, Minnesota.

Beard, (Michigan State) the optimum temperature for shoot growth of Poa annua is 60° to 70° F. and the optimum for root growth is 55° to 65° F. In his opinion, it is more important to maintain an optimum temperature for root growth than for shoot growth. Youngner, (UCLA, Riverside), indicates that a high temperature for only a few days may seriously deplete carbohydrate reserves and that young Kentucky bluegrass plants are unable to store reserve carbohydrates and may even lose those which may have been stored earlier at a cooler temperature. LeBeau, at Lethbridge, Alberta, has shown that careful control of soil temperature near the surface is effective in reducing snow mold (Fusarium nivale) damage. Plots maintained at temperatures a few degrees above freezing were severely infected, whereas the unheated plots and plots with controlled minimum temperatures slightly below freezing were damaged by an unidentified low temperature basidiomycete. No snow mold was found in plots with minimum controlled temperature of 32°F. Beard has shown that Toronto exhibits a high degree and Poa annua a low degree of tolerance to ice cover. Watson, (Minneapolis), has shown the effect of various covers on soil temperature at 2, 4 and 6-inch depths and has discussed their effect on growth and survival of putting green turf. Insulation to prevent wide temperature fluctuations and the retention of moisture are the chief advantages listed.

It would seem then that any cultural practice which could affect only a slight change in the microclimate of a turfgrass area could produce a significant and perhaps vital growth response. The effects perhaps may be temporary and could not be expected to alter the broad impact of climate. Nevertheless, they could mean the difference between acceptable and unacceptable turf. Certainly they will contribute to thatch accumulation if they cause death or excessive sloughing of plant parts.

SOIL

The soil environment is particularly critical on intensively used turfgrass areas such as golf greens and athletic fields. In addition to its normal role in plant growth, the soil under such areas must provide stability and support for players. And, because of the excessive traffic under such conditions, it is highly subject to compaction. Modification or adjustment, particularly of textural porosity, will do much to assure a more suitable environment and more favorable response to cultural practices under such conditions. Ferguson, (Texas A & M), and others have shown the importance of developing and maintaining textural porosity under putting green conditions. The technique described by Ferguson and associates for construction of a putting green employs the principle of a perched water table to counteract the low waterholding capacity of the sandy soil.

The trend toward use of marginal land and fill areas for home building and for recreational purposes plays an increasing and a significant role in the determination of the intensity of the application of cultural practices and in the resulting microclimate of the turf cover. Such is especially true with regard to the drainage characteristics of these marginal areas.

CULTURAL PRACTICES

Cultural practices that influence microclimate of turfgrass and that have important effects -- some good and some bad -- on thatch may be arbitrarily grouped into two categories: (1) those deemed essential for development of a turf that will meet established quality and use criteria, and (2) those deemed of value in combating adversity or stress resulting from climate and use. The first group would include mowing, watering, fertilizing, cultivating and programs to control disease, insects and weeds. The second grouping would include such practices as topdressing, improvement of water and air drainage, mulches, covers and soil heating.

Essential cultural practices -- these techniques are concerned basically with the development, growth and maintenance of a green, dense and pest-free turf. They are the basic cultural techniques required for all types of turf in all locations. The intensity or degree of their application will vary in accordance with the use and quality level expected of the turf site or facility. For example, a successively less intensive cultural program is required for a putting green clipped at 3/16 of an inch, a fairway clipped at 3/4 of an inch, a home lawn clipped at 2 inches, a rough at 3 inches, an airport or highway right-of-way at 4 inches; or, for that matter, a heavily grazed, cultivated pasture which may require mowing only infrequently to assure uniformity of growth.

These basic cultural practices have both direct and interacting effects on the grass plant and the microclimate as well as the turf produced. Because of this, when one or more become limiting it is possible to overcome partially or to compensate by adjustment or modification of the other factors. Frequently, efforts to compensate lead to undue expense and are rewarded by only a very slight improvement in overall turf quality. Such may be illustrated by examining the effects of lowering the height of cut from 1-1/2 inches to 1/2 inch on a Kentucky bluegrass fairway. Such a low height is often demanded by today's golfer. Kentucky bluegrass does not produce sufficient leaf mass at this height of cut to support the photosynthetic activity required to produce a green, dense and pest-free turf. The deleterious effects of successively lower heights of cut on root growth of Kentucky bluegrass have been shown by a number of investigators. As a result of lowering the height of cut, fertilizing, watering, and weed control programs are adjusted in an effort to compensate for the reduced root system and the general weakness of the grass. The resulting change in the microclimate of the sward produces an environment conducive to development of disease-producing organisms. In addition, an overly wet soil reduces the oxygen supply and, if heavily trafficked will become compacted and will further complicate the cultural program.

In situations where the acceptable level of quality will permit the neglect, reduction or omission of one or more of the basic cultural practices (for example, water or fertilizer), then the turf may suffer a loss of color, become thin and unthrifty and usually weed-infested. Also, such will produce a marked change in the microclimate of the turf. The cooling effects of transpiration and evaporation of supplemental water do not exist and an increase in temperature and a decrease in humidity will occur. During a drought, failure to water may produce dormancy or, if prolonged, become lethal with the obvious attendant changes in the microclimate and on thatch.

MOWING

Mowing is a cultural practice that is necessary for turf production. Proper clipping of adapted grasses stimulates development of tillers and shoots either from the crown or from basal buds of rhizomes or stolons. Mowing is an important grooming technique. It improves the appearance of an area. For, unless it is mowed regularly, a turfgrass area would soon become like an overgrown pasture -- an area covered with loose-growing, spindly grasses and tall, rank weeds which cannot persist under normal mowing practices.

The inherent growth habits and characteristics play an important role in selection of a grass for turf purposes. A rhizomatous type like Kentucky bluegrass will have a different height of cut requirements than a stoloniferous or bunch type plant. The ability to produce sufficient leaf surface at the anticipated height of cut is a most important consideration when choosing a grass for turf purposes. Unless the plant can grow and persist under the expected environment, it should not be used.

Mowing height must be keyed to the use for which the turfgrass area is being produced. If for playing purposes, then it must meet the demands of play. More often than not, mowing at the heights necessary to meet these demands severely limits the number of grasses suitable for turf. Musser estimated less than 40 species are suitable. The low clipping height further restricts development of the root system. A number of investigators -- Davis, Juska and Associates, Madison and Roberts, among others, have shown there is a reduction in root growth of a given species as a result of decreasing heights of cut. Such a reduction may have a very direct and interacting effect upon other cultural practices and therefore, upon the microclimate and thatch. In order to compensate for the reduction in root growth it becomes necessary to adjust watering practices to suit the more shallow root depth. Unless very careful attention is paid to the watering program there is likely to be a tendency to over-water. The resulting wet soil may produce a more humid microclimate and a reduction in soil oxygen. This could lead to disease development and an accumulation of plant debris -- ultimately thatch.

Frequency of clipping, if performed often enough so that no more than 1/4 to 1/3 of the leaf surface is removed at any one clipping, will greatly enhance the beauty and appearance of the turf area. Infrequent clipping or clipping performed on the basis of a time schedule rather than on the growth rate of the grass may result in removal of excessive leaf surface. This will detract from appearance and, unless collected and removed from the site, may produce an environment highly conducive to disease development.

Mowing with a dull or improperly adjusted mower will multilate, tear, shred, or pinch the grass leaf rather than cut it cleanly. Torn or shredded leaf tips of themselves probably would have little effect on microclimate; however, such tips would provide a ready entrance for pathogens and insects. And, the activity of these organisms would produce a thinning of the turf, hence affect air movement, light and temperature of the microclimate.

Vertical mowing usually removes excess thatch. This thinning operation opens the turf to light and air. However, when temperature and moisture favor the germination of weeds such as crabgrass or *Poa annua*, rather than grass, a change in the microclimate and ultimately in thatch can be expected. Youngner has demonstrated such a situation with regard to *Poa annua* infestation of a Bermuda grass turf. Light vertical mowing to control grain will aid in maintaining a more healthy environment for satisfactory growth and does much to control thatch.

WATERING

Of all the cultural practices, watering probably exerts the greatest influence on the microclimate of a turf. Some of the reasons have been discussed above and relate, in part, to over-watering. The frequency, rate of application and the amount of water applied at each irrigation are influenced by the kind of soil, rainfall, the depth of root development and the rate of evapotranspiration. Scheduling irrigation to avoid many of the pitfalls of over-watering is frequently impractical because of interference with play, inadequate distributive systems or unavailability of labor. Thus, many turf areas may be too wet or too dry at any given time. The effect on humidity and temperature of the microclimate is readily apparent.

Water transpired by the leaves serves as a temperature regulator. Sprinkling to relieve temperature stress is a standard cultural technique. In addition, syringing to maintain turgidity during periods of heat stress is a key factor in golf course maintenance operations. Traffic or pressure on grass leaves when they are under moisture stress will cause severe damage. A light showering of a turf area when the cells begin to lose water will reduce the temperature a few degrees and restore turgidity. Workers at Michigan State point out that the application of 0.25 inches of water at 12 noon resulted in only a few degrees drop in temperature in the turf. However, syringing did prevent the temperature from reaching the maximum which would have occured had no water been applied. On the other hand, they found where irrigation was applied to a tomato field at midday, the temperature at 12 inches above the soil surface was lowered some 18° F. and the surface of a muck soil, 22° F.

Water plays a role in determining the dominant species in a mixed turf. Watson in work at Penn State showed that only moderate usage of supplemental irrigation on an intensively managed fairway type turf of Kentucky bluegrass, creeping red fescue and bentgrass caused major shifts in dominance. Within a two-year period, the irrigated plots were predominately bentgrass, whereas on non-irrigated plots, Kentucky bluegrass and red fescue dominated. However, the unwatered plots were not considered satisfactory from a playing standpoint; hence, it would seem bent could be expected to dominate a low-cut, irrigated fairway in regions of its adaptation.

Supplemental irrigation is always necessary if turfgrass areas are expected to remain green throughout the growing season. The frequency of irrigation is governed by the water-holding capacity of the soil and the rate at which the available water is depleted. For the most vigorous and healthy growth, watering should begin when approximately 40 to 60 per cent of the available water has been depleted. Most plants show a marked growth response when soil moisture is maintained between these levels. Assuming equal depth of rooting, sandy type soils will have to be watered more frequently than will loams or clays. Climatic conditions, such as high wind movement, intense sunlight, low humidity and temperature, all contribute to high water use rates. Such conditions dictate more frequent watering than the reverse set of conditions.

The amount of water to apply at any one time will depend upon how much is present in the soil when irrigation is started, the water-holding capacity and the drainage characteristics of the soil. Enough water should be applied to ensure that the entire root zone will be wetted. Too, on natural soils (as opposed to those modified for intensive use) sufficient water should be applied to maintain contact with subsoil moisture and to assure percolation especially in arid and semi-arid regions. Continuous contact between the upper and lower levels of moisture will avoid a dry layer through which roots cannot penetrate. Application of too much water at one time (misuse) is serious when the soil is poorly drained and the excess cannot be removed within a reasonable period of time. Ponding will cause a marked change in the environment and, under high temperature conditions, death of the turf.

In actuality, watering practices are to a large extent a function of clipping height and frequency because of the relationship between height of cut and root development.

Fertilization will stimulate growth. When applied in amounts needed by the permanent species and in accordance with their growth response, it will aid in satisfactory development of both roots and leaves. Inadequate amounts, improperly balanced ratios and timing of application at periods of low growth activity, all contribute to poor turfgrass performance. Soft, succulent turf results from improper fertilizer application. Such turf is more easily damaged by traffic and requires more frequent watering to prevent collapse under heat or moisture stress. A more humid microclimate is frequently produced by these practices.

CULTIVATION

Coring, slicing and spiking operations tend to open the soil and permit movement of water and fertilizer into the root zone. Such practices will assist in drying the surface if it is overly moist and, if excessively dry, will provide a trap for moisture. Thus, many greens in northern sub-humid and semi-arid areas are cored in late fall to trap additional moisture. This aids in combating desiccation during the late winter-early spring when snow cover is absent.

Failure to apply programs to control disease, insects and weeds may result in greater changes to the microclimate than would occur if these pests were properly controlled. As an example, presence of insects that feed on leaves or roots of the plants will, if unchecked, defoliate the turf or sever the root system. Either situation may cause death of the plant and, most certainly, will contribute to thatch accumulation unless controlled or handled properly.

CULTURAL PRACTICES OF VALUE IN COUNTERACTING ADVERSITY OF CLIMATE AND USE

Wind movement is an effective agent in temperature reduction in the turfgrass microclimate. Carolus has shown that at low wind velocities, doubling the rate of air movement over a leaf quadruples the rate of potential transpirational water loss. Duff and Beard have indicated a 13° F. temperature reduction in turf at a wind movement of 4 mph as compared to a restricted 0 mph air movement. Under the conditions of this study, relative humidity 3 inches above the grass was not influenced by air movement of 4 mph. Thus it seems that removal of obstructions, such as mounds, underbrush, and other impediments which restrict air movement, would aid in controlling temperatures during hot weather and would result in high quality turfgrass.

Topdressing of putting greens is a frequently used technique. The primary purposes of topdressing are to "true" a putting surface and to provide a desirable medium for microbial activity. Because the material usually contains peat or compost, it is dark and amorphous and it will absorb heat. For this reason, topdressing of bentgrass greens is usually avoided in the summer months. Conversely, this characteristic will produce a favorable response if topdressing or a similar dark material is used during the winter or early spring. The additional warmth is sufficient to stimulate early rapid growth of bentgrass greens. Lamp black, Milorganite and similar materials are often used to assist in the melting of ice sheets in late winter or early spring.

Topdressing has been shown to be very beneficial in the elimination and control of thatch. In fact, topdressing is probably the most effective and practical means of controlling thatch. Coupled with vertical mowing and cultivation this technique will assume thatch control. The addition of a fresh supply or nutrients or organic material may be a factor; however, the addition of a new supply of micro-organisms almost certainly is a major factor.

Overwintering Diseases of Turfgrasses[1]

J. Drew Smith[2]

Summary

In regions with long, cold, snowy winters there is a broad climatic pattern to the distribution of Fusarium nivale, Typhula spp., Sclerotinia borealis and an unidentified low-temperature basidiomycete and the diseases they cause in turfgrasses. Their ranges show considerable overlapping. The further clarification of this pattern is largely dependent on the availability of more accurate diagnostic data. These pschycrophilic pathogens cause diseases termed "snow molds" because much of the pathogenic activity takes place under snow or at snow melt. Fusarium nivale shows the widest geographical range; it can cause turf disease where snow never falls while in other regions it functions as a snow mold. Depth of snow cover, state of the ground before snow and rate of snow melt probably influence the incidence of these pathogens and the severity of the associated disease. The severity of Fusarium patch disease is related to dosage of nitrogenous fertilizer and to the balance of nitrogen with phosphorus and potassium. Alkaline turf surfaces also make turf more prone to this disease. Observations suggest that excessive nitrogenous fertilization increases the severity of Typhula blight and of gray snow mold but experimental evidence is required to clarify this. Inorganic mercury fungicides (mixtures of mercurous and mercuric chlorides) are the most effective preventive fungicides for snow mold diseases.

Introduction

The rather loose terms "winter injury" and "winter kill" have been used to describe damage which may occur on turfgrasses during late fall, winter and early spring in regions with long, cold, snowy winters. The principal causes of winter damage to the fine turf of golf and bowling greens and also to that of less closely mown domestic lawns, park grass and playing

[1]Contribution no. 360

[2]Plant Pathologist, Grasses, Research Station, Research Branch, Canada Agriculture, University Campus, Saskatoon, Saskatchewan.

fields are the pschycrophilic snow molds. Roadside verge turf may also suffer. The same snow mold diseases are found on forages and cereals and may determine or modify the botanical composition of natural and sown grasslands in colder climates in N. Asia, N. Europe and N. America (1), (2), (3), (4). Ekstrand (1) has commented that "the ultimate cause of winter damage is the climatic conditions" and that "it is not always the extremely cold winters that are most dangerous but the mild winters with deep snow, especially on unfrozen ground". Some of the obvious conditions affecting grass damage which are of importance are: time of snow cover in relation to season, frozen or unfrozen state of the ground and its moisture content, depth and disposition of snow drifts; extent of exposure of plants to desiccating winds, duration and intensity of cold spells, actual temperature and wind chill, rate of snow melt, and ice sheet formation. The purpose of this paper is to briefly review information available on the distribution of some overwintering diseases of turfgrasses, consider differences and similarities in their epidemiology and the influence of these factors on disease control.

The overwintering diseases

Some of the characteristics of five winter diseases are outlined in Table I. Alternative common names are given since these have not been standardized. When in doubt it is best to refer to the Latin name of the pathogen. The first disease, *Fusarium* patch will be considered in some detail and the others compared with it.

FUSARIUM PATCH DISEASE or pink snow mold caused by *Fusarium nivale* Fr. Ces. is widely distributed on amenity turf of many types in the cool humid regions of the world. It has been reported from N. Europe (5), N. America (6), (7), New Zealand (8) and S. Africa (9). It is often referred to as a snow mold disease since it will develop under a snow cover at about 0°C (5) but it causes much damage in areas which never receive snow. Frequently it causes most damage in fall and in spring, e.g. in California, W. Washington, Oregon, Coastal B. C., Alaska (7), (10), (11). In Britain it has been found in an active state in every month of the year (5). *F. nivale* is an important seedling pathogen in the Gramineae generally and causes both pre- and post-emergence damping off in turfgrasses, the latter sometimes occurring in patches (5). Symptoms of *Fusarium* patch diseases after snow melt are often very similar to those of *Typhula* blight except that the latter show a "speckling" from the presence of sclerotia. The alternative name for Fusarium patch, pink snow mold, is derived from the appearance of the patches some time after snow melt. When the aerial mycelium on the patches is exposed to light, it gradually turns pink. This is due to the formation of pink spore masses. The pink color is rare in Britain because aerial mycelium is very sparse.

The fungus may penetrate and kill grass tissues as far as the crowns but complete death of the plants often results mainly from "winter injury" or from the activities of secondary pathogens. Patches may fill in gradually from surviving plants when the disease has passed over; this is a slow process in winter and spring when leaf production is low. The fungus survives as dark aggregates of mycelium in grass tissues and is spread by spores and infected clippings (5). Most turf-grass species are susceptible to F. nivale and most Agrostis spp. are particularly prone. Annual bluegrass (Poa annua) is also specially liable to attack because it responds very rapidly to nitrogenous fertilizer and can produce unseasonable flushes of very succulent growth. It was shown by the Author (Table 2), Madison et al. (13), Goss and Gould (14), that infection increased as more nitrogen was used on turf. The results of the latter workers in Washington agreed with those of Smith (12) in Britain that nutritional imbalances could cause increased disease losses and that high nutritional levels whether balanced or not, when fertilizer was applied in the growing season, could result in infection. Factors which favor the maintenance of a moist turf surface, e.g. lack of "air drainage", shelter shading and irrigation (13) are also conducive to the disease.

There is considerable contradictory evidence in the literature about the effect of soil pH on the incidence and severity of the disease in amenity-turf. Shaffnit and Meyer-Herman (15) found that their isolates of F. nivale were unable to grow in acid soils. Bennett (16) found that the fungus could survive and attack cereals in all normal field soils whether acid or alkaline in reaction. On the other hand, Jones (17) suggested that in Britain the disease was most prevalent on acid soils. Strong evidence that an alkaline turf surface favors the disease in Poa annua turf is given in Table 3. The disease increased in severity as the surface pH increased. Goss and Gould (14) applied elemental sulphur to bentgrass turf. This lowered soil pH and reduced the severity of Fusarium patch disease.

Fungicidal control of Fusarium patch disease is achieved very effectively with fungicides based on inorganic mercury, organo-mercury and pentachlornitrobenzene (5), (6). Some economy has been effected in control without loss in efficiency by the substitution of microfine for the precipitated calomel in inorganic mercury fungicides (18).

GRAY SNOW MOLD caused by a still unidentified low-temperature basidiomycete is probably the most important turfgrass pathogen in Manitoba, Saskatchewan, Alberta, the interior of British Columbia, Yukon and Alaska (19), (20), (21). It is possibly present on turf in N. Dakota and Idaho as well as in Montana (7). The mycelium of the fungus often has a dirty cobwebby gray appearance on disease patches at snow melt. When very dense, the mycelium is white. Disease development is dependent on the production of HCN gas under the snow cover. This kills plant tissues and permits the invasion of the fungus (22). Damage to turf is most severe when snow melts slowly in spring. Deep drifts are conducive to slower melting and severe infections are often found under these. Golf and bowling green turfs are often severely attacked, probably because the fine grasses used are more susceptible than the coarse ones of domestic lawns, but these may also be severely damaged. The Merion variety of Poa pratensis appears more susceptible than Kentucky. Northland bent appears to be resistant. Fungicides containing inorganic or organic mercury are the most effective types (19) and (unpublished); they are best applied before snowfall in October. It is possible to make a further fungicide application in chinook areas during mid-winter thaws but sufficient thawing may not take place in the eastern prairies for this application to be feasible. Applications of fungicide at snow melt have not been found worthwhile at Saskatoon since most of the damage has occurred under the snow. Current cultural controls consist in avoiding late nitrogenous fertilization; mowing grass until freeze-up, using snow fences to reduce drifting and spreading drifted snow at snow melt. The results of a recent snow mold disease survey in the City of Saskatoon are given in Table 4. A 4% sample of the front yard lawns of the city was rated for the disease. Symptoms in all cases were characteristic of damage caused by the low temperature basidiomycete. The results show that first year lawns largely escaped severe infection but that there was little change in susceptibility with age after 2 years. Lawns in heavily shaded streets were noticeably more heavily infected than unshaded ones. Lawns in luxury housing areas tended to be more severely affected on the whole, perhaps because of higher and later fertilizer use to keep up appearance and the employment of susceptible

Merion bluegrass. This variety responds to high levels of nitrogenous fertilizer better than Kentucky.

TYPHULA BLIGHT, snow scald, winter scald, or speckled snow mold is characterized by the presence of sclerotia (resting bodies) in the diseased turf patches which gives them a speckled appearance. There are several Typhula spp. associated with this snow mold disease of turfgrasses. In the Northern states of the U.S.A. and in Britain T. incarnata Lasch ex Fr. (=T. itoana Imai = T. borealis Ekstrand (1) is implicated (11), (5). T. ishikariensis Imai (=T. idahoensis Remsberg) occurs in Idaho and other western states of the U.S.A. (23). Typhula snow mold is general throughout the northern U.S.A. (7), (24), (25), and probably occurs in many of the adjacent eastern provinces of Canada although there do not seem to be any reliable records of this. One case of Typhula blight was noted on a bowling green in Saskatoon in 1965 but the sclerotia did not germinate (unpublished). Typhula spp. are pathogens of cereals and grasses in N. Europe, N. Asia and Japan (1), (23); they are very active under the snow and at snow melt. Sclerotia of the fungus remain dormant during the summer months but in autumn under the stimulus of colder weather, high humidity and exposure to light rays of short-wave length (u.v.) the sclerotia germinate and produce fruiting bodies bearing basidiospores which initiate new infections. Optimum conditions for infection take place when snow falls on unfrozen ground. Sclerotia deprived of light germinate under a snow cover to produce mycelium and establish primary infection centers. Patches are small at snow melt and grass leaves are matted together with mycelium. These patches may coalesce but patch enlargement ceases with the onset of warmer weather. The disease is reported to be favored by excessive late nitrogen applications and grass left long in the fall. It is necessary to use fungicides in a preventive role in areas where the disease occurs, cultural practices alone will not suffice. Mercury and cadmium fungicides, are effective control materials in the U.S.A.; P.C.N.B. is satisfactory in Europe (5).

SNOW BLIGHT, caused by Sclerotinia borealis Bubak and Vleugel is generally regarded as a winter disease of cereals and forage grasses. It is found in the higher latitudes and at higher elevations in lower latitudes in N. America, N. Europe and N. Asia (1). It has been reported as causing damage to Agrostis, Festuca and Poa, in the interior of British Columbia. Effective control of the pathogen on cereals and grasses was obtained in Finland with P.C.N.B., phenyl mercuric acetate and phenyl mercuric salicylate (27).

FROST SCORCH or string of pearls disease caused by Sclerotium rhizoides Auerswer is so called because leaf blades of affected plants are bleached and rigid, with symptoms like frost damage. Rows of sclerotia 1-5 mm. in diameter develop like beads in leaf tissues. Forage grasses are attacked in N. Europe (28) and Poa pratensis and Agrostis alba were reported damaged in Pennsylvania (29). It is doubtful whether this is a pathogen of any great significance in mown lawn grasses (26). It is of interest because the fungus appears to be systemic and unlike the other winter diseases and is most severe on poor acid soils (28), (30).

General discussion

There appears to be a broad geographic (climatic) pattern in the distribution of the turfgrass pathogens F. nivale, Typhula spp., Sclerotinia borealis and the low temperature basidiomycete in northern Europe and northern N. America (1), (3), (23), but the ranges show considerable overlapping. F. nivale is more frequently associated with snow mold in the slightly warmer regions while Typhula spp. and Sclerotinia borealis are more prevalent in the colder parts of both continents. The low temperature basidiomycete occupies a special ecological niche in the drier, colder parts of the Great Plains of N. America. It has not been reported elsewhere. However the writer found a non-sporulating basidiomycete causing disease on Agrostis turf in N. E. Scotland. There is a great lack of precise diagnostic evidence on the causes of winter diseases of turf (and forage grasses) in N. America and elsewhere. It is not possible to relate directly the distribution of the pathogens or the diseases they cause to their cardinal temperatures on culture media or to the temperatures at which they cause disease. While temperature is an important factor, for these pathogens data are incomplete and when available sometimes divergent. That which is available is given in Table 5.

It is probable that some of the differences in cardinal temperatures reported by different workers were due to variations between ecotypes of the fungi (1). Some of the best experimental evidence on the effect of temperature on the incidence of over-wintering disease was supplied by Lebeau (31). He showed that if soil temperatures under snow were maintained above freezing point by electrical soil heating cables and thermostats, F. nivale was the most important pathogen. At -3°C the low temperature basidiomycete was prevalent.

There seems to be some relationship between the prevalent pathogen and the depth of the snow cover. This is strongly suggested by the occurrence of *T. incarnata* on turfgrasses in Britain (5). *Fusarium* patch is the common winter disease of turf in Britain. Before the winter of 1963 *Typhula* spp. had been reported only occasionally on wheat in England, not on grasses. After the melting of the heaviest snowfall in living memory in March 1963, *T. incarnata* was recorded as a common pathogen of turfgrasses in England and Scotland. But *F. nivale* can also cause very severe damage when snow is deep (1) and the low temperature basidiomycete is particularly severe when deep snow drifts melt slowly. Both *T. ishikariensis* (*T. idahoensis*) and *F. nivale* occur on turf in deep snow areas in Idaho, Washington and Oregon according to Sprague (24). One epidemiological factor which may be significant is the state of the ground at snowfall. Disease production by *Typhula* spp. and *F. nivale* are reported to be favored by snow falling on unfrozen ground (6, 23, 32). This may partly account for the general absence of these pathogens in western Canada where snowfall, which is lighter than that in the northern U.S.A., usually first occurs when the ground is frozen.

It has been reported by research workers (loc. cit.) that excessive nitrogenous fertilization which produces a succulent sappy growth renders turf prone to attack by *F. nivale*, *Typhula* spp. and the low temperature basidiomycete. This conclusion is probably sound but only in the case of *Fusarium nivale* has the author seen experimental evidence to support this conclusion. More precise data than is available now is required about the effect of fertilizers on disease caused by *Typhula* spp., the low-temperature basidiomycete and *Sclerotinia borealis*.

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Table 1. Some characteristics of overwintering diseases of turfgrasses

	Common names	Pathogen	Distribution	Some predisposing causes
(1)	Fusarium patch	Fusarium nivale Fr. Ces.	Colder temperate to cool temperate oceanic climates in N. Europe, N. Asia & N. America	Forced growth from late, unbalanced or excessive nitrogen fertilizer. Alkaline turf surface. High turf surface moisture. Slow grass growth. Susceptible Poa annua or Agrostis spp.
(2)	Gray snow mould	Unidentified low-temperature basidiomycete	Interior B.C., Alta., Sask., Man., and possibly adjacent states of U.S.A.	Forced fall growth. Deep snow. Slow snow melt. Most turfgrasses susceptible but some Poa pratensis and Agrostis stotonifera cultivars less susceptible.
(3)	Typhula blight, snow or winter scald, speckled snow mould	Typhula spp. especially T. incarnata Lasch ex Fr. and T. ishikariensis Imai	From N.J. through Minn. to Idaho, B.C. and Alaska, N. Europe, N. Asia and Japan, Britain, Probably Sask.	Forced fall growth. Ragged long growth before winter. Deep snow falling on unfrozen ground. Seaside bent susceptible.
(4)	Sclerotinia snow blight	Sclerotinia borealis Bubak & Vleugel	Higher latitudes and higher elevations at lower latitudes than Fusarium patch and Typhula blight in N. America, N. Europe and N. Asia.	Not known. Most forage and turfgrasses are susceptible.
(5)	Frost scorch or string of pearls disease	Sclerotinia rhizoides Auersw.	Northern N. America, N. Europe, Britain	Low pH and low soil fertility. Agrostis, Calmagrostis and Poa spp. are susceptible.

Table 2. Effect of applications of ammonium sulphate in July, August and September at three rates on the amount of _Fusarium_ patch diseases on _Poa annua_ turf in late winter

Treatment (Pounds of ammonium sulphate per application/1000 sq. ft.)	% area of turf affected by patches of the disease. Average of 4 plots: 6 July 1955	20 March 1956
A Check - no fertilizer	0.0	0.0
B 1.75 (total 5.25)	0.0	1.0 ± 0.40*
C 3.50 (total 10.50)	0.0	13.8 ± 2.34
D 7.50 (total 21.00)	0.0	32.5 ± 4.79

*Standard error.

Differences in amounts of disease between B & C, B & D and C & D on 20 March was highly significant.

(Unpublished data, from Smith, J. Drew. 1957. M. Sc. thesis, University of Durham)

Table 3. Effect of applications of 40 mesh calcium carbonate (ground limestone) at different rates on the pH of the first ½ in depth of turf and on the occurrence of *Fusarium* patch disease in *Poa annua* turf

Treatment lb per 1000 sq ft	pH Average of 4 plots 4 Dec. 1957	% area affected by the disease, Average of 4 plots: 1957 14 Oct.	1957 30 Oct.	1957 18 Nov.	1957 3 Dec.	1958 10 Apr.	1958 15 Oct.	1958 19 Nov.	1958 8 Dec.	pH Average of 4 plots 21 Aug. 1958	pH Average of 4 plots 19 Jan. 1959
Check - no lime	4.6 ±0.09*	0.3	0.6	0.4	0.1	0.1	0.2	2.7	2.0	4.3 ±0.09	4.6 ±0.10
Lime - 7.5 lb	6.5 ±0.06	3.6	6.9	7.0	4.6	16.0	1.0	2.0	3.2	4.6 ±0.09	4.7 ±0.09
Lime - 15.0 lb	6.8 ±0.03	1.9	7.0	10.6	8.8	41.0	4.5	8.4	17.5	5.2 ±0.05	5.0 ±0.08
Lime - 30.0 lb	7.1 ±0.02	3.9	13.0	11.3	16.3	46.2	15.0	24.0	41.2	6.4 ±0.09	5.7 ±0.10
Lime - 60.0 lb	7.2 ±0.03	6.1	15.5	16.9	25.0	71.0	17.5	30.0	57.2	7.0 ±0.10	6.7 ±0.06

*Standard error.

From Smith, J. Drew. 1958. J. Sports Turf Res. Inst. 9: 467-470.

Table 4. Snow mould on domestic lawns in Saskatoon, 4 May 1969

Age or condition of lawn	Number of cases in each rating category* None 0	Slight 1	Mod. 2	Mod. severe 3	Very severe 4	Average rating
Sown 1968	46	27	7	1	0	0.5
2-10 years old	20	74	89	101	29	2.0
Older than 10 years	47	138	133	164	37	2.0
(From above data)						
Heavily tree shaded	9	62	87	130	28	2.3
Open	38	76	46	34	9	1.3
Luxury landscaping	0	13	41	56	21	2.7

*Rating scale
Slight = 0-10% of lawn surface affected
Moderate = 11-25% " " " "
Moderate/Severe = 26-50% " " " "
Very Severe = 51-100% " " " "

Table 5. Temperature ranges (°C) for snow mould pathogens

Pathogen	Growth in culture Maximum	Optimum	Minimum	Minimum temp. for disease production	Reference
Fusarium nivale Fr. (Ces.)	30	22	0		(32)
	32	20	0		(33)
	32.5	20-21	0-1 Survives at -20	0 to +1	(16)
	30	22	-5	below 0	(1)
			-0.5 to +0.5	-0.5 to +0.5	(12)
Typhula incarnata Lasch ex Fr.	18	9-12	0		(26)
	22-23	10-15	below -5	below 0	(1)
	22-23	8-15	-5	below 0	(34)
	25	0-5			(35)
	25-30	20-30	0		(36)
T. ishikariensis Imai	20	10	-5	below 0	(1)
(=T. idahoensis Remsberg =T. borealis Ekstrand)		9-12			(26)
T. hyperborea Ekstrand	15-20	5-10	-5	below 0	(1)
Low temperature basidiomycete	26	15	-4		(37)
Sclerotinia borealis Bubák & Vleugel	20	5-10	below -5	below 0	(1)
Sclerotium rhizoides Auers.		16			(30)

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International Turfgrass Research Conference And European Turfgrass Tour[1]

Roy L. Goss[2]

The first International Turfgrass Research Conference and Turfgrass Tour was conducted during July 1969. The Research Conference was held at the "Old Swan Hotel" at Harrogate, England, July 15-19. Upon completion of the Research Conference most of the attendees went on a tour of Turfgrass facilities in England, Scotland, Denmark, Sweden, Germany and Holland. Perhaps the most unique thing about the entire conference and tour was the excellent degree of planning. Mr. John Escritt of the Sports Turf Institute at Bingely, Yorkshire, England, and Dr. J. B. Beard, Michigan State University, were co-chairmen in making the arrangements for the conference and tour. Dr. Beard was general chairman and helped to co-ordinate the U.S. efforts, and Mr. Escritt was chairman of the local arrangements committee and all of the British and European tours. Mr. Escritt worked very closely with Mr. Bjarne Langvad from Landskrona, Sweden, who saw us efficiently and safely through our tours in Sweden and Denmark and finally into Germany. In Germany, Professor Skirdie of Giessen, Germany, was the host in that area and finally Mr. Vos of Swaginengen research station, was in charge of the Netherland tour. Each of these men were very familiar with conditions and problems in their own respective areas and organized the tour to see the best of each of the areas in the short time available. There is no way that anyone else could see the same things we saw in a period of three weeks if they planned this trip on their own. Needless to say, the entire tour and conference consisted of long hours and a lot of hard travel but very rewarding.

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[1]Paper presented at the 23rd N. W. Turfgrass Conference, Hayden Lake, Idaho. September 24, 25, and 26, 1969.

[2]Associate Agronomist & Extnsion Specialist in Agronomy, W.W.R.E.C. Washington State University, Puyallup, Washington

About 85 papers were presented from 76 different scientists and researchers throughout the world. The conference was attended by over 80 persons representing 15 countries with interests in turfgrass management. The conference language was English and everyone did a good job in presenting their papers in English. A wide variety of subjects was included in the conference which included turfgrass fertility, breeding and selection of warm and cool season grasses, management of sports fields, disease control, weed control, insect control, soils for specific uses, management of water and physiologic studies, including light quality and intensity and other factors. A key-note speaker would present a paper of approximately 15 minutes in length and this was followed by several supporting papers of 5-7 minutes in length. At the end of each major section there would be ample time for questions and answers from the floor. The questions were recorded and the answers as well and these will be written up and included with a final proceeding of this conference.

TOUR OF SPORTS TURF INSTITUTE AT BINGELY

Mr. John Escritt, director of the Sports Turf Research Institute at Bingely, Yorkshire, England, had a complete field day set up at the research center for all the visitors. This included several hundred research plots which included mowing heights, fertility levels, sources of fertilizers, grass varieties, disease studies, weed control studies, pre-emergence herbicide studies, and a number of management studies. The two and a half or three hours that were spent at this station was hardly enough to get a good look at what is going on but did give us an idea of the vast variety of research subjects being carried out at this station. Certain pieces of equipment were demonstrated including the Sisis contravator, which is a machine that slices small grooves into the soil and feeds seed into these simultaneously. This is an excellent means of overseeding turfgrass areas. It is similar to some machines here in the United States but seemed to be very well designed and very precise. After the lunch at the Sports Turf Institute we boarded buses and left for Scotland.

SCOTLAND TOUR

Our destination in Scotland was Edinburgh and vicinity. The Royal and Ancient Golf Course at St. Andrews was one of the objectives so everyone could see and ask questions about turf that had been in existence for several hundred years. Mr. Campbell, who is superintendent of the Golf Courses at St. Andrews was our genial host and guide around the old course. The turf at St. Andrews was typical of most of that in Britain. It is difficult to compare turfgrass conditions in Britain with those in the United States because of the major significance of the difference in philosphy. It is the philosphy of the British that Sports turf is created to be used and not to be looked at entirely from the standpoint of beauty. It must be durable, trouble free, and above all it must perform. Little emphasis is placed on color and considerable emphasis is placed upon disease control. It is the general feeling that extensive fertilization will produce a grass that does not have the proper texture and is very prone to many turfgrass pathogens. It is also their feeling that extensive fertilization will encourage *Poa annua* and cause certain other problems. It is doubted that the greens at St. Andrews receive more than three or four pounds of available nitrogen per 1000 square feet per season from all sources. It is difficult to compute since some of the nitrogen comes from top dressing and the balance from ammonium sulphate. It was estimated that in the climate of Edinburgh, which is equally conducive to disease development as Seattle, that fungicides are possibly used once per year or once every other year. Considerable red thread disease was in evidence while at this location, but it was not serious enough to be epidemic. If this condition had appeared upon more highly managed turf in the Pacific Northwest, it would have been treated because it would have been more obvious than on the less highly colored turf in that area.

Their management programs, however, are outstanding. They practice frequent aerification and spiking with solid tined spikes and hollow tines as necessary. The fairways are not irrigated but the tees and greens do receive water.

It is the writers opinion with all due respect, to the Royal and Ancient Golf Course and to other Golf Courses seen in Britain, that if putting greens of this nature were maintained in this area it would take a considerable amount of education or the firing of a number of superintendents before agreement could be reached. In general, the golfing members in the U.S.A. require a little higher degree of color and appearance in grooming than in Britain.

SPORTS FIELDS

Rugby Soccer and football are played extensively in all of Great Britain. Considerable emphasis is placed upon the production and management of excellent fields. The writer specifically wanted to study these fields in as much detail as possible so that management programs, construction techniques, grass varieties, etc., could possibly be adapted to the Pacific Northwest. Before comparing any particular differences, some major points should be considered to help the reader understand some of these differences. Some of the fields in England and Scotland receive as many as 100 games per year. Few of any of the fields in the U.S. are played this extensively. Here are some of the differences as we compare them:

1. The size of the English Rugby Soccer and Football fields is considerably larger than the standard American football field.

2. The entire field is used in Great Britain as compared to principally the center 60 feet by 300 feet of the American Football field. In other words, we concentrate play in only about 1/5 or less of the area that is encountered in the Sports fields in Great Britain.

3. Much of the play in Britain occurs during the summer months as well as in the fall and winter. Our football fields are not played in the summer but only in the fall. Grass can recover from injury better during the warmer growing season than in the later cold, wet months.

4. In England and possibly in other parts of Britain, their rain is more uniform throughout the year. In some areas they receive approximately three inches of rain in every month of the year. On the West Coast of the Pacific Northwest this is not so. During the playing season, it is not unusual for 15 to 20 inches to fall. Particularly from mid-September to mid-November. And likewise it is not unusual to run near 60 days without precipitation during July and August. These are some of the major differences that must be understood before any comparison in management programs and quality of turf can be considered.

MANAGEMENT OF BRITISH SPORTS FIELDS

I must compliment the British Sports Field managers for both their competence and diligence with their work. Most of these people are very carefully selected individuals or they have been developed through many years of practical experience. It was my observation that most of these fields did not have extensive construction processes. Most of them were built on soil materials that were native to the area. In some cases these were sandy and in other fields, the soils were heavier. Obviously the heavier soil sites required the highest degree of management in order to keep them from becoming mud holes during the playing season. Although good management is practiced some of the sports grounds managers reported mud hole areas in certain parts of the fields regardless. Ryegrasses, were the principal grasses used on these sports fields and the variety S-23 appears to be the most popular. This grass seems to have the ability to come back, withstand a lot of beating, withstand drouth conditions and wetness as well. The British turfgrass manager overseeds frequently and repairs damage as it occurs. They aerify with solid tined aerifiers frequently during the playing season (at least once per week) and overseeds regularly as divoting or tearing of the turf occurs. The average sports field receives about three or four pounds of available nitrogen per 1000 square feet per season with ample phosphorus and potash to go along with this rate. Fungicidal programs are rarely or never practiced on the sports fields. Most of these fields have a good drainage system and by providing surface infiltration from aerification, they can be maintained in a relatively firm condition. Sports fields were visited in Edinburgh (Murray field) and Twickenham near London. After visiting Muirfield Golf Course, which is a seaside course near Edinburgh, we returned to Leavington to visit Fisons and Ransomes-Sims and Jeffries. On our way to Leavington, which is near Ipswich, we passed through Cambridge and the Newmarket race course. At a brief stop at the Newmarket race course, we saw turf that is about 400 years old and the peculiar systems of management of turf for professional horse racing. Fisons were our luncheon hosts as well as dinner that evening in Ipswich. At this time they described their function in producing materials for the turfgrass industry in all of Britain. Fertilizers, chemicals and pesticides is their business. The following day we went over their research grounds which were very impressive and saw demonstrations of herbicides, grass varieties, mowing treatments, disease control and fertilizer treatments. Considerably higher rates of fertilizer were being used on most of the test plots at Fisons than on any other place we had seen in Britain. In fact, these plots looked more reminiscent of those in the Pacific Northwest than any others that we had seen anywhere in Britain. Mr. Bob Morris of Fisons, indicated that a change in thinking of the average Englishman, that they would like to have a little bit more color and better looking turf and this was one of the reasons for increased fertilizer usage at their location. The following afternoon we visitied Ransomes-Sims and Jeffries where we had lunch and a demonstration of most of the equipment manufactured by this corporation. Their equipment is of very high quality and does an extremely good job of mowing and maintaining grass. Included in the demonstration, was the old Buddington Patent Mower, which was the forerunner of all modern mowers today.

As a final tour in England we visited the Lords Cricket grounds in London to see some of the problems associated with soil and grass management in the game of Cricket. Those of us who think we have problems in managing grass at 1/4 inch height need only to examine that which is cut considerably lower to understand some of the problems that the manager of the Cricket pitch has on his hands.

EUROPEAN TOUR

In Sweden our stops took us to Weibulls, which is a major plant breeding station in South Sweden at Landskrona. Mr. Bjarne Langvad was our tour guide at this station since he is a breeder for Weibulls. We examined many plots of bluegrasses, fescues, bentgrasses and ryegrasses which they were selecting and developing themselves. Many of the common varieties of bluegrasses, such as Merion, Fylking, Sodco and others were in test plots as comparisons to the numbered selections being developed in Sweden. Among all of the bluegrasses being examined, K404, Primo, Sydsport, and Sodco looked the best. Sydsport looks as though it may have considerable adaption in the Pacific Northwest. Other plots of bentgrasses and fescues were examined before leaving Weibulls.

From Weibulls research station we proceeded on to local golf courses and examined their turf. The first was a seaside golf course on the North Sea and was very pretty, with Scotch or Swedish Pines. The usual problems encountered in golf course establishment were evident but it had all indications of developing into a very pretty golf course.

We left from there and went to Landskrona Golf Course which is equivalent to a municipal or public course. The greens were in very good condition, indicating very high levels of fertility and with a mixture of bentgrass and Poa annua much the same as in this area. According to Mr. Langvad it costs about $20,000. per year to maintain the 18-hole golf course at Landskrona. They do not water the fairways in any of those areas and maintain only tees and greens. The climate at Landskrona is about the same as it is in Seattle, therefore, it is considerably milder than in other parts in Sweden.

The Swedish people are very sports minded and realize the need for recreation, exercise and sports. They have a formulae to develop a ratio of a given number square meters of recreational and sports area for outdoor sports and so many square feet of indoor sports area for every person. If they continue to do this they will maintain a healthy ratio between population and sports and recreational areas.

Upon leaving Landskrona, we proceeded back to Copenhagen by way of ferry and bus where we looked at roadside plantings which were done by hydro-seeding. We flew from Copenhagen to Stockholm where we went to the Swedish sports federation training area to examine some turfgrass facilities and then visited the famous Solna Stadium in the outskirts of Stockholm. The Solna Stadium has heating cables installed with a sand rooting medium over the cables. The turf, principally a ryegrass and bluegrass is grown in this sand media. A plastic sheeting on an extensive electric reel stands ready at all times to cover the entire soccer field in case of extensive rains during the period of play. The heat is maintained about 60 watts per square yard of area and extends their playing season by about one month. This is very important since they can begin play in the latter part of April as compared to the latter part of May without the heating. Their season ends in October with the advent of winter. Murray field in Edinburgh, Scotland, also has soil heating and has probably been in existence longer than any other in Britain or Europe. Murray field in Edinburgh appeared to have about 90% Poa annua and possibly 10% ryegrass. The field in Solna was also very high to Poa annua at this time. A second field inspected in Stockholm was about the same as the one at Solna and it was being used at the time we inspected. Repairs were constantly underway for reseeding and repairing small injured areas and for normal maintenance of the field.

GERMANY AND HOLLAND

We flew from Stockholm to Frankfurt, Germany and went by bus from Frankfurt to Giessen. We spent the following morning on the research grounds inspecting plantings of bentgrasses, fescues and bluegrasses. Some of these grasses were being investigated by Dr. Skirdie for their ability to produce good turf cover without growing too tall. These grasses were to be used for highway embankment plantings. Some of the fescues exhibited entirely different characteristics when let grow to their mature height.

A considerable amount of red thread disease was encountered on the plots at Geissen but due to drought conditions during the summer of 1969, the grass was turning quite brown and the red thread was not too noticeable.

We boarded buses and left for Arnhem, Holland where we arrived at about 7 P.M. The next morning we boarded buses and left for Wageningen and the IVRO, which is the department that tests varieties for all of the independent private breeders in the Netherlands. On the way to Wageningen, some of the battlefields of World War II were observed and a good comentary of conditions in the Netherlands during the war was given.

Mr. Vos, of the IVRO, conducted the tour through the trial plots at this station. According to Mr. Vos, Lolium perenne will withstand more treading than any of the other grass varieties. He indicated that in gate-ways leading into pastures, the only grass that holds up is ryegrass. All of the others are tramped out. In plots on the station it was found that nearly all of the bluegrasses were devostated with Helminthosporium and that the ryegrasses looked much better than any of them. Most of the bentgrasses were either attacked by Fusarium or other diseases. Agrostis stolonifera, Seamarsh bentgrass, was heavily infested with Fusarium this last year and so was Agrostis canina. None of the plots at Wageningen received fungicides because they are trying to determine if grass varieties developed by the independent breeders are resistant to turfgrass diseases.

The tour was completed in the Netherlands and we proceeded on to Amsterdam for flights back to the Pacific Northwest by way of New York.

I would like to take this opportunity to express my appreciation to the Directors of the Pacific Northwest Turfgrass Association for their financial help in making this conference and tour possible. It is hoped that the information gained from this trip can be used in our own research programs and improvement of turfgrass in the Northwest.

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Fall City, Wa. 98024

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Marysville, Wa. 98270
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2041 South 320th
Space 67
Federal Way, Wa. 98002

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Box 654
Coeur d'Alene, Idaho 83814
Attention: J. Harrison

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Box 2446
Parkland, Wa. 98444
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Piedmont Station
Portland, Oregon 97211

Crane Creek Country Club
500 W. Curling Drive
Boise, Idaho 83702

Douglas County Parks
Rt. 1, Box 20
Rifle Range Road
Roseburg, Oregon 97470
Attention: T. Keel

Diamond Shamrock Corporation
300 Union Commerce Bldg.
Cleveland, Ohio 44115
Attention: T. J. Neidlinger

Diamond Shamrock Corporation
3945 S. W. 57th Avenue
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Attention: Bill Pierson

Early Bird Spray & Garden Service
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Selah, Washington 98942
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Box 307
Hoodsport, Wa. 98548

Edmonds School Dist.
Maintenance Department
3800-196th S.W.
Lynnwood, Wa. 98036

Enumclaw Golf & Country Club
Rt. 3, Box 599
Enumclaw, Wa. 98022

Eugene Country Club
255 Country Club Road
Eugene, Oregon 97401
Attention: John Zoller

Everett Golf & Country Club
Box 1105
Everett, Wa. 98201

Evergreen-Washelli Memorial
11111 Aurora Ave. N.
Seattle, Wa. 98133

Fred Federspiel
16755 S. W. Pacific Highway
Lake Oswego, Oregon 97034

Fircrest Golf Club
6520 Regents Blvd.
Tacoma, Wa. 98466

Forest Hills Golf Course
Rt. 2
Cornelius, Oregon 97113

Forest Lawn Cemetery
5409 Kitsap Way
Box 1279B
Bremerton, Wa. 98310

Emerald-Turfgrass Farms
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Sumner, Wa. 98390

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Bellevue, Wa. 98004

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Alderwood Manor, Wa. 98036

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320 Lancaster Crescent
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1003 N. Central Street
Olympia, Wa. 98501

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Portland, Oregon 97230
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Vancouver, B. C., Canada

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Aberdeen, Washington 98520

Green Valley Fert. & Chem. Co.
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Surrey, British Columbia
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Greenup Spray Service
12437 1st avenue S. W.
Seattle, Wa. 98146

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Bellingham, Wa. 98225

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201 Boren Avenue, N.
Seattle, Wa. 98109

Hercules, Inc.
Alcoa Building
One Maritime Plaza, Golden Gate
San Francisco, Calif. 94111

Hillcrest Country Club
Box 1083
Boise, Idaho 83701
Attention: J. Leonard

Don Hogan
9060 37th Avenue S.
Seattle, Wa. 98108

Holmes Harbor Golf Course
Rt. 1, Box 99
Freeland, Wa. 98249

Holyrood Cemetery
205 N. E. 205th Street
Seattle, Wa. 98155

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Rt. 6
Kenmore, Wa. 98028

Jacklin Seed Company
8803 E. Sprague Street
Dishman, Wa. 99213

Jackson Park Municipal G. C.
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Seattle, Washington 98125
Attention: R. Werth

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4101 Beacon Avenue South
Seattle, Wa. 98144

Jenks-White Seed Co.
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Salem, Oregon 97308

Robert Trent Jones, Inc.
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Bremerton, Wa. 98310
Attention: Harvey Banks

Wilber-Ellis Co.
2460 6th Ave. South
Seattle, Wa. 98134
Attention: J. R. Fisher

Glendale Country Club
13440 Main Street
Bellevue, Wash. 98004

Lake Oswego School Dist.
658 First Street
Lake Oswego, Oregon 97034

Malmo Landscapers Northwest, Inc.
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Tacoma, Wa. 98467
Attention: George Harrison

Lewiston Golf & Country Club
Lewiston, Idaho 83501

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Attention: Vern Turgion
5200 Denver Ave. South
Seattle, Wa. 98108

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Attention: R. O. Oliphant
109 S. E. Alder Street
Portland, Oregon 97214

Loamite Corporation
One Bush Street
San Francisco, Calif. 94104
Attention: R. W. Lateer

Manito Golf & Country Club
Box 8025
Manito Station.
Spokane, Wa. 99203
Attention: C. Everhart

A. Charles Hoydar & Assoc.
4612 Union Bay Place N. E.
Seattle, Wa. 98105

Marine Drive Golf Club
P.O. Box 5039 Postal Stn. E
Vancouver, B. C. Canada (13)

McChord Air Force Golf Course
McChord, Wa. 98438
Attention: Joe Bishop

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1301 Michelbook Lane
McMinnvelle, Oregon 97128

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Mount View Cemetery
Box 632
Walla Walla, Wa. 99362

Mountain View Memorial Park
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Tacoma, Wa. 98409

Moses Lake Golf Club
Box 1694
Moses Lake, Wa. 98837

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Olympia, Wa. 98501

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Lake Oswego, Oregon 97034

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1856 S. 112th Street
Seattle, Wa. 98188
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Rainbird Sprinkler Mfg. Co.
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Olympia, Wa. 98501

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Seattle, Wa. 98109
Attention: Carl Andresen

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145th and N. Greenwood Ave.
Seattle, Wa. 98177
Attention: Ken Putnam

Seattle Park Department
100 Dexter Ave. North
Seattle, Wa. 98109

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Junction City, Ore. 97448
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Renton, Washington 98055

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Spokane, Wa. 99201

Sun Dance Golf Course, Inc.
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Nine Mile Falls, Wa. 99026

Sunset Northwest
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Seattle, Wa. 98104

Tacoma Country & Golf Club
Gravelley Lake Drive S. W.
Tacoma, Wa. 98499
Attention: G. Lawton

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236 Co-City Bldg.
Tacoma, Wa. 98402
Attention: M. E. Anderson

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Vancouver, B. C., Canada
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Attention: A. D. Elliott

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Spokane, Wa. 99200
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Twin Falls, Idaho 83301

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341 E. Ohio Street
Chicago, Ill. 60611

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Hillsboro, Ore. 97123
Attention: Ron Collins

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Walla Walla, Wa. 99362

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Seattle, Wa. 98155

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Portland, Ore 97222
Attention: R. Schwabauer

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Woodinville, Wa. 98072

Willamette Valley Country Club
2396 N. E. Country Club Road
Canby, Oregon 97013

Wenatchee Golf & Country Club
Box 1479
Wenatchee, Wa. 98801

Wing Point Golf & Country Club
Rt. 5, Box 5195
Bainbridge Island, Wa. 98110
Attention: B. Bowers

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Tacoma, Wa. 98421

West Seattle Golf Course
4470 35th Ave. S. W.
Seattle, Wa. 98106
(Park Department)

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Box 171
Yakima, Wa. 98901

Jackson Park Municipal G. C.
1000 N. E. 135th Street
Seattle, Wa. 98125
Attention: Dick Haskell

Liberty Lake Golf Course
Box 235
Liberty Lake , Wa. 99019
Attention: B. Ashworth

Morton Chemical Company
1620 S. W. Custer
Portland, Ore. 97219
Attention: R. O. Hartman

Riverside Golf & Country Club
8105 N. E. 33rd Drive
Portland, Oregon 97211
Attention: L. Kussman

Morton Chemical Company
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Chicago, Ill. 60606
Attention: John C. Egbert

Sunriver Golf Links
c/o Sunriver Properties, Inc.
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Bend, Oregon 97701

Duane R. Coffman
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Seattle, Wa. 98109

Calvary Cemetery
7201 54th Ave. West
Tacoma, Wa. 98467

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Kent, Wa. 98031

Redmond Golf Links
7730 Leary Way N. E.
Redmond, Wa. 98052

Sahalee Country Club, Inc.
P.O. Box 183
Redmond, Wa. 98052

Sun Irrigation Co.
916 N. E. 64th
Seattle, Wa. 98115

Ocean Shores Estates, Inc.
Ocean Shores, Wa. 98551

Olympic Landscaping
941 North 182nd
Seattle, Wa. 98133

Baldwin & Son
4430 North 8th
Tacoma, Wa. 98406

Leon's Landscaping Service
7504 124th N. E.
Kirkland, Wa. 98033

Green Valley Turf Farms
8127 190th S. W.
Edmonds, Wa. 98020

Twin Lakes Golf & Country Club
3460 S. W. 320th
Federal Way, Wa. 98002

Fairwood Golf Club
17240 140th S. E.
Renton, Wa. 98055

Tam O'Shanter Golf Club
c/o Keith Gardner
1313 183rd Ave. N. E.
Bellevue, Wa. 98004

David R. Brown
RFD 1, Box 167
LaGrande, Oregon 97850

Swift Agricultural Chemical Co.
Box 245
North Portland, Ore. 97207

B. G. & P. Inc.
2041 South 320th (space 67)
Federal Way, Wa. 98002

Pacific Lutheran University
Maintenance Dept.
Tacoma, Wa. 98447
Attention: W. B. Moore

North Coast Seed Co.
2204 Airport Way South
Seattle, Wa. 98134

J. R. Fisher
c/o Wilber-Ellis Co.
2460 6th Ave. South
Seattle, Wa. 98134

Glenacres Golf Club
1000 South 112th St.
Seattle, Wa. 98168

Wilson & George Meyer & Co.
318 Queen Anne Avenue N.
Seattle, Wa. 98109

Dave Hulo
P.O. Box 16327
Portland, Oregon 97216

Griswold Controls
Box 1530
Costa Mesa, Calif. 92626

Vance Gribble
Cascade Golf Course
91 Spring St.
Seattle, Wa. 98104

Omer Henderson
Edmonds School District #15
3800 196th S. W.
Lynnwood, Wa. 98036

G. C. Frank
Northwest Hospital
1551 North 120th
Seattle, Wa. 98133

Cascade Golf Course
Cedar Falls Road
North Bend, Wa. 98045

Baldwin & Son
4430 North 8th
Tacoma, Wa. 98406

Bellevue Lawn Cemetery
311 116th S. E.
Bellevue, Wa. 98004

Bellevue Municipal Golf Course
111 116th Ave. S.E.
Bellevue, Wa. 98004

Diamond Alkali Co.
300 Union Commerce Bldg.
Cleveland, Ohio 44115

General Sprav Service of
Magnolia Inc.
1031 N. E. 114th
Seattle, Wa. 98125

W. R. Grace & Co.
Box 168
Halsey, Oregon 97348

Green Valley Turf Farms
8127 190th S. W.
Edmonds, Wa. 98020

Hayden Lake Country Club
Rt. 2, Box 14
Hayden Lake, Idaho 83835

LaGrande Country Club
Box 167
LaGrande, Oregon

Liberty Lake Golf Course
Box 235
Liberty Lake, Wa.

Leon's Landscaping Service
7504 124th N. E.
Kirkland, Wa. 98033

North Coast Seed Co.
2204 Airport Way South
Seattle, Wa. 98134

Northwest Mower & Marine Co.
1149 North 98th St.
Seattle, Wa. 98103

NORTHWEST TURFGRASS MEMBERSHIP DUES

1. Annual dues, $25.00, 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 $8.00.

3. NO INITIATION FEES ARE CHARGED.

4. Non members may attend the Annual Conference by paying a $25.00 registration fee. For further information on dues, contact the Northwest Turf Treasurer.