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Proceedings
Of the
34th Northwest Turfgrass Conference

Sept. 22-25, 1980
Sunriver Lodge
Sunriver, Oregon

NORTHWEST TURFGRASS ASSOCIATION

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PRESIDENT'S MESSAGE

Earl P. Morgan

With the conclusion of the annual conference, my term as a Director and President for 1979-1980 comes to a close.

It has been an eventful year. Dr. Roy Goss, our Executive Secretary, spent six months in New Zealand, and upon his return, Mt. St. Helens erupted causing havoc, all over eastern Washington, with the ash fallout. To be involved with the operation of our Association during Dr. Goss's absence was a privilege, and helping arrange our annual conference in Sunriver, Oregon, and the results were most gratifying.

As one studies the following Proceedings, he will note the quality of the professionalism of the speakers. We thank them for the time and knowledge they shared with us.

I wish to thank the Board Members, Dr. Goss and the membership for their ongoing support in keeping Northwest Turfgrass Association a leader in turfgrass research.

My sincere good wishes to Mr. Dick Schmidt, our President for 1980-81.

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FERTILIZATION AND ENVIRONMENTAL STRESS[1]

R.C. Shearman[2]

Each season, turfgrass communities are exposed to environmental stresses that affect their quality and usage. Turfgrass managers are faced with developing practical cultural systems that will help the plant withstand these stresses. Mowing height and frequency, irrigation, fertilization and pesticide applications are manipulated to benefit the grass plant and maintain the turf for its principle use. This article will be confined to turfgrass nutrition and fertilizer practices and their influence on the plant's ability to withstand stress.

Turfgrasses are exposed to heat, drought, desiccation, cold, shade, pests, and traffic during the course of a growing season. Alone or in combination, these stresses can seriously impair turfgrass growth and recuperative potential. Turf managers must study these stresses and their influence on the turfgrass plant to better understand the role of nutrition and fertilization in combatting turfgrass stress.

Heat Stress

Under most field conditions, heat and drought stress are closely associated. Many turfgrass nutritional aspects that influence heat tolerance also affect drought tolerance. A minimum level of nitrogen nutrition is essential to maintain adequate growth to withstand heat stress. However, when excessive nitrogen nutrition is practiced, the turfgrass plant becomes more prone to high temperature injury. This is generally associated with an increase in tissue moisture

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1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

2/ Turfgrass Specialist, Department of Horticulture, University of Nebraska, Lincoln, NB.

content and succulence. Succulent tissue is more prone to injury. Increased potassium with increased nitrogen improves heat tolerance when compared to high nitrogen levels alone. Similarly, adequate phosphorus levels are needed to maintain sufficient root growth and rhizome growth. High nitrogen and phosphorus nutritional levels interact to reduce heat hardiness of turfgrass plants.

Properly timed late-season fertilizer applications combined with late-spring applications can reduce susceptibility to heat stress. Late-season applications should be made about the time of the last mowing in the fall. At this time, the turf is slowing down in its vertical elongation of topgrowth, but its root growth is still continuing. The turf can take up some of the applied fertilizer without causing excessive growth. In the spring the turf will green-up earlier and have a slower but steadily improving growth rate when compared to plants fertilized in the early spring. Heavy spring fertilization promotes lush, rapid growth that is difficult to mow and more prone to heat and drought stress.

Drought Stress

When water limits or prevents turfgrass growth, the plant is drought stressed. Slow growing plants tend to have smaller cells and increased cell-solute content with increased drought hardiness. Factors such as high nitrogen nutrition levels increase cell size and tissue moisture content, and reduce drought tolerance. Potassium deficiency reduces drought resistance. Low potassium levels result in increased transpiration or water loss and promote wilt. Adequate potassium levels enhance water retention and increase cell turgor pressure. Phosphorus deficiencies are associated with a reduction in extent and depth of turfgrass rooting which in turn affects the plant's ability to tolerate drought stress. Fertilizer programs should be adjusted to prevent rapid, succulent growth during periods of drought stress. Fall fertilizer programs are well suited to turfs that typically become dormant due to drought stress.

Desiccation

Winter desiccation is a prominent environmental stress factor on turfs growing in the Great Plains. Adequate N-P-K levels are essential to maintain turfs that can recover from this injury. Potassium deficient turfs are prone to desiccation. Turfs receiving excessive nitrogen are also prone to injury. Nitrogen and iron interact to influence the degree of winter desiccation injury. Iron, with proper application timing, can reduce some of the detrimental aspects of nitrogen on winter desiccation.

Low Temperature Stress

Vigorous-actively growing turfgrass plants lack low temperature hardiness. They tend to have high tissue moisture content and reduced carbohydrate levels. Low potassium levels and high nitrogen levels result in reduced low temperature tolerance. Increased potassium fertilization levels reduce the detrimental influence of increased nitrogen on turfgrass low temperature tolerance. Nitrogen-potassium ratios approaching 2:1 have been suggested as the optimum for minimizing injury. More work is needed in this area to delineate the relationship of nitrogen and potassium in minimizing direct low temperature injury, especially in conjunction with hardened versus non-hardened plants. Some preliminary work conducted at Nebraska has indicated a beneficial effect from potassium applications in reducing direct, low temperature injury of unhardened Kentucky-31 tall fescue plants. Hardened plants were influenced by potassium but not to the same degree as unhardened plants.

Enhancement of low temperature tolerance with phosphorus or potassium fertilization is primarily successful where either or both of these nutrients are limiting. In areas where potassium is deficient, late-season applications do not satisfactorily enhance cold tolerance of susceptible species. These applications need to be made in the early fall, so that the plant can assimilate the potassium adequately before being exposed to low temperatures.

Shade

Many turfgrass areas are exposed to some degree of shade, during the course of a day. Prolonged periods of low light intensity stress the turfgrass plant. Turfs growing in heavy shade are succulent and more disease prone. Excessive nitrogen nutrition increases tissue succulence, reduce carbohydrate synthesis, and produces tissues that are prone to injury from disease and wear. In addition, surface fertilization encourages tree root competition. Deep fertilization should be practiced to encourage deeper tree root growth and minimize tree-grass, root competition. Excessive surface applications of fertilizer in the shade can affect the turfgrass community. Red fescue, the desirable turfgrass species for many shaded areas in northern climates, can be driven out of the turfgrass community by excessive nitrogen fertilization. Adequate phosphorus and potassium nutritional levels are also critical to maintain adequate root and rhizome growth in shaded areas.

Late-season fertilization programs are also well suited to turfs growing in shaded areas. Late in the season, tree root competition is less of a factor and the improved light penetration to the turf community makes late-season fertilization practices conducive to better growth of adapted species in shaded areas.

Pests

Turfgrass pests influence the quality and use of a turf. Actively growing plants that are adequately fertilized are essential to maintain the recuperative ability of a turf and increase its potential to withstand pests such as insects, nematodes and fungi.

Kentucky bluegrass billbug and sod webworm are more active on lush well fertilized turfs than on slow growing or dormant turfs. Injury by these insect pests is greatest on these kinds of turf. However, adequate N-P-K levels must be maintained in order to encourage the recuperative potential. Fertilization practices alone cannot eliminate the insect injury but they can improve the recovery of the turf and pesticides are necessary when infestations interfere with turfgrass quality and use.

Weed competition increased with inadequate levels of nutrition. Nutrient imbalances can also influence weed competition. High soil phosphorus levels encourage clover and annual bluegrass competition in turfs. Increased sulfur levels reduce annual bluegrass competition.

Nutritional level influences turfgrass disease incidence. Nitrogen level and timing of its application influences disease development. Early-spring applications of water-soluble or readily available nitrogen increases leaf spot and *Fusarium* blight problems on susceptible turfs. Low nitrogen nutrition tends to increase the susceptibility to dollar spot, rust and red thread. While high levels of nitrogen nutrition promote leaf spot, brown patch, *Ophiobolus* patch, *Pythium* blight, *Fusarium* blight, snow mold and stripe smut. Phosphorus level influences the susceptibility to stripe smut. High phosphorus levels reduce the incidence of stripe smut and *Ophiobolus* patch in susceptible turfs. Potassium reduces dollar spot and red thread severity. Sulfur reduces the severity of *Fusarium* patch and *Ophiobolus* on susceptible turfs.

Traffic

Intense traffic results in increased turfgrass wear injury and compaction problems. Adequate N-P-K levels are essential to maintain desirable verdure to cushion the crown against injury and maintain sufficient recuperative potential. When nutrients are lacking, wear tolerance and recuperative potential decline. Wear tolerance increases with nitrogen, until a critical nutritional level is reached. At this point, added nitrogen results in succulent tissues with thin cell walls that are prone to wear injury. Turfgrass wear tolerance increases with additional potassium nutrition.

Summary

The influence of turfgrass nutrition on the ability of the plant to withstand stress is complex and constantly interacts with the environment and other cultural practices. Nutritional programs that maintain adequate growth for recuperative potential should be promoted. Nutritional programs that encourage excessive growth should be avoided. This makes good economic sense, and promotes more efficient energy and resource utilization.

PROBLEMS, PROGRESS, AND PLANNING[1]

Donald D. Hoos[2]

It's a pleasure to once again attend and participate in the Northwest Turfgrass Conference. It continues to be one of the best conferences in the nation. The members of the Northwest Turfgrass Association can be truly proud of their organization.

Today, I would like to briefly discuss with you some of the problems observed on golf courses in the Northwest during the past year. Progress in achieving solutions to some problems will also be mentioned. Perhaps more important to most turf managers is developing effective plans to solve problems encountered in their operations. The planning process can be difficult, but will pay important dividends if effectively practiced.

PROBLEMS (Slide Presentation)

Let's begin by reviewing some of the problems observed during the past year. If we ignore Mount St. Helens, Mother Nature treated us much better in 1980 than in 1979. The winter was much milder and very little winter damage occurred on golf courses. Summer temperatures were also milder, and there was much less disease incidence in 1980. Anthracnose and Leaf Spot were less common. Several courses reported a high incidence of disease on Poa annua greens with low soil pH. On courses practicing a program of sulfur applications to control Poa annua, there were obvious signs of physiological stress on the Poa. In some cases, disease symptoms were found. But whatever the mechanism involved, it is obvious that Dr. Goss' program of low soil pH is effective in controlling Poa annua.

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2/ Western Director, U.S.G.A. Green Section, Tustin, CA.

CHEMICAL MISAPPLICATIONS

During the past few years we are observing with increasing frequency damage to turfgrass caused by chemical misapplications. Courses in the Northwest are not immune to this problem. I visited several courses in this area where substantial turfgrass loss had occurred due to chemical misapplications. Label recommendations should be followed closely during any chemical application whether it be herbicides, fungicides, wetting agents, or fertilizers. As these slides illustrate, any chemical being applied to turfgrass can create problems. Operators should be well trained and closely supervised. Recovery from chemical damage can take quite a while. On the courses seen in these slides, it took fully six months to achieve recovery.

PROGRESS (Slide Presentation)

Many courses are making progress in solving their problems. Improved drainage is a continuing effort in your area. Many courses have developed extensive drainage improvement plans and are implementing the plan as time and labor permit. In the high rainfall areas of the Northwest, this is a continuing and needed program.

Development of improved equipment has helped many courses minimize damage to turfgrass. For example, hydraulically driven reels on fairway mowing equipment can reduce tracking and rutting caused by tractors.

Improved control of irrigation systems with modern controllers is also important to progress on many courses. The ability to apply only the amount of water needed by the turfgrass plant can eliminate many problems on the golf course. Disease incidence can be reduced. Drainage problems can be minimized. More conservation of water can be achieved.

PLANNING

Good management means never stopping the planning process, whether talking about the day-to-day operation of the golf course, solving drainage or irrigation problems, or planning equipment purchases. Even the simple task of equipping a section vehicle requires planning. If you can visualize the top 100 golf courses listed in Golf Digest each year, one thing becomes obvious, especially if you have the privilege of visiting some of these courses. Most are well managed; everything involving the golf course operation is well planned. No decision is made quickly, no matter how trivial it may seem. The planning process is continuous.

The golf course superintendent must be intimately involved in the planning process. He is the one most familiar with golf course problems. His recommendations for solutions should be sound, thorough, and based on the latest technical information. In solving problems, the long term effect on the golf course should be considered. Is an immediate solution to a problem ultimately going to result in a bigger problem? This must be considered and probably is one of the major responsibilities of the superintendent. Many courses have found it advantageous to develop a long range plan. In this plan, such things as tree plantings, drainage, irrigation system renovation, green rebuilding, etc. can be considered. Several key people at the club such as past presidents, professionals, green chairmen, and the golf course superintendent should provide input to such plans. A good long range plan can be invaluable to a golf course.

I recently read a book called "Restoring the American Dream." The book is about libertarianism. The libertarian philosophy basically believes that no government is the best government. In the book, the author states that one of the major problems in America is the vote. His reasoning is that elections elect officials who make promises that provide short term solutions to problems so that officials can get elected. This analogy may also apply to many country clubs. The golfer is only concerned with playing conditions today. Short term solutions to problems will appease him, but later, greater problems may result. The golf course superintendent must be concerned with the many tomorrows and the long term solution of problems on the golf course.

AIR POLLUTION AND THE GREEN INDUSTRY[1]

W.J. Johnston[2]

Air pollution is not always a popular subject to discuss. Many in our industry don't consider it a problem, at least not a "real" problem like diseases, insects, weeds, etc. Others feel if it is a problem there is little they can do about it. Therefore, the recent research update article in the August, 1980 issue of Golf Course Management makes my task somewhat easier, for it indicates that personnel in the Green Industry are becoming aware of the importance of air pollution and the impact it has on our industry. Also in the same issue I noted that Dr. Ray Dickens of Auburn University had been awarded a grant by the CGSAA to study the effects of ozone on tall fescue. I think these are two important steps: 1) recognition of the problem, and 2) research on the problem. However, this Conference, that is actually getting the information out, is equally if not more important if progress is to be made on this problem.

Several questions arise when one thinks of air pollution: 1) Do we have air pollution in the Pacific Northwest? 2) Where does it come from? 3) What does it look like, i.e., what are the symptoms? 4) What harm does it do? and 5) What can we do about it? These are some of the questions I will try to answer.

Do we have Air Pollution in the Pacific Northwest?

Plant injury from industrial fumes and dusts has been recognized since the 1800's. Many chemicals if present in the atmosphere can cause plant injury. However, only a few are common enough to be a major prob-

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2/ Assistant Professor, Washington State University, Pullman, WA.

lem. These are: sulfur, dioxide, fluoride, ethylene, nitrogen dioxide, peroxyacetyl nitrates (PAN), ozone, acid rain, and industrial dusts. Of this group ozone is by far the most important pollutant affecting vegetation.

Using data from Washington State as illustrative of the air pollution in the Pacific Northwest, we find that several areas were designated in 1978 by the EPA as not attaining the national air quality standards. These are listed below:

Nonattainment Areas in Washington State

Total suspended particles: Central area of Port Angeles, south Seattle, Duwamish Valley, Kent, Renton, Tacoma tideflats, industrial areas of Longview, port area of Vancouver, Clarkston, and Spokane.
Sulfur dioxide: Portions of Tacoma and south of Ruston.
Carbon monoxide: Seattle-Tacoma-Everett urban area, Spokane and downtown Yakima.
Ozone: Greater Seattle-Tacoma area and Vancouver urban area.

I have added carbon monoxide to the list, even though it is not listed as a phytotoxic air pollutant, because of its known harmful effects on humans. Human beings are, after all, an important segment of the Green Industry. It would seem that from our list of eight phytotoxic air pollutants we are affected by only three. However, there is a catch. Only three of the phytotoxic air pollutants I have listed are routinely monitored by Washington State; therefore, we are in effect batting 100%. In summary, there is air pollution in the Pacific Northwest.

What are the Sources of Air Pollution?

For the most part environmental pollution is a man-made problem. The motor vehicle is the single most important source of atmospheric pollution. Industrial sources are a distant second, emitting about 1/4 as much as transportation. Generation of steam and electricity produce slightly less. The composition of pollutants from various sources differs greatly, with industry emitting the most diversified pollutants.

The following table shows the primary sources and distribution of what are probably the three most important air pollutants in the Pacific Northwest.

	Sulfur dioxide	Fluoride	Ozone
Source:	Coal combustion Petroleum combustion Smelting	Aluminum Steel Ceramics Chemicals	Automobiles Industrial combustion Oil refineries
Distribution:	Point source; 0 to 25 miles	0 to 25 miles	Widespread; 100 to 200 miles

In addition to its extreme phytotoxicity, the widespread distribution of ozone contributes enormously to making it the number one air pollution problem for vegetation.

What are the Symptoms?

The following is a brief summary of the chronic symptoms caused by sulfur dioxide, fluoride, and ozone to vegetation.

Sulfur dioxide: Gradual yellowing of the leaf interveinal area; progressive bleaching of the leaf; tissue does not collapse following injury.

Fluoride: Initial water soaked appearance of the leaf tip; subsequent reddish-brown lesions appear and extend down the leaf in a fairly uniform front.

Ozone: Initially, light brown lesions appear; necrosis and bleaching of the leaf tip follows; red fescue has minute, dark brown stipples; ryegrass has a glossy dark brown color to the entire leaf.

The above is a general guideline. Various environmental factors have been found to increase plant injury from phytotoxic air pollutants. Most factors which favor a high level of physiological activity within the plant, especially those which favor a high rate of gas exchange within the leaves, increase injury due to air pollutants.

What Harm does Air Pollution do?

From the slides I've presented showing visible injury to various types of vegetation and from pictures you have seen elsewhere I think it is well accepted that air pollutants can indeed harm vegetation. However, I would like to present some data that indicates that some air pollutants can cause harm without obvious injury to plants.

I have recently completed a series of experiments investigating the effects of ozone on the growth of tall fescue (Festuca arundinacea Schreb.). As part of this study tall fescue was exposed to 0.08 ppm ozone for 7 hours per day over a 6-week period. The 0.08 ppm level was the former standard for ozone. The standard was subsequently raised to 0.12 ppm in 1979; therefore, these studies were conducted at levels substantially below those now permitted by federal law. I would also point out that during the 6-week ozone exposure the tall fescue showed no visible symptoms of injury. Table 1 shows a comparison of my findings on tall fescue and those of Bennett and Runeckles at the University of British Columbia (Agron. J. 17:443-445) with annual ryegrass (Lolium multiflorum Lam.).

Table 1. Effects of ozone on turfgrass growth.

Species	Leaf dry wt.	Above ground dry wt.	Root dry wt.	Leaf area	Tiller number
	% Change				
Ryegrass	--	-22*	-32*	-23*	--
Tall fescue	-17*	-16*	-8	-13*	-8

* Significant at the 5% level.

Exposure to ozone thus caused a significant reduction in several growth factors. Yet as I've indicated, the plants showed no visible symptoms of injury.

Table 2 shows the effect of ozone on the nutrient and chlorophyll content of tall fescue leaves.

Table 2. Effects of ozone on nutrient and chlorophyll content in foliage of tall fescue.

Nutrient or Chlorophyll	Change
	(%)
P	-8
K	-4
Ca	-6
Mg	-27*
Chlorophyll	-13*

*Significant at 5% level.

Exposure to ozone reduced both Mg and total chlorophyll in the leaves of tall fescue. P, K, and Ca although statistically unaffected were reduced somewhat. These types of trends indicate that many physiological processes were impaired in the plants due to exposure to ozone. In short, it appears that low-level long-term exposures to ozone can cause growth reduction and adversely alter many physiological processes in turfgrass species.

<u>What Can You Do About Air Pollution?</u>

1. Be aware of the problem. I think this is the most important statement of my presentation. We should become aware that a potential problem does exist and could be getting worse.

2. Recognize the symptoms. Try to become familiar with what the various pollutants do to plants. Especially study their effects on the most sensitive indicator plants such as <u>Poa annua</u>. Remember, thinking you have a disease problem and treating with fungicides, when actually the damage is caused by

air pollutants, is a very effective means of throwing your money away.

3. Select resistant varieties. If you are in an area of known high concentrations of air pollutants, it might be well to consider choosing resistant varieties. In the future it is possible that plant breeders will be screening and developing varieties resistant to air pollutants much as they presently do for resistance to many common diseases and pests.

LOW MAINTENANCE AND QUALITY TURFGRASSES[1]

C.R. Skogley[2]

Most Americans have begun to realize that our natural resources are limited. If for no other reason costs of doing what we have always done have escalated to the point that we may think twice before taking an action or making a purchase. A few years ago we thought nothing of burning petroleum products, using more fertilizer, using water when and how we wanted, applying pesticides in unlimited quantities and in general, being somewhat extravagent as the means of reaching our goals in turfgrass or crop production. The "so-called" energy crises of the early 1970's, and more recently, created many changes, both in thinking and in action. We began to wonder how we could reduce our dependency in management if we wanted to or had to. Agronomists have known how and can prescribe management that will result in perfect turf as long as costs are not an object. We may have had this luxury for quite a few years but this time is past. As individuals or as a nation we cannot afford to be wasteful, if not of dollars, most certainly not of our natural resources.

For the past 20 years our turfgrass research program in Rhode Island has been geared toward finding simpler, less costly ways of providing and maintaining acceptable turf. A summary of many of the things we have been doing will be presented with slides. They include some of the following:

1. Soil modification. This is potentially one of the major ways in which we can simplify turfgrass production.

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2/ Turf Research Specialist, University of Rhode Island, Kingston, RI.

2. Test or screen our grasses or other plant material (?) on soils of poor quality or at least on soils representative of the area or region.

3. Modify our soils chemically with limestone, phosphorus, etc. adequately at establishment.

4. Utilize grasses or grass mixtures most adapted to the soil, climate and use.

5. Apply fertilizers at the optimum season, rate and frequency, utilize the most efficient forms of fertilizer.

6. Provide protection from damaging insects.

7. Consider the possibility of utilizing grasses or ground covers other than those we have come to take for granted.

8. Increase research in seed production to assure ample quantities of good quality seed of whatever variety or species does the best job.

9. Make most efficient use of water.

10. Increase our awareness of integrated pest management possibilities.

11. Consider cutting height and mower type influence on turfgrass performance.

12. Consider the purpose or function of turfgrass and program the management so that it meets our needs rather than exceeds it -- under-do rather than over-do and learn that color is not necessarily a criterion of quality.

TURFGRASS SOILS[1]

Jim Barnes[2]

So many words have been written about soil and its relationship to plants. There hardly seems to be an area where additional opinions on the subject aren't running the risk of being redundant. The only recourse is to go ahead and write this from a turf manager's viewpoint and hope that it will in some way be of benefit to you.

Only too well I remember the days of listening to and trying to understand the reasoning behind the reaction I was seeing in turfgrass as a result of my overzealous applications of some ingredient or another. I remember the days when a gut feeling told us what to apply and, of course, "if a little bit was good"...we generally over applied.

Those first years as a laborer on a golf course, listening to the "old timers" discuss the idiosyncrasies of their particular grass, instilled in me a real desire to want to know more of what is really going on down there in the micro-world of the turfgrass plant.

So began a career in turf management with all the mistakes, indigestion, and bewilderment that accompanies a real learning experience.

The key I've found to good turf management is an understanding of the soils in which the turf is growing. While I probably will never completely understand everything there is to know about soils, I've been able to pick-up a few basics that seem to help a great deal.

To begin with, a plant has to have available to it certain elements or nutrients in order to grow and function. There are sixteen plant essential elements that

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2/O. M. Scotts and Sons, Marysville, OH.

must be present for grass to do its thing. One of the more important points concerning these elements is that when they are in the plant available form they generate an electrical charge. These plant available nutrients are said to be in their "ionic" form. Some will exhibit a positive charge and some will have a negative charge. The positively charged ions are placed in a general category of "cations" while the negatively charged ions are called "anions". From the following list you can see that there can be more than one positive or negative charge generated by a single ion. Also note that it is possible for some nutrients to have more than one ionic form and that these different forms can have varying degrees of electrical charges.

Element	Chemical Symbol	Source	Ionic or Plant Available Form
Nitrogen	N	S-F	NH_4+, NO_3-
Phosphorus	P	S-F	HPO_4=, H_2PO_4
Potassium	K	S-F	K+
Sulfur	S	S-F	SO_4=
Calcium	Ca	S-F	Ca++
Magnesium	Mg	S-F	Mg++
Iron	Fe	S-F	Fe++, Fe+++
Manganese	Mg	S-F	Mn++
Boron	B	S-F	H_2BO_3-
Copper	Cu	S-F	Cu++
Zinc	Zn	S-F	Zn++
Molybdenum	Mo	S-F	MoO_4=
Chlorine	Cl	A-W	Cl-
Carbon	C	A	CO_2=
Hydrogen	H	A-W	H+
Oxygen	O	A-W	Many forms

S = Soil, F = Fertilizer, A = Air, W = Water

Keeping all this in mind, let's look at the next step towards understanding turfgrass soils. Just as we have discussed the charges of plant available nutrients I would like to address the electrical charges in soil. Basically these charges are derived from the clay and/or the organic fraction. Sand and silt are not chemically active. This is a very important point which we will return to in step three of understanding turfgrass soils.

During the original chemical formation of clay particles, many negative charges are created. These charges come as a result of a physical replacement or substitution of cations. For example: a montmorillonite clay will have one out of every six aluminum ions replaced by a magnesium ion. Aluminum has a plus 3 charge and magnesium has a plus 2 charge. This creates within this newly formed clay mineral permanent, unsatisfied, negative charges which will attract positively charged ions or cations from the soil solution. It should be noted that, while they are few in number compared to negative charges, there are also positive exchange sites on clay particles. Fracturing and weathering of clay breaks some of the chemical bonds of the cations within the mineral structure and exposes the positive charges to the surface. Anions are then attracted and held for exchange with the soil solution.

The electrical charges derived from the organic fractions of soil are a result of decomposition and the subsequent loss of hydrogen ions (H+) into the soil solution. This leaves behind unsatisfied negative charges within the organic structural complex.

There are very few positive sites available for anion exchange purposes in the organic fraction of soil.

We have discussed the electrical charges of both the plant essential nutrients and the soil or growing medium. The significance of this point is that because of the attraction of positive and negative charges the soil has the capability of holding nutrients in reserve and releasing them to the soil solution for plant use.

Hopefully this preliminary discussion has not been oversimplified. The principle of ionic exchange is the basis for understanding the turfgrass/soil relationship and it must be understood to have the rest of the soils story be meaningful.

Now let's enter into the third phase of contributory facts that effect the soil environment of turfgrass. The physical attributes of a soil will greatly influence the total success or failure of a turfgrass maintenance program.

As mentioned earlier sand and silt are not considered chemically active within the soil complex. This doesn't mean to imply that they are not important. Sand particles actually serve as a framework around which the active part of the soil is associated. When present in the right proportion to the clay and silt fraction, sand will increase the size of spaces between particles. The larger the size of the pore space the faster water will move through it. As the speed of infiltration or percolation of water increases, leaching of exchangeable ions increases.

In the event that salts were a problem this increase of water movement would be valued rather highly. In terms of keeping a constant supply of nutrients available to the grass plant this feature of increased water percolation might be considered a liability. Nonetheless, sand is an important tool for modifying a soil profile to accomplish the desired rate of water movement. Conversely, if water retention is the goal, the logical approach would be to reduce the pore space size. Three soil fractions can produce this effect of reducing pore size within the profile; clay, organic matter, and silt. The chemical activity of clay and organic matter have been touched on and, at this point, it would be proper to mention that they also have a high attraction for water molecules.

The physical and chemical make up of clay creates an almost tenacious competition for water and relinquishes only those water molecules in the outer film surrounding the clay colloid. Now is the time to inject an important word of caution, as we are about to discuss the silt fraction of the soil. To begin with, silt has several noteworthy characteristics. It actually consists of very small particles of sand, mostly quartz in composition. These particles do not have an attraction for one another and will shift and settle to fill pore spaces within the soil profile.

This does two things: 1) the addition of silt will increase the surface area and the subsequent water retention through the forces of adhesion, and 2) silt will reduce the percolation rate or water movement in the soil. This is a good news, bad news story. Soils with the largest capacity for holding plant available water are characterized by being high in silt. In the presence of decaying organic matter or humus (which acts as a cementing agent) silt particles may cement together and form very hard layers in the soil profile.

The application of this principle, for us as turf managers, is to exercise careful consideration of the percentages of silt and organic matter in the soil we use. Greens construction and topdressing material should generally be limited to a silt content of 5% or less. Topsoil used for fairways, athletic fields, and home lawns is not as easy to control, therefore, frequent aerification may be necessary if you suspect a high silt percentage.

It starts becoming quite evident that as this discussion procedes that a foundation is being prepared for a rather complex final phase of understanding turfgrass soils. This is through the use of soil testing.

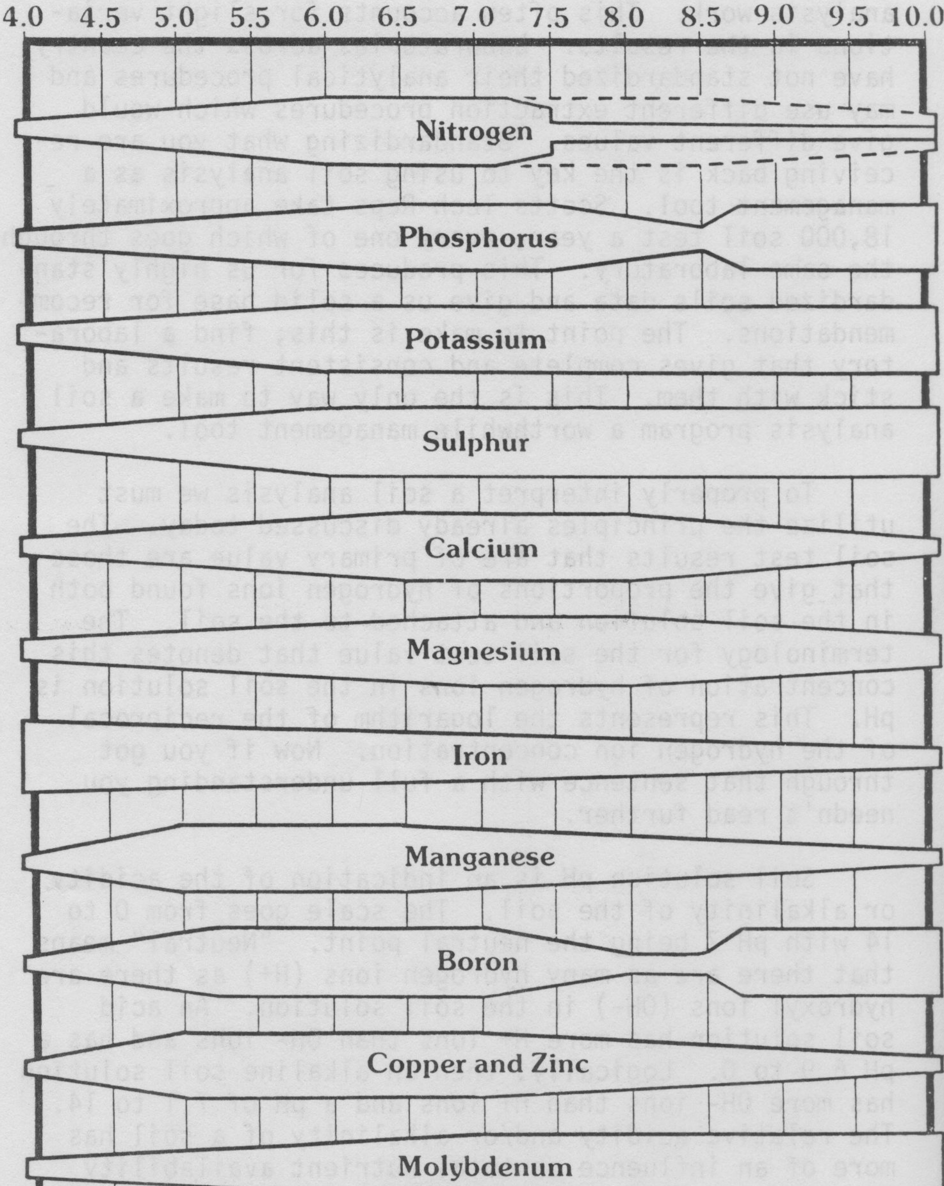
The analysis of soils has long been a source of bewilderment and confusion to turf managers, mainly because of an interesting phenomenon that can be observed all over the country. For every 10 laboratories that an identical sample is sent to, there will be returned to you at least eight different results and recommendations.

Only a quick point on this and we'll move on. Different analytical answers for identical soils could be the result of several factors and does not necessarily mean that one laboratory is more accurate than another.

Many university labs have a periodic change over of people, generally graduate students, performing the analysis work. This often accounts for slight variations in the results. Laboratories across the country have not standardized their analytical procedures and may use different extraction procedures which would give different values. Standardizing what you are receiving back is the key to using soil analysis as a management tool. Scotts Tech Reps take approximately 18,000 soil test a year, every one of which goes through the same laboratory. This produces for us highly standardized soils data and give us a solid base for recommendations. The point to make is this; find a laboratory that gives complete and consistent results and stick with them. This is the only way to make a soil analysis program a worthwhile management tool.

To properly interpret a soil analysis we must utilize the principles already discussed today. The soil test results that are of primary value are those that give the proportions of hydrogen ions found both in the soil solution and attached to the soil. The terminology for the soil test value that denotes this concentration of hydrogen ions in the soil solution is pH. This represents the logarithm of the reciprocal of the hydrogen ion concentration. Now if you got through that sentence with a full understanding you needn't read further.

Soil solution pH is an indication of the acidity or alkalinity of the soil. The scale goes from 0 to 14 with pH 7 being the neutral point. "Neutral" means that there are as many hydrogen ions (H+) as there are hydroxyl ions (OH-) in the soil solution. An acid soil solution has more H+ ions than OH- ions and has a pH 6.9 to 0. Logically, then an alkaline soil solution has more OH- ions than H+ ions and a pH of 7.1 to 14. The relative acidity and/or alkalinity of a soil has more of an influence on total nutrient availability than any other single factor. The pH/nutrient availability chart which accompanies this paper explains it all pretty well. The widest portion of the individual bands indicates it all pretty well. The widest portion of the individual bands indicates the greatest availa-



Nutrient Availability as Influenced By Soil pH bility and would suggest that a pH of 6.5, which is slightly acid, affords the most plant available nutrients. Earlier I mentioned that the hydrogen attached to the soil was also important. We determine this portion of the H+ concentration by adding what is known as a buffer solution to the soil sample and taking a regular pH reading after so many minutes and some stirring. In effect what you have is another pH reading that reflects the hydrogen that was exchanged off the soil. The importance of this is that we can use these values to determine an appropriate liming recommendation. Without this extra reading, an application of enough lime to correct an acid soil solution would only do just that. The hydrogen attached to the soil would be exchanged into the system and you'd be right back where you started. By using the buffer pH reading, we not only correct the solution pH but we counter the H+ ions that will enter the solution from the reserve held by the soil. A buffer may be classified as a soil's resistance to change. This buffer concept, as you will see later, can apply to more than the pH of a soil.

Remember the earlier part of the paper about the electrical charges of ions? We can apply that to the next item on the soil analysis sheet. Soluble salts are the results of the combining of a positively charged ion and a negatively charged ion. Generally we are concerned about those salts which have a solubility greater than gypsum. Examples of the more common soluble salts would consist of varying combinations of the following ions:

Cations	Anions
Sodium (Na^+)	Chloride (Cl^-)
Calcium (Ca^{++})	Bicarbonate (HCO_3^-)
Magnesium (Mg^{++})	Sulfate (SO_4^{--})
Potassium (K^+)	Nitrate (NO_3^-)
Ammonium (NH_4^+)	Carbonate (CO_3^{--})

The actual number you see on the test is an electrical conductivity reading expressed in millimhos per centimeter. The general guidelines we have found as optimum for turf is in the range of .25-.60. Soluble salt readings below .2 indicate that the grass plant simply isn't getting the amount of nutrients that it should in order to function properly. A reading of more than .7 or .8 begins to point towards a possible problem. An understanding of this problem lies in an introduction to plant physiology. Water will move through the membrane of plant root cells by a principle called osmosis. To explain how this works I'd like you to invision a glass of pure water divided down the middle by a membrane such as found surrounding a plant cell. Water can move freely through this membrane however salts cannot. If you pour salt into one side of the glass and mix it thoroughly an interesting phenomenon will occur. The water from the pure side will move through the membrane to the salty side. A grass plant produces carbohydrates and sugars by photosynthesis in the leaves and transports these throughout the plant with most of it concentrating in the root system. This concentration inside the plant root cells allows the plant to take up water from a moderately concentrated soil solution because the water will move from the area of least concentration to the area of greatest concentration. If, just as in the glass of water, the soil solution becomes too concentrated with soluble salts, the grass plant will have a great deal of trouble taking up water and may even lose water to the soil solution. This can be witnessed in a situation called "wet wilt" where, even though water is present, the grass plant simply cannot use it because it is more concentrated with soluble salts then the solution inside the root cells. I hope this points out the practicality of soluble salts reading.

I really don't wish to expand on individual nutrient levels in this paper but one does deserve an honorable mention. Phosphorus is a nutrient whose availability is very pH dependent. Too acid of conditions and it will be tied up by iron and aluminum; too alkaline and it will become unavailable to plants as a calcium compound. Phosphorus really needn't be present in quantities over 50 ppm to maintain healthy turf. Excesses over this will result in an increasing tendency to tie up minor elements and create a somewhat "puffy" turf. However, an application of phosphorus is always appropriate when seeding.

The elements of potassium (K^+), magnesium (Mg^{++}), calcium (Ca^{++}), and sodium (Na^+) are cations which are a group we call the bases. These four in addition to hydrogen (H^+) occupy the biggest percentage of the negative exchange sites on a soil. To measure the relative ability of a soil to attract and retain these cations for later exchange with the soil solution, a mathematical formula is used. It takes the soil test results of these base exchange ions and reduces them to a value called Cation Exchange Capacity or CEC.

Going back to the physical nature of soil you will remember that the more sandy a soil is the less nutrient holding capacity it has. By applying this principle the following chart shows that the lower the CEC value the more sandy a soil is expected to be and the less cations it will be able to retain. The greater the CEC value the more clay and/or organic matter will be present. This also means an increase in the negative exchange sites in the soil and its relative capability to adsorb cations.

CEC	SOIL TEXTURE
0-8	Sand
8-12	Loamy/Sand
12-20	Sandy/Silt Loam
20-28	Loam
28-40	Clay Loam
40+	Clay and Organic Soils

It would follow that the lower the CEC the more intensive the fertility program will have to be in order to maintain proper nutrient availability to the turfgrass. At this point I would like to bring up again the buffer pH concept. A highly buffered soil will be characterized by a higher range CEC value. Often the term "well buffered" is applied to soils that have a high nutrient reserve. This is frequently confused with the buffer pH reading and does not necessarily mean that a "well buffered" soil has a high hydrogen content on the colloid.

Now let's discuss these five major cations from yet another angle. It is very critical for these nutrients to be in the proper ratios or balance with one another. Fertilizer efficiency, plant vigor, and total soil nutrient availability is dependent upon the respective levels of these ions. I'd like to show you the relative activity or replacement capabilities of these five ions which occupy the biggest percentage of the negative exchange sites on a soil.

RELATIVE IONIC ACTIVITY

Hydrogen (H+)

Calcium (Ca++)

Magnesium (Mg++)

Potassium (K+)

Sodium (Na+)

From this you can see that the most active ion is H+. It can easily replace any of the other ions below it. The same holds true for Ca++, Mg++, and K+ with their respective energy level allowing them to replace easily those ions below them on the chart. Now we have the lowly Na+ ion that, even though it is at the bottom of the reaction list, can be a real pain in the grass, if you know what I mean. The point to make here is that the exchange activity of these ions can be overcome by merely flooding the system with any one of them. This concept should really be expanded to include the total soil/nutrient relationship. An overabundance of any one ion will start a domino effect of exchanges in the soil that will result in a predominance of the abundant ion.

The easiest way I've found to keep tabs on this activity is to utilize another soil testing value which merely offers a comparison of the five major cations in the soil from a percentage standpoint. It is called the Percent Base Saturation and is the result of the same mathamatical CEC formula which utilizes the parts per million of hydrogen, calcium, magnesium, potassium, and sodium. When these percentages are not in the ranges given in the following chart we can anticipate that you have had or will shortly have problems in maintaining green, vigorous turf.

PERCENT BASE SATURATION

Hydrogen	0-5%
Potassium	.7-7.7%*
Magnesium	15-20%
Calcium	65-75%
Sodium	0-5%

*Potassium will vary greatly depending on the CEC value. The lower the CEC the higher the potassium percentage should be.

Five major points have been covered that should be part of any good soil analysis.

1) pH
2) Buffer pH
3) Soluble Salts
4) Cation Exchange Capacity
5) Percent Base Saturation

With these soil analysis values a turf manager can truly determine the direction of his maintenance program. I have seen the principles talked about today applied to literally thousands of turf situations with consistent, successful results. These are not easy concepts to readily understand but they work and it isn't by coincidence or sheer luck! They are very definitely worth any time and effort you can put forth in order to know how to use them. They will help you turn seemingly impossible situations into beautiful turf. Bad turf is the result of very specific laws of nature and can be reverted to beautiful turf by utilizing these laws to work for you.

It can be very gratifying to have as a working knowledge the concepts of soil reactions in order to apply correct principles of turfgrass nutrition.

All of us at Scotts wish you well in your turfgrass career.

SURFACTANTS AND QUALITY TURF
OR THE WAY TO MAKE WATER WORK[1]

Robert A. Moore[2]

So far at this Conference you have been exposed to talks on Nutrition---Environmental Stress---Air Pollution ---Soils---and working for quality turf under low maintenance conditions.

I see in all these subjects a common factor---and that common factor is water. Water is basic to nutrition response and needs. Water is a major factor in environmental stress. Air pollution effects can be ameliorated to some extent by proper water management. One of the major aspects of soils is its response to water. And to me quality turf under low maintenance means precise water control. Water is a subject of growing interest to all people in the green world industry. Last year Dr. James Watson figured up the hours spent at different conferences on discussions of water in the previous two years, and came up with an impressive total of 700 hours. And this rate of interest is accelerating---Why? Because it must; we must learn more about water, and how to use it wisely, if we and this profession of yours are to survive.

You, as professional turf managers, know that plant growth and all biological systems are only possible on this planet because of water and its unusual combination of properties. Enviornmental extremes are tempered, and reduced by these properties. For instance, evaporation produces a cooling effect; condensation a warming effect. Water is a good conductor of heat, and thus distributes heat rapidly throughout the plant. Water adheres firmly to plant surfaces, and its tendency to be absorbed explains why there are large amounts of water in cell walls

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1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

2/ Aquatrols Corp. of America, Pennsauken, NJ.

and protoplasm; why cells swell when they take in water. Water is involved in every plant function as a constituent, a reagent, a solvent, and as a means of maintaining turgor. Because of its many unique properties, water is an essential factor to the very existence of life on earth.

In a recent article by Bob Riley called "Water and Circulation" he likens water to blood in our bodies and the ancient Chinese who ascribe all ills to poor circulation. He points out that anything that impairs water's proper circulation within the soil and within the plant weakens the plant. Proper circulation and supply of water means healthy plants. Thus the significance of proper soil and water management, and their key role in your profession.

Water is the most precious, most fragile of our natural resources, and yet in most parts of the world it is taken for granted. The amount of water on earth is constant. Think about that for a moment, it will be the same amount in 2030, fifty years from now, as it is today. But in our misuse of water we are polluting and wasting water faster than nature can purify it. Since water on turf, and particularly on golf course turf, is such a vital issue, people are constantly looking for ways and means to conserve and protect their water supply. Conservation of water is not only a necessity, it can be a real saving in reduced costs for the energy needed to pump that water---another very important item today.

Plants have a known requirement for water, depending of course, on such variables as: turfgrass variety, climatic conditions, cultural practices, and end use of the turf area. You hear in many of the discussions on water management that one should apply enough water, but not too much. What you, as practical operating turf managers, want to know is: How does one do this---apply just enough and not too much? Some aids you already have. Irrigation is one---and automatic irrigation is an improved aid. But as Dr. Watson pointed out at the 1979 USGA Green Section meeting: "---more golf greens were killed with improper irrigation in 1977 because there is a large gap between what we know and what we practice." He went on to caution everyone to operate their golf course as if they were in a drought---to establish watering priorities and sound irrigation practices.

So we have tools to apply water to the turf---to the turf surface that is---but we still must learn to use them properly, to get the most out of the water.

At the same meeting Rees Jones, then President of the American Society of Golf Course Architects, stated: "without good drainage, a course will lose revenue". He pointed out that water and drainage can be the most critical criterion for determining the site of a new course. Thus we have as the primary constituents recommended for any good water management program (1) the applying of water "soundly" to the surface as Dr. Watson advised, and (2) providing for good drainage as Mr. Jones specifies. Sometimes these recommendations are looked upon as the ultimate answer to water management.

I wish today to introduce or reintroduce to you the idea, and practice that can complete the above water management picture which now specifies a well designed irrigation and good drainage system. We feel that something is missing from this picture. That something is the rootzone area between the surface applied water, and the good drainage below. What is needed is a full consideration of the behavior of water in that root zone area. This is the area where the unusual properties of water that are so beneficial <u>within</u> the plant---the high tensile and surface tension of water---can cause turf related problems---localized dry spots; puddling; compaction; diseases; wilt; and shallow rooting. This is the zone where too much or too little water can result in turf losses.

I mentioned a moment ago that I wanted to introduce or reintroduce to you an idea and practice to "complete the water management picture". A way to actually control the surface applied water as it moves into and passes through the root zone area. A way to make water work more efficiently and thus make your whole operation more effective in growing quality turf.

We are talking about changing the physical properties of water so that the surface applied irrigation or rainfall will: (1) wet rapidly; (2) move uniformly throughout the root zone, uniformly moistening all of the root zone; (3) drain rapidly any excess moisture; and (4) increae the availability of the moisture remaining in the root zone. Sound impossible? Well let me show you a little demonstration. The most important point to be made at this time is that the media, soil in your case, has not been changed.

You may have noted that we haven't mentioned anything about the soil mixes or renovation up until this time. Yes, soil modification is another aid, like irrigation, for the management of water. But like irrigation one must learn to manage the modified soil. Further, modified soils, again like irrigation, are only a limited aid,---and when you highly modify the soil to increase drainage and reduce susceptibility to compaction, you usually increase localized drying and susceptibility to wilting. We'll see more on this in the slides. The main reason for not discussing soils in this presentation is because I want to stress what can be done in your root zones as they are. Think about it, most of your turf areas will never be modified regardless of how much money you have to spend. For this reason we are concentrating on what can be done to improve the existing root zone now, whether it be a heavy clay loam or a highly amended sandy green mix.

We have shown you in the demonstration that water can be physically changed to wet rapidly. This same principle allows for rapid spreading and uniform wetting. The low tensions in a treated profile releases any excess water so that drainage is improved.

Slides 1 and 2: The high tensions of plain water are at the heart of the problem of how water moves---or doesn't move in the soil.

Slides 3, 4 and 5: creating puddled areas

Slides 6, 7 and 8: thatch and its poor wetting and drainage characteristics are well known.

Slides 9 and 10: compaction, and poor drainage, limits root development.

Slide 11: Any one or all of these factors can result in a poor profile distribution of water and limit the availability of root zone moisture---regardless of the type irrigation applying the water to the surface, or the drainage provided below. Note the pattern of water distribution produced by aerifier holes, a common recommendation for correcting poor infiltration or poor soil conditions. Aerification helps, but only in a limited way.

Slides 12, 13 and 14: Now let's look at the action of surfactants, and evaluate their effect upon quality turf. Remember the demonstration? Remember the fast movement of the low tension water---how it penetrated, spread, and wet quickly?

Slides 15, 16, 17, 18 and 19: Once you treat an area with an effective wetting agent program, and have a treated root zone, your surface applied irrigation penetrates rapidly, wets and drains through thatch, and uniformly wets the <u>entire</u> profile. Again note the aerifier holes---but look at the distribution under treated conditions. Also note the root development as compared to the untreated profile (slide 20).

Slides 21, 22, 23 and 24: When you rapidly move the irrigation water into the root zone and away from the surface you reduce the potential for compaction. These data from the University of Maine show the reduced bulk density---reduced compaction---in the treated plot under actual fairway playing conditions. This means reduced turf losses in areas of heavy traffic. Note the depth of moisture penetration in the treated probe.

Slides 25 and 26: The improved drainage and reduced compaction aids in improved root development, shown in slide 19. These data from the University of California show how significant this effect can be under severe conditions. I might point out here that all wetting agents are not alike. Note the continuing improvement of root weight for Aqua-Grow even at many times the normal rate---WI shows some improvement. It would be well to bring up, at this time, some other comparative work, because all wetting agents are not the same. Drs. Beard and Rieke at Michigan State conducted tests on sandy soils that had developed severe localized dry spots---a condition that sandy green mixes are very susceptible to. You may remember I earlier mentioned how soil modification had some limits---you gain some advantages but also inherit some problems.

Slides 27, 28, 29, 30 and 31: Water repellent coatings develop on the soil surface and the area becomes almost impossible to wet. Beard's and Rieke's initial tests with out wetting agent showed a dramatic response. This led to expanded tests and product evaluation. The problem of localized dry spots can be quite extensive and severe. Many of these test plots are marketed wetting agents which as you see have little or no beneficial effect. These data indicate that you must use an effective material and you must use the specified amounts---small dosages do not always work!

Slides 32, 33, 34, 35 and 36: In their studies Drs. Beard and Rieke also evaluated the effect of cultivation technique, since these have been historically recommended for the prevention or curing of dry spots. This slide shows the lack of improvement in turf quality although there was some increase in soil moisture from coring aerification. Coring was more effective than spiking or slicing, but none of the cultivation techniques were as effective as a proper wetting agent treatment shown here. It should be mentioned that effective management of the root zone water relationships by the use of our effective wetting agent has some side effects, that are not always as obvious as puddles or localized dry spots.

Slides 37, 38, 39 and 40: One such effect relates to the movement and availability of pesticides. Using the organic phosphates as an example this next series of slides show a summary of Dr. Niemczyk's work on white grubs. These pesticides tie-up rapidly on organic matter, Dursban being the most highly adsorbed. For insects oriented in the thatch or stem and leaf areas this is no problem; but it does become a problem for soil-borne insects, such as grubs. Plain water does not very effectively move these materials into the soil. Thatch definitely reduces the effectiveness. Combining an effective wetting agent with the pesticide can prevent the total adsorption in the thatch, and thereby improve control. The wetting agent forms a micell---essentially encases some of the pesticide --- and distribute it unformly throughout the entire profile. Watering the spray immediately is still necessary to prevent the micells from breaking and allowing the insecticide to adsorb before watering. These data show the necessity of proper procedure. Treating the soil profile with the wetting agent before spraying the insecticide can actually reduce control---Why? A perfectly logical reason. More of the insecticide can now be adsorbed in the thatch, because of the more effective wetting by the spray solution in a treated thatch. Spraying the insecticide and wetting agent together gives the kind of effective control that is needed.

Slides 41, 42, 43 and 44: I would like to refer again to Bob Riley's comment "that proper circulation and supply of water means healthy plants". It may seem simplistic--but it is true. Proper soil and water management will control the results you obtain and provide turf that is healthier, deeper rooted, and physiologically better developed. The treated turf is more resistant to wilting, and according to Dr. Daniels of Purdue---more turf is lost to WILT each year than to all other causes put together.

Slides 45 and 46: We are all striving to prevent this kind of loss of turf. Here is a well designed irrigated course, with a light loaming soil, where the superintendent was sure that he must have a new disease or insect, since he had "control of the watering". We inspected the course, found the wilted areas to be dry, and subsequently suggested an immediate double dose wetting agent treatment due to the severity of the situation. Three weeks after the course was treated the same fairway looked like this. Time of year, July. Rainfall for the month of July, one-tenth of an inch. This result was obtained with the same irrigation program on the same soil, but the wetting agent made it work.

HOW TO GROW AND MAINTAIN QUALITY POA ANNUA[1]

Dr. Roy L. Goss[2]

Annual bluegrass is a native of Europe that is widely distributed throughout the world. It is commonly found in nearly every region of North and South latitudes, especially in temperate regions. Annual bluegrass is usually classified as a turfgrass weed and is rarely included in seed mixtures except as impurities for turfgrass use. It will frequently invade, persist, and become a major component of irrigated, close cut, intensely fertilized turfgrasses. Annual bluegrass becomes the predominant species under these conditions and the cultural program is frequently adjusted to meet the specific requirements of this species.

Annual bluegrass forms a very fine textured turf of high shoot density, uniformity, and quality under the proper cultural, environmental and soil conditions. The leaves are generally shorter, broader, softer and lighter green in color than those of Kentucky bluegrass. The color is usually light green to greenish-yellow. It is a low-growing plant that is well adapted to close mowing. The rooting depth is generally comparable to that of Kentucky bluegrass and colonial bentgrass, however, it is capable of surviving and growing with a very shallow root system. The variability in annual bluegrass has been attributed to its origin as a hybrid between Poa infirma, an annual, and Poa supina, a perennial. The annual types have an upright bunch-type growth habit, produce a few adventitious roots, tillers and shoots and are quite prolific seed producers with the seed possess-

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1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

2/ Agronomist/Extension Agronomist, Western Washington Research and Extension Center (WSU), Puyallup, WA.

ing a dormancy factor. Poa annua var. annua is a subspecies classification given to this plant type. In contrast, the perennial types have a prostrate, stoloniferous growth habit, produce numerous shoots, tillers and adventitious roots and are more restricted in seeding potential although those seeds produced have no dormancy factor. The perennial type is classified as Poa annua var. reptans.

Propagation and dessimination are primarily by seed. Annual bluegrass is a prolific seed producer even at cutting heights of less than 1/4 inch. It has the unique capability to ripen viable seeds on panicles removed from the plant only one or two days after pollination. The seedheads can be very objectionable during peak flowering period and can drastically reduce turfgrass quality of annual bluegrass putting greens. The vegetative recuperative potential is poor but it can be established readily from the many seeds that are widely distributed in soils where it has been grown.

AREAS OF ADAPTATION

The heat, drought and low temperature tolerances are quite poor, particularly from Poa annua var. annua. Poa annua var. reptans is capable of persisting as a perennial under moderate environmental conditions where the plant is not subjected to severe cold, heat or drought stress. During periods of environmental stress Poa annua is subject to severe injury and thinning. In the warm, humid regions it behaves more as a winter annual, whereas in cooler portions of the cool, humid climates, it behaves as a summer annual. Annual bluegrass is well adapted to moist, shaded environments. It will grow on nearly any texture soil that is kept continually moist. Soil pH levels of 5.5 to 6.5 with a high phosphorus content and supplied with high levels of nitrogen are best for Poa annua. Poa annua has a high tolerance to compacted soils, will not tolerate extended periods of submersion or waterlogged soil conditions, particularly during summer. It is not adapted to soils with high salt levels.

FACTORS LEADING TO PURE STANDS OF POA ANNUA

The climate in the Pacific Northwest, especially west of the Cascade Mountains, is very conducive to the growth and propagation of quality stands of *Poa annua*. Long extended periods of rainfall, mild winter temperatures and cool summers provide an environment that is nearly perfect for this plant. Long periods of low light intensity during winter months allow this plant to grow and increase in density while other turfgrasses are either dormant or barely able to survive in a weakened state under these conditions.

The use of farm or garden-type fertilizers in past years with high levels of phosphate have led to increased domination by *Poa annua*. Nearly all quality lawns, athletic fields and golf course putting greens have been maintained with exceedingly high levels of nitrogen in the past and this favors the increase in *Poa annua*.

No doubt diseases affecting desirable turfgrasses causing thin or weak areas have allowed infection routes for germinating seeds of *Poa annua* as well. The coincidence of the timing of *Fusarium nivale* infection of turfgrasses in the Northwest and the most favorable germination period of *Poa annua* seeds work toward the advantage of *Poa annua* domination.

Practices such as late summer or early autumn verticutting and aerification have increased the rate of spread of *Poa annua* by providing an excellent seedbed for establishment. No doubt, excessive use of putting greens and playfields during this same period of time has resulted in damage to desirable grasses and served as a means of planting *Poa annua* seeds.

Compacted, wet surfaces with high levels of nutrition provides an unfavorable environment for bentgrasses, fescues and bluegrasses while *Poa annua* can adapt to these conditions admirable. Indiscriminate use of fertilizers causing burns and herbicides which may injure all turfgrasses will also create conditions favorable to *Poa annua* domination. Since large quantities of seed are lying in the soil ready for germination, competition is reduced or nonexistent.

MAINTAINING THE BEST QUALITY POA ANNUA

1. Close Mowing. Poa annua will survive very well when mowed as closely as 1/8 inch. Close mowing tends to increase populations of perennial strains vs the annual strains. The perennial strains are finer textured and are more desirable grasses.

2. Maintain High Fertility Programs. It is very important for all grasses to maintain balanced nutrition; that is, adequate amounts of nitrogen, phosphorus, potassium, sulfur, calcium and magnesium, and the trace minerals. It is especially important to maintain high levels of nitrogen and phosphorus. Soils well supplied with phosphorus will maintain higher quality Poa annua than those that are deficient or low in this nutrient. Nitrogen should be supplied in the amounts of 1 lb or more per 1000 ft^2 for each growing month. Approximately 2 to 3 lb of P_2O_5 phosphorus will be adequate for maintaining excellent quality Poa annua. It is important to supply adequate amounts of potassium since this will help the Poa annua plant through periods of stress in summer and winter and may impart some disease tolerance to the plant as well. Avoid excessive use of sulfur since research data has shown that high levels tend to weaken Poa annua.

3. Maintain High Soil Moisture, Especially During the Summer. This does not imply that the soil should be saturated or waterlogged, but should be maintained near field capacity moisture at all times. Avoid all water stress.

4. Avoid Overirrigation in the Summer. This can also induce a stress from low oxygen levels in the soil. Maintain good oxygen diffusion to the root zone through spiking, aerifying and the avoidance of excessive irrigation.

5. Practice Light Syringing or Irrigation During Summer Stress Periods. This will prevent excessive water loss from the leaf tissue. Excessive water loss can result in death of the leaves and the plant. This term, syringing, should not be confused with heavier watering. None of this water should reach the soil unless the surface soils are drying. The only intention here is to moisten the leaves and provide a cooling effect at the leaf surface level.

6. Do Not Allow the Use of Any Turfgrass Area Dominated by _Poa annua_ When Frosted or the Soil is Frozen. Excessive injury can be caused and loss of stands have frequently occurred. Due to large numbers of seed in the soil, the stands will generally replenish themselves, but only after several weeks during which time the surface quality is very poor.

7. Provide Moisture to the Leaves, Crowns and Surface Roots During Low Temperature Desiccating Conditions. Frequently we have very low temperatures (30°F downward) without snow cover and frequently accompanied with winds. Moisture will be withdrawn from leaves, crowns and surface roots while the tissue is frozen and can cause the total death of plants. Water should be supplied in any form to maintain moisture to these areas even if it is a light glazing of ice.

8. It May be a Good Idea to Leave the Clippings in Place a Few Times During the Maximum Seeding Period. This way _Poa annua_ will provide as many seeds as possible to maintain new plant populations and density.

9. Guard Against Summer Diseases, Especially Anthracnose in the Pacific Northwest. In the case of anthracnose, begin a program early in the summer using benomyl or other good systemic fungicides to prevent thinning and loss of _Poa annua_ stands. This disease has been with us for many years but appears to be on the increase and can virtually wreck putting greens within a short period of time.

I have also observed significant losses in lawns, parks and golf course fairways to what appears to be anthracnose during summer periods.

10. It is imperative to practice good fungus control programs during autumn and winter. Diseases such as Fusarium patch and Typhula snowmold can dessimate stands of Poa annua that take many months during spring and summer conditions to repair. Follow the disease control recommendations recommended by pathologists to the letter.

In order to maintain superior stands of Poa annua, it is important that the turfgrass manager be one step ahead at all times. Frequently when symptoms of disease or other stress factors are apparent, it is too late to prevent significant injury to Poa annua stands. You must anticipate these problems and practice preventative measures.

TURFGRASS MANAGEMENT IN NEW ZEALAND[1]

Dr. Roy L. Goss[2]

The purpose of my professional leave to New Zealand was to study soil conditions, in the field, as they influence botanical composition of the turfgrass stands and any specialized management conditions associated with these soils. Soil residual levels and applied phosphorus and sulfur were intensively investigated to determine their effect on <u>Poa annua</u> prevalence, especially on golf course putting greens. Golf course putting greens were chosen since deficiencies are exhibited more quickly than other turfgrass areas due to the system of management.

In order to correlate soil fertility status and turfgrass quality, it was necessary to travel extensively on both the North and South Islands of New Zealand to obtain soil samples, evaluate turfgrass quality, and record management programs. In many instances fertility and other management programs were not accurately known due to recently hired greenkeepers or a lack of written records.

A brief overview of climate and soils in New Zealand will aid the reader in understanding similarities and differences of turfgrass management programs in New Zealand and the Pacific Northwest, U.S.A.

THE CLIMATE

New Zealand, lying as it does in mid-ocean and within temperate latitudes, has an overall temperature and insular climate for the most part, without extreme seasonal or daily fluctuation of temperatures. The

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1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

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length of New Zealand (over 14° latitude) and the sharp relief of the Islands (considerable areas of the South Island lie above 5,000 feet) are sufficient to produce a significant range in temperatures from both North to South and with altitude. The extreme North latitude of New Zealand (approximately 32° South latitude) is about equivalent to San Diego, California, and the extreme South of the Island (approximately 46° South latitude) is about equivalent to Salem, Oregon. Mean temperatures at sea level are approximately 59°F in the North, 54° about Cooks Strait (Wellington area), and 49°F in the South, and these fall about 2.7°F for each 1000 ft of elevation.

Due to prevailing westerly winds, more than 200 inches of rain fall on the western side of the Southern Alps and less than 20 inches in the central Lotago basins on the eastern side. In general, 40 to 60 inches of rainfall occurs in most urban and agricultural areas. From the climatic description, it is easy to understand that temperate grasses perform very well.

Agrostis tenuis var. New Zealand Browntop dominates golf courses, parks, home lawns and some sports fields. Lolium perenne L. vars. Nui and Ruanui dominate grazing lands and sports fields alike. These grasses are subjected to the same diseases found in the Pacific Northwest, U.S.A., notably Fusarium patch (Fusarium nivale), red thread (Corticium fuciforme) and anthracnose (Colletotrichum graminicola) and brown patch (Rhizoctonia solani). Due to moderate climate without extremes, Poa annua is a serious and competitive weed in turfgrass stands in New Zealand.

THE SOIL

New Zealand soil patterns are extremely complex owing not only to the many different kinds of rocks, but also to the varied conditions under which they have been transformed into soil. In the north of New Zealand many soils are old, but in the south they are relatively young, the old soils, having been almost everywhere destroyed during the ice age. In many instances, however, the events such as flooding of rivers over aluvial plains, the drifting of sand and dust and the fall of ash from erupting volcanos have interrupted soil development.

The soils of New Zealand where turfgrasses are cultured are dominantly heavy textured silt loam or heavier, usually with moderate to good internal drainage. Puddling and compaction are the chief problems on the sports fields and golf courses and appear to be worse where automatic irrigation is misused resulting in turf dominated by Poa annua.

LAND USE

New Zealand has a total land area of 66 million acres on both the North and South Islands. More than 2/3 (69%) of this acreage is hilly and steep land on which cultivation and other practices requiring wheeled machinery are not applicable at the present time. Instability is a severe limitation to the pastorial use of 26 million acres (40% of the land area). Moisture deficiency is a limitation on 10,000 acres (15% of New Zealand's land). Most is steep and cannot be overcome by irrigation.

In 1979 the estimated sheep population was approximately 64 million and with vast herds of beef and dairy animals would bring the total ewe equivalent to well over 100 million head.

Recent estimates (G. S. Robinson, Director, Turf Culture Institute of New Zealand) of land used for sport and recreation, home lawns and roadsides are listed as follows:

Facility	Total area (acres)
Parks and Reserves	25,200
Golf Courses (320 total)	37,000
Bowling Greens (620 total)	650
Home Lawns	50,000
Mown Roadsides	125
Race Courses	3,300
Schools	9,000
Total	127,750

New Zealand people are very sports and recreation minded and in general enjoy adequate facilities for cricket, rugby, soccer, softball, golf, tennis and lawn bowling. Sports fields sustain heavy use nearly the entire year due to summer schedules of cricket followed by late summer or autumn use as rugby, followed then by soccer and other uses. Golf is played predominantly during the winter months and to a lesser extent during the summer. Cricket, lawn bowling and summer vacations reduce the use of golf courses during this period of time. It can be seen readily, then, that most of their recreational facilities with the exception of bowling greens receive their heaviest use during periods of slower grass growth and more intense rainfall. This alone can bring on a multitude of problems of soil compaction, puddling and turfgrass wear.

TURFGRASS MANAGEMENT

Fertilization. For the most part New Zealanders do not practice high levels of fertility management. Most home lawns are rarely fertilized and those that do receive fertilizer are only once or twice annually.

Most New Zealand fertilizers are formulated with ratios that are required dominantly by agriculture. These are usually high in phosphate to satisfy the needs of clover on grazing lands and to a lesser extent with nitrogen. Due to this factor alone many New Zealand turfgrass soils are highly supplied with phosphates which alone can stimulate high populations of Poa annua. Fortunately, the chief source of nitrogen used on most turfgrass areas is ammonium sulfate. Due to the fact that New Zealand soils are historically low in both phosphorus and sulfur, it has been the rule to apply fertilizers with high phosphate levels, and of course, ammonium sulfate will supply adequate amounts of sulfur. For the most part, it was difficult to find soils that were low (never deficient) in phosphorus for turfgrass purposes. It was interesting to note, however, that golf course putting greens particularly that received low phosphate applications and normal applications of nitrogen with ammonium sulfate had the highest percentage of bentgrass and the least amount of Poa annua.

pH values of most turfgrass soils ranged from 4.5 to 5.8. Due to the acidic nature of most of these soils lime is required and in certain instances turfgrasses have very poor vigor if lime is not applied. Most New Zealand soils are well supplied with potassium and it is not one of the heavier applied elements.

Sports fields usually receive about 4 lb of nitrogen per 1000 sq ft per year whereas putting greens receive from 4 to 10 lb of available nitrogen per 1000 sq ft per year. Putting greens receiving lesser amounts of nitrogen were found to have higher populations of bentgrass and lesser amounts of *Poa annua*. Although density and overall quality of the putting surfaces were somewhat better at slightly higher than 4 lb of nitrogen, they were acceptable at these levels. It must be remembered, however, that most golf course putting greens in New Zealand were built from native soils and for the most part are extremely heavy in texture. Most of the applied nitrogen is retained in the soil for plant use and lesser amounts are leached away.

Weed Control. Weed problems on lawns, parks and golf course fairways are dominated by *Paspalum dilatatum* (commonly known as Dallas grass in the U. S.), hairy crabgrass, Kikuyugrass, velvetgrass (*Holcus lanatus*) plus the usual spectrum of cool season broadleaved weeds such as plantain, dandelion and the various clovers. One additional weed that causes much discomfort, particularly to bare feet is Onehunga (*Soliva* spp.). Herbicides are commonly used by turfgrass managers on golf courses and parks particularly and to a lesser extent by homeowners on home lawns.

Disease Control. Little disease control is practiced on any areas except on golf course putting greens. Most of the New Zealand golf superintendents practice control of *Fusarium* patch disease and some for the control of brown patch during the summer. Red thread disease is mostly ignored or is cared for through nitrogen applications and mowing. Most fungicides in New Zealand are applied on a curative basis only and only a few on a preventative program.

Other Maintenance Programs. Aerifying and topdressing are standard programs on most golf courses in New Zealand. Topdressing materials vary with location. Most New Zealand golf superintendents use reasonably good quality topsoil which is at hand while those in coastal areas with large amounts of sand available topdress with sand. By and large, all golf courses that topdress regularly with sand had excellent quality putting greens as compared with those using heavier soils for their programs. Most sands in New Zealand are of normal deposit and few superintendents use washed sand. Although these sands sometimes are on the fine side of the spectrum, it is my opinion that they are better for use in topdressing than native soils. For the most part aerifying and topdressing is carried out about twice per year with only a few topdressing more often.

Thatch control is one of the worst problems in New Zealand on nearly all turfgrass areas including golf putting greens. Little is done for the control of thatch in most home lawns and other areas; however, verticutting, grooving (a deeper and more drastic form of verticutting), aerification and topdressing and principally employed for thatch control.

Due to the very heavy nature of New Zealand soils on turfgrass areas, sub-airing (penetrating 6 inches or more deep), the use of mole draining equipment is frequently employed to improve drainage.

Mowing maintenance on golf putting greens is accomplished for the most part with triplex type mowers with a few of the golf courses employing hand cutting equipment. It was a common site to observe Jacobsen and Toro greens mowers on most of the golf courses to conserve on labor. Gang units, of course, were employed on golf fairways, parks and larger sports and recreation areas. A prototype of electric gang mowing units was observed in the Aukland area and is called the Wimpway and could possibly be an excellent piece of machinery with further development. The generating unit designed for operation of the reels has many other uses such as emergency lighting, running welding equipment and other uses.

Automatic irrigation was found on only a few golf courses and park areas in New Zealand. For the most part the play and recreation areas were not irrigated at all while most golf courses irrigated tees and greens only.

Construction of sports facilities with sand and sand topdressing programs were being strongly considered and debated in New Zealand at the present time. There is a reluctance on the part of many to accept sand construction and topdressing while a few are going ahead with the program with great success. New Zealand is no different from any other part of the world when it comes to accepting new methods and procedures. We are all victims of the usual and ordinary practices and any radically new programs are eyed with a great deal of suspicion.

Most turfgrass facilities in New Zealand are maintained and operated with a minimum of labor and equipment. Some 18 hole golf courses were operated by a single greenkeeper with perhaps some contributed labor by the membership. The maximum number of employees found on any golf course was about 6, and the average for an 18-hole golf course was 3 to 4. In one instance at Clyde, New Zealand, a 76-year-old greenkeeper was maintaining an entire 18-hole golf course alone.

With increasing population and increasing demand for sport and recreation facilities, the New Zealander is asking for a little more each year. With the exception for certain rural golf courses, the use of sheep for grazing fairways is not very common and with increased affluence, this may eventually disappear as well.

In general, I felt that the Kiwi is doing an excellent job of growing grass with the budgets and facilities available to them. Outdoor recreation and especially golf and bowling are available at prices that any New Zealander can afford. We might take a lesson from these people and take a hard look at minimum maintenance programs to reduce maintenance in the future in order to cope with rising prices and inflation.

OREGON STATE UNIVERSITY TURFGRASS PROGRAMS[1]

Tom Cook[2]

At last year's NTA Conference I outlined the course-work portion of the turf and landscape curriculum at OSU. This year I would like to discuss the progress we have made in field laboratory facilities and research. In addition I will briefly comment on the fate of students leaving our turf program since my arrival in 1977.

One of my original goals was to develop an outdoor teaching lab to give students the opportunity to observe the principles discussed in the classroom. The construction of our field lab has largely been done by the students themselves. At the present time we have about 2 acres of turf and landscape plantings at the Lewis Brown research farm and about one-half acre of turf plots right on the OSU campus.

Campus turf plots include a small variety test featuring perennial ryegrass and Kentucky bluegrass. Small plantings of each of the basic turfgrasses are located adjacent to this variety test. The remaining campus plot area is used for annual demonstrations of turf establishment techniques. For example, each fall we put out tests comparing germination of common grasses, fertilizer effects on establishment and weed invasion, effects of seeding rate, and the effects of mulches on turf establishment. We also demonstrate techniques used in planting sod. In spring we typically put out dethatching and turf renovation tests. When possible moss control tests are also put out in spring.

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Having plot space on campus is particularly nice since all tests can be observed regularly by the students. Space limitations preclude replicaton of treatments but these tests do provide interesting and generally realistic results. I feel students learn the value of experimentation and observation as opposed to taking textbook information Carte Blanche. Often, tests results challenge students' preconceived ideas and actually make them think a little bit.

The one major limitation in conducting outdoor experiments in the fall is the fact that school starts so late at OSU. For example, this year my first lab is on October 2. If the fall rains come early or if weather is unseasonally cold it cuts down on the number of outdoor projects we can attempt. Fortunately this has not been a major problem yet. Still, I wish school started earlier so we could spend more time outdoors.

Field plots at the Lewis Brown research farm are much more diverse than those on campus and include significant landscape plantings as well as turf. Eventually there will be large demonstration plantings of all turfgrasses used in the Pacific Northwest. Currently large areas are planted to perennial ryegrass, Kentucky bluegrass, colonial bentgrass and, believe it or not, annual bluegrass. Other turf includes a variety test containing 54 entries of perennial ryegrasses, Kentucky bluegrass, chewings fescues, and mixtures and blends of these grasses. Additional plantings of fine and tall fescues are planned for the near future.

Some of the demonstrations currently underway or scheduled for the future are outlined below.

- Mowing height effects of turf quality -
  Currently a perennial ryegrass, Kentucky bluegrass mixture is being maintained at cutting heights of 1, 2 and 3 inches. Similar tests are scheduled for each of the other grasses.

- Fertility effects of turf performance -
  All variety plots are receiving split fertilizer applications. Low N plots receive 1 lb N/1000 ft^2/yr,

and high N plots receive 4 lb N/1000 ft^2/yr.

- Turf response to N sources and rates - A variety of soluble and slow release fertilizers are currently being applied at several rates to demonstrate relative turf response.

- Broadleaf weed control - New turf plantings are purposely left weedy so that herbicides can be demonstrated in spring. Various herbicide combinations and rates are included.

- Turf performance in shade - Fast growing deciduous trees have been planted in a grid arrangement to provide a uniform and natural shade area. Both turf varieties and cultural intensity will be evaluated at this site.

- General turf performance charateristics - Side by side plantings of the more common turf varieties and types of grass help students understand basic differences in growth habit and year around turf performance. This is something that can't be described, it has to be seen.

- Wear tolerance and turf recovery - In the future I hope to have wear equipment that will allow me to demonstrate this important aspect of turf performance.

- Drought tolerance and turf recovery - As time passes this will become more and more important in turf maintenance. While students won't get to see this first hand, I will be able to develop photos and data to tell the story for them.

Much of the turf at the Lewis Brown farm is and will be used for turf research. Our major project currently underway involves herbicide research on control of annual bluegrass. In the planning stages right now is an annual bluegrass fertility study aimed at improving turf quality and reducing maintenance problems such as seed production and disease susceptibility. Recently a cooperative project was initiated with Turf Seed, Inc., in Hubbard, OR.

In early September we established the first of what I hope will be a series of national variety evaluation tests. This particular test includes 84 Kentucky bluegrass entires which will be tested at 56 locations across the U.S.A. With luck a national perennial ryegrass test will be started in 1981.

I feel that we have made a strong start in establishing a field laboratory and research facility that will serve both students and the public. Between myself and my students and the generosity of various suppliers (see attached list of contributors) we have pretty much reached our limit however. The next step will require funds for hiring summer help for maintaining plot areas and developing new demonstrations. This poses somewhat of a problem since financial resources at OSU are extremely limited. Unless contributions to the NTA research fund increase significantly I feel it is unfair to expect them to subsidize my program at the expense of established programs at WSU and elsewhere. As I learn more about this business I am finding that there are many other sources of money so I'm optimistic that money for summer help will be found. Consequently, I'm confident we will be able to develop our program to a realistic level within the near future.

The final area I would like to comment on concerns the fate of turf students leaving our program at OSU. Twenty years from now might be a better time to answer this question, but we appear to be off to a positive start even after three years.

A profile of our program indicates an average of 40 students enrolled in the landscape curriculum at any given time. Interests range from landscape design and construction to golf course maintenance. On the average there are probably no more than 5 to 7 students with a serious interest in turf or landscape maintenance. It is relatively easy to keep track of these people after they leave OSU.

In 1978 out of 10 students in my advanced turf and landscape class 3 have become golf superintendents, 2 are assistant superintendents, 2 are in landscape construction, one is in the seed trade, one is in graduate school, and the other is unaccounted for. Of those 10 people the five who were hard core turf people all ended up at golf courses.

In 1979 and 1980 a total of 4 students entered the turf industry. One is an assistant superintendent, and the other three all went to work in the chemical lawn care industry. So far all reports are positive.

Interest in turf oriented careers appears to be increasing at OSU. Many of these students are more interested in commercial turf and landscape maintenance than in golf course maintenance, however. One of the factors that attracts these people is the relative financial rewards compared to other areas in horticulture. Regardless of the increasing number of students with an interest in turf careers the number of mature, sensible, experienced graduates is not likely to increase dramatically in the future. Opportunities for the good people who do graduate should continue to be excellent.

CONTRIBUTORS TO OSU TURF PROGRAM 1977-1980

CONTRIBUTOR	TYPE OF SUPPORT
Best Fertilizers Inc.	fertilizer
Broadmoor Golf Club	equipment, repairs
Corvallis Country Club	equipment, repairs
E. F. Burlingham & Sons	seed
Fisons Inc.	grant-in-aid, chemicals
International Seeds Inc.	seed
Jacklin Seed Co.	seed
Lofts Seed Co.	seed
3-M Company	chemicals
N.A.P.B.	seed
Northrup King	seed
Northwest Turf Association	grant-in-aid, equipment
O M Scott & Sons	seed, fertilizer, equipment
Oregon Turf Farms	sod, chemicals
Ortho Division of Chevron	fertilizer, equipment
Pennwalt Inc.	chemicals
Pickseed West Inc.	seed, equipment
Rhone Poulenc Inc.	chemicals
Turf Seed Inc.	seed
Union Carbide	chemicals, equipment
Western Farmers Assoc.	seed

My personal thanks goes out to those of you who have contributed to our program. If I have overlooked anyone, please accept my apologies.

A QUARTER CENTURY OF GREENS TOPDRESSING STUDIES[1]

C.R. Skogley[2]

The first major greens topdressing study at the Rhode Island Station was initiated in 1944 and was continued through 1956. The indicated reason for starting this research was to determine the effects of continued applications of various amounts of limestone and topdressing on the accumulation of thatch under velvet bentgrass putting green turf and to observe treatment effects on putting quality.

New England soils are very acid so limstone usage was standard. Topdressing was a hit or miss proposition and no specific recommendation for quantity or quality existed in the 1940's. The treatments included annual application of limestone to large plots at rates of 25, 50, 100, and 150 lb per 1000 ft^2. An unlimed check was included. Topdressing treatments included bi-monthly applications of 1/4 and 1/3 yd^3/1000 ft^2 of a 1 part sandy loam - 1 part sharp coarse sand dressing and a 2 parts sandy loam - 1 part sharp coarse sand - 1 part organic matter dressing.

Conclusions at the end of 12 years were that 25 lb of limestone per 1000 ft^2 applied annually did aid in organic matter breakdown and was beneficial. Also, the topdressing material containing only soil and sand was better than that containing organic matter. The amount of topdressing applied appeared to be of little consequence in this study.

1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

2/ Turf Research Specialist, University of Rhode Island, Kingston, RI.

During 1961 the velvet bentgrass on this test area was stripped to the soil level. The area was tilled carefully to preserve the levels of soil pH which had developed over the previous 17 years. The area was seeded to Penncross creeping bentgrass and a new topdressing study was established. Treatments included soils of five pH levels ranging from 5.2 to 7.3. Across these pH levels the following topdressing treatments were established: a. untreated check; b. sand - a graded material with a high proportion of the particles in the 0.02 to 0.08 inch size; c. silt loam compost (8.4% organic matter); d. one half sand and one half silt loam. Applications were made in May and October. One half of each treatment was sliced with an aerothatch machine (similar to Ryan mataway) prior to topdressing application.

After three years of treatments the following conclusions were drawn: a. Soil or soil and sand dressing was better than sand only but sand only was better than no topdressing. b. During the fall season root growth was deeper in the sand treatment than in other dressings. c. All topdressing treatments decreased sponginess. Sand produced the firmest surface. d. Soil pH had little effect on density, color or uniformity of the turf. Winter injury was greater on soils of higher pH during one season. e. Greater root weights occurred on lowest soil pH (pH 5.2). There appeared to be less seasonal death and decay on lower pH soils. Despite this root difference, wilt appeared quicker on lowest pH soil. f. Cultivation was beneficial from the standpoint of reducing winter injury, producing more uniform growth and resisting wilt.

Additional topdressing studies were initiated on velvet bentgrass in 1966 which included applications of a 1-1 soil-sand material at frequencies of 2, 3.4 to 7 times a year. Each level of application frequency was fertilized with 3, 5 and 7 lb of N/1000 ft^2/year. All topdressing applications were heavy - from 1/4 to 1/3 yd^3/1000 ft^2. The study was continued for 10 years. Only slight differences in turf performance occurred as a result of topdressing application frequency. Major differences occurred in relationship to fertilization.

The most recent study was established in 1974. The purpose of this study was to evaluate light, frequent applications of graded sand or 1-1 sand-soil compost and heavy spring and fall topdressing with the 1-1 mix with and without aerification. These treatments were replicated on Penncross and Emerald creeping bentgrass and on Kingstown velvet bentgrass. General conclusions after three years are: a. Light, frequent applications of 1-1 topdressing provided better quality turf than other treatments, including improved spring and fall color. b. Semi-annual dressings with a 1-1 mix without aerification, gave better seasonal turf quality scores than did straight sand. c. Semi-annual application of a 1-1 mix preceded by aerification resulted in poorest quality turf. d. Wilt occurred most rapidly on straight sand plots. e. Dollar spot incidence increased with frequent dressing. f. Speed of green as measured with stimpmeter was similar for all treatments. g. Sand dressing provided the firmest greens with the least surface organic matter.

This study is being continued. It is apparent that all the answers are not in when it comes to topdressing putting greens.

TURFGRASS MANAGEMENT IN THE 80'S?[1]

R.C. Shearman[2]

Inflation, double-digit interest rates, spiraling wage and material costs, water restrictions, limited resource availability, and increasing government regulation paint a dismal picture of what turfgrass managers may face in the next decade. One might take a pessimistic outlook and become discouraged with the future, or look upon the 80's as a challenge requiring more efficient management practices.

Services of the turfgrass industry will continue to be in demand during the 80's. There will be increased use of parks, sports fields, bowling greens and golf courses due to increased population and leisure time. If present trends continue (there is no reason to doubt they will) numbers of individuals playing golf will increase by 12% to 15% annually. This will result in more pressure being placed on public and semi-private golf courses. Individuals using parks on a casual and a structured program basis is also on the increase. Small and medium-sized communities are reporting estimates of 10 to 15% increased park use. While larger more urban areas are reporting increases as high as 20%. This probably reflects increased travel costs and the fact that families are staying closer to their homes rather than traveling great distances for thier vacations. All of this adds up to increased use pressure on sites such as parks, recreation areas, sports turfs, and golf courses. One solution to alleviate this problem would be to increase land area set-aside for parks and other recreational turfs. The probability of this occurring is rather slim in most cases, since many municipal budgets are already being stressed and taxpayers

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are not interested in supporting bond issues or in-creased tax levies. Thus the added-use pressure will fall on the shoulders of turf managers requiring them to be more efficient and intense in their management programs in order to cope with increasing use of their sites.

Economists project that inflation will be with us well into the mid to late 80's. Difficulties in reviving a recessing economy and increased government spending will be factors that must be handled before spiraling inflation can be curbed. This will result in the projected lag time into the 80's that many economists predict. Along with the double digit inflation rates that are predicted, increased costs for wages and materials will place added stress on turfgrass managers' operating and capital budgets during the 80's. It will be difficult for budgets to keep pace with these increases in many cases. Cuts in services in these cases are projected. Spiraling inflation influences interest rates. Double digit interest rates, very likely in the low teens, are expected during most of the 80's. High interest rates will influence business and industry expansion by suppressing their growth and development. Housing starts are likely to continue to decline. As a point of interest, it is felt by some experts that housing trends in the 80's will continue to move toward multiple dwelling homes (i.e. condominiums, duplexes, quadraplexes, etc.) and single dwellings will become smaller and will be placed on smaller lots. These trends will influence the lawn care and sod production industries to the greatest extent.

The lawn care industry has had an interesting growth pattern. Much of its growth has occurred during periods of recession (i.e. 1973 oil embargo). This may not be as surprising as first thought, since during these periods homeowners again tend to remain close to their homes, spending more time there and having greater interest in its appearance. Grass seed sales, for example, remain fairly constant through these periods with little or no decline in sales resulting from the recessed economy. During the 80's the lawn care industry will continue to grow and expand market areas but at a slower pace than it did in the 70's. The slow down will be influenced by economic effects and the tendency for the industry to be maturing by the mid to late 80's. Over this same period, the sod industry is likely to decline along with the trend of declining housing starts.

Turf managers will be faced with continued supply shortages and increased materials cost in relation to products derived from petroleum products (i.e. nitrogen fertilizer sources, pesticides, plastic products, etc.). Limitations in petroleum by-products may result in manufacturers lacking necessary intermediate materials to produce their products. Turf managers will be forced to utilize fertilizers and pesticides as efficiently as possible. Fuel costs will continue to rise during the 80's. This will stress turf managers' budgets directly through increased operating costs for fuel purchases, and indirectly through increased transportation costs. Increased transportation cost will also indirectly influence turf managers, since these costs will force individuals to find entertainment and recreation nearer to home, increasing the intensity of use on sites managed by turf managers.

Along with resource limitations, turf managers find that the development of systems approaches to management will most efficiently suit their needs. Areas will be prioritized according to intensity of management they require. In the 80's, homeowners will have increasing interest in low maintenance lawns that require less fertilizer, water, and pest management.

Government regulations will continue to become more strict, especially in areas involving environmental aspects, water control and similar aspects. This trend will continue into the mid-80's, but then will likely turn around and begin to slacken. This is an important aspect, since the Office of Management and Budget now estimates that the annual costs of Federal regulation of U. S. industry alone exceeds $135 billion. This is estimated to add about 10% to product costs produced by U. S. industry. This costs the average person about $500 per year. Of these regulatory costs, the Environmental Protection Agency accounts for nearly 77%.

Industry trends during the 80's will move toward the development of energy efficient equipment. Increased emphasis will be placed on diesel engines. Labor-saving equipment will also be emphasized. This will probably mean that use of hydraulics will also increase. As a result, turf managers will have to become more familiar with the mechanics of diesel engines and hydraulic systems in order to handle repair problems on equipment used in the 80's.

Synthesis of new chemicals (pesticides) for use in turf will decline in the 80's. Economics will force this. Spin-off products that are the result of developments for large acreage crops will be the primary source for new products. One exception to this might be the development of growth regulatory compounds. Considerable interest will develop during the 80's in this area for the turf industry. Chemical industries will emphasize research on ways to use existing products more effectively.

To help turfgrass managers through the next decade, turfgrass research extension and teaching programs will emphasize efforts to conserve energy (i.e. non-renewable natural resources) and water, utilize nutrients effectively, reduce dependency on pesticides through integrated pest management programs, and develop cultural systems that suit the function of the turf site. Turfgrass breeders will strive to develop cultivars that require low maintenance inputs and still maintain anticipated functional use and turfgrass quality.

As turf managers, we have a number of reasons to look at the 80's with more than a bit of pessimism, but we shouldn't allow this to cloud our vision or destroy our enthusiasm to meet the challenge of maintaining turf in the 80's. We should not face the 80's from a defensive standpoint, either. Turfgrass makes a positive contribution to our environment, and our mental and physical well-being. It's easy to see, as turf managers, we will play an even more important role in our society during the 80's.

VOLCANIC ASH DEPOSITS AND PROBLEMS ON TURFGRASSES[1]

W.J. Johnston[2]

Soon after the volcanic ash stopped falling in Pullman I began a series of experiments at W.S.U. on the "Pullman ash". When I speak of the Pullman ash I am making a critical point, for the volcanic ash differed widely in chemical and physical composition across its entire region of deposition. Therefore, any gross generalizations about the effects of volcanic ash are somewhat difficult to make.

The first question to asnwer was "Would grass grow in the ash?" I found that seeds of annual ryegrass (Lolium multiflorum) germinated quite well in ash lechate. Bluegrass (Poa pratensis), bentgrass (Agrostis tenuis), annual ryegrass, and perennial ryegrass (Lolium perenne) showed good emergence when seeded into straight ash, layers of ash over soil, or several ash:soil mixtures. Growth was excellent in all treatments except those of ash alone. The ryegrasses, harvested after two months, showed a significant reduction in dry weight when straight ash treatments were compared to the soil check. This reduction in growth occurred whether the ash received supplemental fertilization or not.

Dr. Goss performed similar studies at Puyallup and found that several grass species grew quite well in unfertilized volcanic ash. These somewhat conflicting results could be due to several factors: 1) the nature of the volcanic ash material used to grow the plants; 2) the grass species involved; and/or 3) the nature of experimentation, for heavily seeded large pots were used by Dr. Goss and I used sparsely seeded shallow flats.

1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

2/ Assistant Professor, Washington State University, Pullman, WA.

In re-establishment of grass in volcanic ash it was found that the depth of seeding was much more critical in volcanic ash than soil. The margin of error was less in seeding grasses into volcanic ash if excellent emergence and good stands were expected. The depths of emergence for bentgrass, bluegrass, ryegrass, and fescue from ash were found to be approximately one-half that of soil; e.g., perennial ryegrass emerged through 1/2 to 1 inch of ash as compared to 1 to 2 inches of soil (Palouse silt loam).

Another concern of turfgrass managers was the effect of volcanic ash on water infiltration. When water passes through a fine textured material, such as the volcanic ash in the Pullman area, into a coarser material, such as a sand mix on a green or tee, water movement will be retarded until the fine material becomes saturated. Only when the fine material becomes saturated does water move into the coarser layer. It was feared that the ash layer would retard water infiltration in such a manner.

In this area, as with most ash research conducted so far, results from studies on infiltration rates are somewhat conflicting. In general it is felt that while the ash might have some affect on infiltration the effects are not as dramatic as once thought. The use of non-ionic wetting agents seems to improve infiltration. Also, the benefit from wetting agents should increase as one approaches the source of the ash (Mount St. Helens) and particle size becomes larger.

REMOVAL AND MANAGEMENT OF VOLCANIC ASH DEPOSITS IN TURFGRASSES[1]

Roy L. Goss[2]

The May 18, 1980 eruption of Mount St. Helens deposited over one cubic mile of ash over large portions of Washington, and to some extent in western Idaho and Oregon. This amount of ash would cover over 10,176,000 acres to a depth of 4 inches. Not all of the ash fell in this region since finer particles travelled around the world. The deposition was variable with some areas receiving over 4 inches of loose ash and some areas only a minor dusting. Subsequent eruptions of Mount St. Helens deposited lesser amounts of ash, but nothing to compare with the first major eruption.

After heavy ash deposition there were two major concerns - chemical and physical properties. Early analyses of the ash indicated a rather wide range in pH with the highest values being slightly over neutral (pH 7.0) and the lowest values in the mid 5 range. Other than high levels of chlorides in some of the ash, fears were quickly allayed about phytotoxic effects of the ash. Attention was simultaneously focused on the physical aspects which were and are at present the greatest problem. The ash material does not have the ability to hold large amounts of nutrients; therefore, any chemical elements contained in the ash or applied fertilizers can be expected to leach readily below the ash layer. There are some chemical constituents that are useful for plant growth from the ash such as iron, phosphorus and potassium.

1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

2/ Agronomist/Extension Agronomist, Western Washington Research and Extension Center (WSU), Puyallup, WA.

PHYSICAL COMPOSITION

Composition of the ash varied with distance from the mountain in a westerly to easterly direction. The heavier or coarser particles fell in the proximity of the mountain and in the Yakima region and became finer in the Moses Lake-Ritzville and areas east. A particle size distribution analysis of a sample collected at Moses Lake revealed the following particle sizes:

Sand sized particles	47%
Silt sized particles	40%
Clay sized particles	13%

The material is gritty to the touch, finer particles cling readily, and is very abrasive in nature. Finer particles, when in a dry state, are easily carried by wind, and dust clouds commonly and frequently obscure vision. The material is not considered injurous to health except for individuals who have respiratory problems or eyes sensitive to dust although it is recommended that respirators and dust protection masks be used when dust is heavy.

The waterholding capacity of the ash is quite high due to a high percentage of fine particles in many areas. Fresh material forms an unmanageable slurry when wet and cakes and crusts upon drying. Shrink cracks occur after drying and grasses will emerge through these although the stand may not be dense.

METHODS OF HANDLING FRESH ASH DEPOSITS ON TURFGRASSES

It appears from observations and available data that gently settled loose ash will compact to about 50% of its original volume from rain or irrigation. The depth of ash, mowing height of turf, and use of the turf area are factors to consider with respect to whether to remove or leave in place.

If it is deemed necessary to remove the ash, it is advisable to do so when in a loose, dry, powdery form. It is lighter and easier to handle. Respirators or dust masks should be worn for personal protection.

GOLF COURSE PUTTING GREENS

1. Remove as much ash as possible when work can be resumed. Deep ash layers can smother greens and result in total grass loss but early removal leaves the grass virtually undamaged. If the compacted depth is expected to be over 3/16 to 1/4 inch, it should be removed dry to prevent perched water tables later as well as puddled and compacted surfaces resulting in slow water infiltration.

2. Three point hitch box scrapers, preferably outfitted with a durable flexible rubber edge will help prevent excess damage to the turfgrasses.

3. After removal, thoroughly water the greens to wet the dry ash, provide water to the grass rootzone and wash all ash from the grass leaves.

4. Apply nonionic organic wetting agents to green surfaces to aid in ash wetting and water penetration.

5. Mow greens with old mowers without baskets the first few mowings to help stabilize ash which could not be removed.

6. Mow in the morning after night irrigation to minimize dry ash damage to equipment.

7. Aerify greens with 1/2 inch hollow tines and remove cores and topdress with 6 - 8 ft^3 of specified sand per 1000 ft^2. This will help cover the ash and reduce equipment wear. Repeat this operation 3 or 4 times if necessary the first season if possible.

8. Maintain normal fertility and watering programs.

9. Overseed damaged or thin areas.

LAWNS, PARKS, FAIRWAYS, ETC.

1. Follow the same procedure as in Step 1 for golf course putting greens if practical. Size of area may influence your decision. Shallow deposits may be

dragged or floated into the surface with any type of equipment practical or even a length of garden hose.

2. If ash becomes consolidated from rain or irrigation, it may be necessary to loosen the layer before attempting removal. Spring tined harrows or even spike toothed harrows with the teeth layed well back may be employed on large areas to bring the ash up or to sift and mix it into the turf. Power rakes, similar to those used for thatch removal makes moist ash easier to rake or scrape from lawns.

3. Float, drag, or hand smooth all ridges left before they become stabilized by new stem and root development. Otherwise, they will become permanently bumpy. They cannot be rolled out. If properly managed, the remaining ash can serve as a smoothing agent on uneven ground.

4. If ash has been scraped from the turf, it is important to loosen the matted grass by power rakes, spring tined harrows or any other innovation that will not tear out the sod. It is important to expose the grass leaves to light as quickly as possible, especially if the temperature is warm.

5. Ash layers do interfere with water infiltraton and aerification may be essential on lawns. Wetting agents (surfactants) are beneficial.

6. Ash removal may not be feasible or possile in some areas. If it is not, irrigate to settle and stabilize the material. Use rotary hoes (not rotovators) to scarify the surface, break crusts, and punch holes. Grass, in sufficient quantity may find its way through.

7. If sufficient grass for a stand does not recover, scarify the surface for a loose seedbed and reseed with a brillion or other accpetable grass seed drills. Use a blend of 30 to 40% turftype perennial ryegrass with 60 to 70% Kentucky bluegrass or other adapted grasses for your area. A broadcast application of

35 lb of available nitrogen per acre following seeding will hasten seedling growth and establishment.

8. After turf is growing normally, several hollow tined aerifications may be helpful in root and rhizome development and water movement.

MAINTAINING EQUIPMENT

New ash is very abrasive to moving mechanical parts. Turfgrass maintenance equipment is generally not as dirt-proof as many types of farming equipment and may sustain heavy damage. The following suggestions may be useful in preventing heavy equipment loss:

1. Grease all fittings regularly to flush out grit.
2. Change or clean air and oil filters often to minimize engine wear.
3. Obtain special filters if available.
4. Employ older equipment where possible. Do not run new and expensive equipment if possible.
5. Mow large turfgrass areas the first few times with large rotary or flail type mowers to save wear on expensive reel type gang mowers.
6. Mow turf slightly higher (possibly 2 inches on parks, lawns, etc. and 1-1/4 inch on golf course fairways. Mowing height can be lowered when ash is stabilized.

AFTERMATH

Most of the turfgrasses receiving heavy ash deposits recovered within 60 to 90 days. Most areas show no affects except through examination of the thatch and soil profiles. The ash layer, of course, is still there unless it was removed mechanically.

Moses Lake Golf and Country Club at Moses Lake, Washington removed the ash from greens and fairways, and after 90 days appeared essentially normal except for minor areas where excessive damage was done in removing the ash or in depressions where the ash physically could not be removed resulting in smothering of the grass. These areas, however, are minor and play resumed approximately 60 days after the ashfall. Ash could not be removed due to lack of equipment and manpower from the Ritzville Municipal Golf Course at Ritzville, Washington, and significant loss of all fairway turf was experienced. All fairways have been reseeded at this time with total loss of play for the entire year.

Ash collected at Moses Lake, Washington was placed in pots in the greenhouse and were seeded to bluegrass, bentgrass, fescue and ryegrass. Germination was good and subsequent development of the seedlings was normal. The roots penetrated to the bottom of the pots and after 75 days the plants were growing quite well without the addition of any fertilizer. Water infiltration and permeability rates are quite slow, but with developing roots and stems, infiltration and permeability rates improve.

Infiltration rates were tested at Moses Lake Golf Club where a residue of 3/8 inch of ash remained on bluegrass fairways. Rates up to 2 inches per hour were recorded through the ash and into a fine sandy soil beneath. The use of wetting agents significantly increased infiltraton (4 inches per hour) and proves the value of wetting agents on volcanc ash deposits.

TURFGRASS EVALUATIONS IN IDAHO[1]

R.D. Ensign and V.G. Hickey[2]

Turfgrass evaluation tests in Idaho were started in 1972 and have been expanded annually as new and experimental cultivars became available. This program expanded in 1980 with the inclusion of the National Kentucky Bluegrass Turf test, in which several states are jointly cooperating.

The major objective of the turfgrass evaluation program in Idaho is to obtain information about adaptability and performance of the many new cool season cultivars. Of primary importance is how the new grasses will perform under our climatic and soil conditions, and how these data compare with data of other researchers in various areas of the USA and Canada.

Two major locations are utilized in Idaho, they are at the University Plant Science Farm at Moscow, in northern Idaho, on silt loam, neutral pH soils where summer (July) average temperatures 67°F. Supplemental irrigation is required during July - October when the relative humidity is low and the average monthly precipitation is less than one inch. The second test location is in southwest Idaho, on the Parma Research and Extension Center, in an area representing much of the semi-arid intermountain states. The silty loam, shallow soils are generally of the 7.5 to 8.0 pH range. The average July temperatures are 73.5°F with several July - August daily temperatures in the high 90°F range. Monthly precipitation is less than .5 inch during July - October and the relative humidity is very low. Many cool season turfgrasses are subject to chlorosis during the summer period under these temperatures and soil conditions.

1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

2/ Agronomist and Scientific Aide, Department of Plant and Soil Sciences, University of Idaho, Moscow, ID.

The following species are currently under evaluation in Idaho:

Genera-Species	Kind	No. Cultivars*
Poa pratensis	KBG	241
Poa compressa	CBG	2
Lolium perenne	P.R.	57
Festuca rubra	CRF	20
Festuca rubra commutata	CHF	28
Festuca ovina	H.F.	7
Festuca arundinaceae	T.F.	14
Agrostis palustris	CBG	6
Agrostis tenuis	ClBG	4
Agrostis canina	VBG	1
Phleum pratense	T	5

* Some cultivars are duplicated at the two locations.

Standard turf evaluation readings are taken during the growing seasons. These include color, density, texture, overall quality, and diseases.

Moscow 1972-75 Multi-Species Test

During 1980 the outstanding cultivars for color and quality were:

Early Spring (April	August	Mid October
	Kentucky Bluegrass	
Adelphi	Adelphi	Adelphi
Aquilla	Aquilla	Aquilla
Baron	Baron	Baron
Warrens A-34	Fylking	Glade
Newport	Newport	Nugget
Touchdown	Victa	P-164
P-164	Beltturf	Ram #1
Georgetown	Ram #1	Bristol
Plush	Bristol	Merit
P-66	Brunswick	Plush
Kl-159	Merit	Parade
K-1-155	Continental	Galaxy

Early Spring (April)	August	Mid October
Kentucky bluegrass	Kentucky blue	Kentucky blue
Parade	Glade	K-132
Galaxy	Galaxy	K-132
Ida Sel 20	Olymprisp	
		Hard Fescue
K-1-120		
	Creep Red Fescue	
K2-107		Biljart
	Jamestown	
Creep Red Fescue		Crep Red Fescue
	Kennsington	
Fortress	Scarlet	Scarlet
Wintergreen	Barfalla	Wintergreen
Scarlet		
	Hard Fescue	Per. Ryegrass
Jamestown		
	Biljart	Citation
Hard Fescue		
		Yorktown II
	Per. Ryegrass	
Biljart		
	Servo	
Per. ryegrass		
	K-137	
Pennfine		
Norlea		
NK-200		

Moscow 1980 National Kentucky bluegrass and tall fescue Test

This test was established September 5, 1980. There were significant differences in emergence, vigor, and seedling growth as recorded 30 days after seeding. The cultivars rated excellent were:

Kentucky bluegrass	Kentucky bluegrass	Tall Fescue
Wabash	A-34	P-14944
Monopoly	Argyle	Syn55B
A-20	K 1-152	Falcon
Parade	Vantage	Syn 5 LL
Mono	Holiday	Ag 125A
SH-2	Escort	
S.D. Common	W W Ag 463	
Ida Sel. 35	W W Ag 478	
Ida Sel 37	PSU 150	
Ida Sel 39	Mer-pp-43	
Ida Sel 40	Adelphi	
S-21		

The cultivar 'Apart' was exceptionally slow in germinating and had low seedling vigor.

Parma Western Regional Turf Test

These tests included Kentucky bluegrass, fine leaf fescues, and perennial ryegrasses.

Outstanding color and quality in these tests as recorded in September 1980 were:

Kentucky bluegrass		Red Fescue	Perennial ryegrass
Touchdown	Columbia	Atlanta	Acclaim
Merion	W W Ag 480	Pennfine	Pennant
Enmundi	Entopper	Scaldis	Citation
P164	Parade		Blazer
Sherpa	Ram I		Goalie
Cleopatra	Holiday		Elka
1528T	Baron		K5-92
Brunswick	Fylking		
Adelphi			
Victa			

Parma 1975 Multi-cultivar Test

The performance of these grasses since 1975 have been relatively similar. Outstanding among the bluegrass cultivars in 1980 were: Nugget, Park, Pennstar, Touchdown, Beltturf, Baron, K1-187, Merion, and Victa. The perennial ryegrasses and the fine leaf fescues were inferior in overall quality and color to the Kentucky bluegrasses. Blends of bluegrasses, and mixtures of bluegrasses and fescues were not equal to the best cultivar in these combinations.

SUMMARY

Bluegrasses

Our test indicates we have many outstanding Kentucky bluegrasses for the two diverse environments in Idaho. These grasses possess excellent color, rapidly provide dense turf, and are not seriously affected by diseases. The better Kentucky bluegrasses give the best overall quality of all species tested.

Fine leaf fescues

There are significant differences in fine leaf fescues. In general, all cultivars perform better in the cooler, north Idaho climate, especially in the early spring and fall seasons. No major or serious diseases affected these species during the time in which they were tested.

Tall fescues

New tall fescue cultivars suitable for certain turf situations are beginning to appear on the markets. This is a coarse leaf grass, generally best noted as a forage species, but more recently utilized in certain landscape situations where coarse texture is acceptable. Tall fescue is a persistent bunch grass which is somewhat drought and heat tolerant. It is also tolerant to Idaho temperatures. Although considered one of the most widely adopted grasses in the USA, there is some question of its wide use in many turf plantings until more fine leaf cultivars are available. Recent research indicates that these may be forthcoming in the near future.

Perennial ryegrasses

Many perennial ryegrasses have excellent adaptation to Idaho condition. Several have excellent color, quality, density and tolerance to variable Idaho soil and climatic conditions. These grasses make excellent regrowth and look best in early summer to late fall. During winters of prolonged snow cover, some cultivars are quite susceptible to gray snow mold, *Typhula incarnata*. This is especially true at the 3-4 inch verdue cutting. 'Servo' and 'Norlea' are the most tolerant whereas two otherwise excellent perennials ryegrasses, 'Citation' and 'Yorktown II' seem quite susceptible. Recovery rate for the ryegrasses is less than recovery for fine leaf fescues and Kentucky bluegrasses. Continued evaluation of the ryegrasses to winter diseases is necessary before general recommendations are made.

Plant Chlorosis in Turfgrass

Research in Idaho has shown that variability exists in chlorosis response, especially in Kentucky bluegrass cultivars. Chlorosis is an expression of iron deficiency, and creates a poor color in turf, while lowering overall color and vigor of the grass. Some cultivars show excellent tolerance to the condition, which is accentuated by high soil pH and climate conditions similar to south Idaho. Additional research is needed to ascertain cultivars which may be near tolerant to chlorosis susceptibility.

EVALUATION OF SLOW RELEASE FERTILIZERS 1978-1980[1]

R.D. Ensign and V.G. Hickey[2]

Slow release N fertilizers were evaluated in Idaho for three years, 1977-80. The purpose of the evaluations was to determine grass color response to the rate of N, timing of application, and formulation.

Fertilizer treatments were applied on Seaside bentgrass seeded on 18 inches of sand at the University of Idaho golf course; and on Penncross bentgrass, seeded on a soil mix of sand and decomposed peat, on the Lewiston Municipal Golf Course.

The N fertilizers were applied at the rate of 2 lb of N per 1000 sq ft three times per growing season; in early April, in mid June, and early September. One IBDU treatment was applied at 3 lb of N per 1000 sq ft in early April and again in early September, and another IBDU treatment was applied at 4 lb of N in early April and early September, each of the three years. Thus a total of 6 lb of N per season were applied on all treatments except the IBDU treatment where 8 lb of N were applied each year. All materials were applied with a drop fertilizer spreader on plots 3 ft wide and 22 ft long. Each treatment was replicated four times. For complete information on solubility of N materials, refer to Proceedings of the 33rd Northwest Turfgrass Conference, Sept. 25-27, 1979, p. 97.

Table 1 contains average color reading for 3 years, 1978-1980. Of the soluble N products, ammonium nitrate produced the best color on the University of Idaho green, and was second to Scotts 29-3-3 on the Lewiston Municipal Course.

1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

2/ Agronomist and Scientific Aide, Dept. of Plant and Soil Sciences, University of Idaho, Moscow, ID.

IBDU at 8 lb N rate generated the best average color for the 3 year period. Neither Nitroform nor Milorganite produced satisfactory color at either golf course.

Seasonal response to the fertilizer materials are listed in Table 2. The slow release IBDU and more soluble ammonium sulfate N sources provided excellent color from the fall of 1979 through early spring of 1980. Some color response from the ammonium sulfate could be attributed to additional sulfur.

After the initial spring application, the more soluble N products provided better color. The addition of P and K to the more soluble N products (treatments 10, 11 and 12) with rates determined by soil testing, did not greatly influence color. However, these nutrients could result in improved physiological condition which would aid in disease resistance and stress tolerance.

After the second year of application, IBDU maintained good color throughout the year, especially during the fall and early winter periods. The grass fertilized with more soluble N forms became deficient in N before the next applications of N was due.

CONCLUSIONS

1. Fast release N sources provide immediate green-up after application. The slow release materials need a longer time period before color improvement is noted, but maintain color at a more even level throughout the year.

2. With the IBDU product, timing of application was less important than the total amount of N applied. Four lb of actual N/1000 sq ft at one application did not present any serious problems with IBDU.

3. In accordance with previous reports, excellent fall and early winter green-up was produced from the IBDU products. The color response exceeded other treatments at these times of the year.

4. A desirable product or fertilizer program should incorporate a combination of fast and slow release N materials for optimum color throughout the year.

5. Although mower buckets were removed after each fertilizer application, there undoubtedly were some slow release N products, i.e., Nitroform, removed from the green surface by mowing. Thus such N products were removed from plant use.

Table 1. Fertilizer materials utilized and grass color ratings for period 1978-1980.

Treatment	Rate[2]	Average yearly color response[1] Univ. of Idaho G.C.	Lewiston Municipal G.C.
Scotts 29-3-3	2+2+2	6.2	6.4
Scotts 22-0-16	2+2+2	5.1	4.7
Nitroform 38-0-0	2+2+2	4.4	4.1
IBDU 31-0-0	2+2+2	5.8	4.6
IBDU 31-0-0	3+3	5.8	5.1
IBDU 31-0-0	4+4	6.3	5.5
Milorganite 6-2-0	2+2+2	4.8	4.0
Ammonium nitrate 31-0-0	2+2+2	6.9	5.4
Ammonium sulfate 21-0-0	2+2+2	-	5.7
Ammonium sulfate blend 14-4-11-20	2+2+2	-	5.4
IBDU blend 22-2-12	2+2+2	-	5.0
Ammonium nitrate blend 23-4-10-4	2+2+2	-	5.4

[1] 9 = dark green; 1 = light green. Reading taken approximately two weeks after each application and immediately before each subsequent application.

[2] Indicate rate of actual N/1000 ft^2, i.e. 2+2+2 indicates 2 lb of N each April, June and September applications.

Table 2. Seasonal response of N formulation for period 1978-1980.[1]

Treatment	3 year average March	3 year average June	3 year average Sept.	March 1980 only
Slow Release				
IBDU	4.6	5.9	7.5	6.2
Nitroform	3.1	4.8	5.0	3.6
Milorganite	3.3	5.1	6.2	3.9
Fast Release				
Scotts 29-3-3	5.5	6.5	5.9	4.7
Ammonium nitrate 34-0-0	5.7	6.9	7.0	6.3
Ammonium sulfate 21-0-0	6.8	6.1	5.0	6.6

[1] 9 = dark green; 1 = light green. All readings taken before April, June, and September application periods.

1979-80 EVALUATION OF FUNGICIDES FOR CONTROL OF FUSARIUM PATCH[1]

Gary A. Chastagner and Worth E. Vassey[2]

Selected fungicides were tested in two trials conducted at Washington State University's Western Washington Research and Extension Center in Puyallup for control of Fusarium patch (F. nivale, pink snowmold). Fungicide applications (non granular) were made with a sprayer equipped with a boom and 8004 tee-jet nozzles. Applications were made at 40 psi pressure. Each application was made in the equivalent of 5 gallons of water per 1000 sq ft. Granular materials were hand broadcast over the turf. Scott's F IV was applied to moist foliage and Scott's FFII was applied to dry foliage.

MATERIALS TESTED

Baycor (WP (Mobay*) 25% B-[(1,1'-biphenyl)-4-yloxy]- -(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol
Bayleton (WP) (Mobay) 25% triadimefon
Benlate (WP) (duPont) 50% benomyl
BFN 8099 (ED) (Boots*) 40% confidential
Bromosan (F) (Cleary*) 66.7% 3 lb thiram plus 1 lb thiophanate-ethyl/gal.
Caddy (F) (Cleary) 20.1% cadmium chloride
Chipco 26019 WP (Rhone-Poulenc) 50% iprodione
Cleary's 3335 (F) (Cleary) 50% thiophanate-ethyl
Daconil 2787 (F) (Diamond Shamrock*) 40.4% chlorothalonil
Proturf Fertilizer Fungicide II (G) (Scotts) 15.4% PCNB
Proturf Fungicide IV (G) (Scotts) 1.3% iprodione
Sulfur (WP) 90% sulfur
Terraclor (WP) (Olin) 75% PCNB
* Financial assistance provided in addition to product

1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

2/ Assistant Plant Pathologist and Ag. Res. Tech. III, Western Washington Research and Extension Center (WSU), Puyallup, WA.

FIRST TRIAL

The purpose of this trial was to (1) compare the relative effectiveness of each fungicide in controlling Fusarium patch, and (2) compare the relative effectiveness of wettable powder and granular formulations of the same active ingredients in controlling Fusarium patch. This trial was conducted on 'Highland' bentgrass maintained at 1/4 inch height. There was no disease at the start of this study.

Test materials were applied at varying intervals as indicated in Table 1. Individual plots measured 1 m x 2 m and each treatment was replicated 5 times in a completely randomized design. The plots were rated for disease on 11/29/79 and 3/18/80. Ratings were based on percentage of total area which was diseased. Color ratings were made on 3/18 and 4/23 while a density rating was made on 4/23. Data from each rating was subjected to analysis of variance and compared using Duncan's multiple range test. The results are presented in Table 2.

SECOND TRIAL

The purpose of this trial was to (1) compare the relative effectiveness of each fungicide in controlling established Fusarium patch and (2) compare the relative effectiveness of wettable powder and granular formulations with the same active ingredients in controlling Fusarium patch. This trial was conducted on 'Penncross' bentgrass maintained at 1/4 inch height. Disease severity was high and uniformly distributed over the plot area at the start of this test. Test materials were applied at varying intervals as indicated in Table 3. Individual plots measured 1 m x 2 m and each treatment was replicated 5 times in a completely randomized design. The plots were rated for disease on 12/19/79, the day of the first applications, 1/17/80, 2/19/80, and 3/18/80. These ratings were based on the percentage of total area which was diseased or had not recovered from the disease. A rating of the percentage of the total area with active disease was made on 3/18/80. Density and color ratings were made on 3/18 and 4/23. Data from each rating were subjected to analysis of variance and compared using Duncan's multiple range test. The results are presented in Table 4.

COMMENTS

All applications of Scotts FFII, Terraclor 75 W and BFN 8099 40EC at 5 oz ai/1000 sq ft were phytotoxic. Applications of Scotts FFII and Terraclor 75 W resulted in yellowish colored turf while the BFN 8099 killed most of the turf.

Table 1. Application dates for fungicide evaluation on 'Highland' bentgrass.

Treatment	oz ai/1000 ft^2	Application dates 9/26	10/17	11/7	11/28	12/19	1/9	1/30	2/20	3/12
None	-	-	-	-	-	-	-	-	-	-
Chipco 26019 50W	1.0	+	+	+	+	+	+	+	+	+
Scotts F IV	0.5	+	+	+	+	+	+	+	+	+
Scotts F IV	1.0	+	+	+	+	+	+	+	+	+
BFN 8099 40EC	5.0	+	+	+	+	+	+	+	+	+
BFN 8099 40EC	1.0	+	+	+	+	+	+	+	+	+
BFN 8099 40EC	0.5	+	+	+	+	+	+	+	+	+
Bayleton 25W	0.25	+	-	-	+	-	-	+	-	-
Bayleton 25W	0.5	+	-	-	+	-	-	+	-	-
Bayleton 25W	1.0	+	-	-	+	-	-	+	-	-
Bayleton 25W + Dyrene 50W	0.5 + 4.0	+	-	-	+	-	-	+	-	-
Dyrene 50W	4.0	+	-	-	+	-	-	+	-	-
Bayleton 25W + Benlate 50W	0.5 + 4.0	+	-	-	+	-	-	+	-	-
Benlate 50W	4.0	+	-	-	+	-	-	+	-	-
Baycor 25W	1.0	-	+	+	+	+	+	+	+	+
Baycor 25W	2.0	-	+	+	+	+	+	+	+	+
Baycor 25W	4.0	-	+	+	+	+	+	+	+	+
Caddy + Bromosan-F	0.2 + 2.7	+	+	+	+	+	+	+	+	+
Cleary's 3336-F	2.0	+	+	+	+	+	+	+	+	+
Scotts FFII	8.0	+	-	-	-	-	+	-	-	-
Terraclor 75W	8.0	+	-	-	-	-	+	-	-	-
Scotts FF II	16.0	+	-	-	-	-	-	-	-	-
Terraclor 75W	16.0	+	-	-	-	-	-	-	-	-
FF II fertilizer base	43.9	+	-	-	-	-	+	-	-	-
Sulfur 90 WP	0.3	+	-	+	-	+	-	+	-	+
Sulfur 90 WP	0.15	+	+	+	+	+	+	+	+	+
Daconil 2787 4F	4.4	-	+	+	+	+	±	+	+	+

Table 2. Relative effectiveness of various fungicides in controlling Fusarium patch and their effect on color and density of 'Highland' bentgrass.[1]

Treatment	oz ai/1000 ft^2	No. spots 11/29	% area diseased 3/18	Color[2] 3/18	Color[2] 4/23	Density[2] 4/23
None	-	5.8 b	5.6 a	5.0 b-g	4.6 d-f	5.6 c-e
Chipco 26019 50W	1.0	0.2 d	0.2 b	6.0 a-c	6.6 a	7.2 ab
Scotts F IV	0.5	0.8 cd	0.4 b	6.2 ab	5.6 a-d	6.6 a-d
Scotts F IV	1.0	1.6 cd	0.2 b	6.0 a-c	6.6 a	7.6 a
BFN 8099 40EC	5.0	0.2 d	0.0 b	1.2 j	3.8 f	3.0 f
BFN 8099 40EC	1.0	0.2 d	0.0 b	5.4 a-e	4.8 d-f	5.8 c-e
BFN 8099 40EC	0.5	0.0 d	0.4 b	5.8 a-c	4.6 d-f	5.6 c-e
Bayleton 25W	0.25	0.2 d	3.0 ab	5.4 a-e	4.4 ef	5.6 c-e
Bayleton 25W	0.5	1.0 cd	2.4 b	5.6 a-d	4.8 d-f	5.8 c-e
Bayleton 25W	1.0	0.0 d	1.2 b	4.8 c-h	5.0 c-e	5.8 c-e
Bayleton 25W + Dyrene 50W	0.5 + 4.0	1.6 cd	0.8 b	6.0 a-c	5.2 b-e	5.8 c-e
Dyrene 50W	4.0	4.4 bc	1.4 b	5.0 b-g	4.8 d-f	6.2 b-e
Bayleton 25W + Benlate 50W	0.5 + 4.0	0.0 d	0.0 b	4.2 e-i	6.0 a-c	6.2 b-e
Benlate 50W	4.0	0.2 d	0.0 b	5.2 b-g	6.2 ab	6.6 a-d
Baycor 25W	1.0	0.4 d	0.4 b	5.2 b-f	6.2 ab	6.8 a-c
Baycor 25W	2.0	0.4 d	0.0 b	5.4 a-e	6.4 a	7.0 ab
Baycor 25W	4.0	0.0 d	0.0 b	4.4 d-i	6.0 a-c	6.4 b-d
Caddy + Bromosan-F	0.2 + 2.7	0.0 d	0.0 b	5.2 b-f	6.6 a	7.6 a
Cleary's 3336-F	2.0	0.2 d	0.0 b	5.6 a-d	6.2 ab	7.0 ab
Scotts FF II	8.0	0.2 d	0.0 b	3.2 i	4.8 d-f	5.0 e
Terraclor 75W	8.0	0.0 d	0.0 b	3.8 g-i	5.2 b-e	5.4 de
Scotts FF II	16.0	0.2 d	0.2 b	3.4 i	4.8 d-f	5.4 de
Terraclor 75W	16.0	2.6 b-d	1.4 b	3.6 hi	5.0 c-e	5.0 e
FF II fertilizer base	43.9	10.0 a	0.0 b	4.8 c-h	5.0 c-e	5.8 c-e
Sulfur 90W	0.3	0.6 d	0.2 b	6.6 a	5.6 a-d	6.6 a-d
Sulfur 90W	0.15	0.6 d	0.6 b	6.6 a	5.6 a-d	6.4 b-d
Daconil 2787 4F	4.4	1.6 cd	0.4 b	4.0 f-i	4.2 ef	5.4 de

[1] Application dates are presented in Table 1. Numbers in vertical columns followed by the same letter are not significantly different, P = 0.05, Duncan's multiple range test.

[2] Color and density ratings are based on a scale of 1-10; 1 being brown or bare ground and 10 being dark green or thick, dense turf, respectively.

Table 3. Application dates for fungicide evaluation on 'Penncross' bentgrass.

Treatment	oz ai/1000 ft^2	Application dates 12/19	1/9	1/30	2/20	3/12
None	-	-	-	-	-	-
Chipco 26019 50W	1.0	+	+	+	+	+
Scotts F IV	1.0	+	+	+	+	+
BFN 8099 40EC	5.0	+	+	+	+	+
BFN 8099 40EC	1.0	+	+	+	+	+
BFN 8099 40EC	0.5	+	+	+	+	+
Bayleton 25W	0.25	+	+	-	+	+
Bayleton 25W	0.5	+	+	-	+	+
Bayleton 25W	1.0	+	+	-	+	+
Benlate 50W	4.0	+	+	-	+	+
Baycor 25W	1.0	+	+	+	+	+
Baycor 25W	2.0	+	+	+	+	+
Baycor 25W	4.0	+	+	+	+	+
Scotts FF II	8.0	+	-	+	+	+
Terraclor 75W	8.0	+	-	+	+	+
Sulfur 90WP	0.3	+	+	+	+	+
Sulfur 90WP	0.15	+	+	+	+	+
Daconil 2787 4F	4.4	+	+	+	+	+

Table 4. Relative effectiveness of various fungicides in controlling Fusarium patch and their effect on color and density of 'Penncross' bentgrass.[1]

Treatment	oz ai/1000 ft[2]	Percent area diseased or not recovered from disease				Percent area w/active disease		
		12/19	1/17	2/19	3/18	3/18	Color[2]	Density[3]
None	-	45	49	50 a-c	39 ab	25 a	5.2 bc	5.8 b-e
Chipco 26019 50W	1.0	33	36	25 d	27 a-c	12 b-e	5.6 ab	6.8 bc
Scotts F IV	1.0	38	38	33 cd	28 a-c	17 a-d	5.2 bc	6.4 b-e
BFN 8099 40EC	5.0	36	39	49 a-c	30 a-c	3 e	5.2 bc	6.0 b-e
BFN 8099 40EC	1.0	52	53	55 a	42 a	22 ab	5.0 bc	5.6 c-e
BFN 8099 40EC	0.5	47	45	34 b-d	40 ab	23 ab	4.4 bc	5.2 e
Bayleton 25W	0.25	35	36	37 b-d	38 a-c	21 a-c	5.2 bc	5.6 c-e
Bayleton 25W	0.5	42	42	41 a-d	39 ab	24 a	5.6 ab	6.4 b-e
Bayleton 25W	1.0	45	50	42 a-d	43 ab	24 a	5.8 ab	5.4 de
Benlate 50W	4.0	54	51	51 ab	43 ab	23 ab	5.8 ab	5.8 b-e
Baycor 25W	1.0	43	42	39 a-d	38 a-c	18 a-d	5.6 ab	6.2 b-e
Baycor 25W	2.0	52	53	46 a-c	27 a-c	20 a-c	5.8 ab	6.0 b-e
Baycor 25W	4.0	44	47	42 a-d	32 a-c	10 c-e	5.6 ab	6.4 b-e
Scotts FF II	8.0	46	47	42 a-d	30 a-c	10 c-e	5.0 bc	6.4 b-e
Terraclor 75W	8.0	39	44	43 a-c	35 a-c	7 de	5.2 bc	6.6 b-d
Sulfur 90W	0.3	53	52	38 a-d	23 c	4 e	7.0 a	8.0 a
Sulfur 90W	0.15	43	43	43 a-c	25 bc	3 e	7.0 a	7.0 ab
Daconil 2787 4F	4.4	47	45	50 a-c	34 a-c	3 e	3.8 c	5.4 de
		(NSD)	(NSD)					

[1] Application dates are presented in Table 3. Numbers in vertical columns followed by the same letter are not significantly different, P = 0.05, Duncan's multiple range test.

[2] Color ratings based on a scale of 1-10; 1 being dead or brown turf and 10 being dark green. Ratings taken on 4/23/80.

[3] Density ratings based on a scale of 1-10; 1 being bare ground and 10 representing thick, densely green turf. Ratings taken on 4/23/80.

OCCURRENCE OF CHIPCO 26019-TOLERANT FUSARIUM NIVALE[1]

Gary A. Chastagner and Worth E. Vassey[2]

Foliar applications of Chipco 26019, registered during 1979, have been shown to provide excellent control of Fusarium patch in western Washington. During September-October, 1979, an application of Chipco 26019 failed to control Fusarium patch on 2 greens of a golf course near Seattle, Washington. Both greens had been utilized by the manufacturer of this fungicide during the 1977-78 and 1978-79 disease season to develop data in support of registration of Chipco 26019 against Fusarium patch.

From November 8, 1977 to February 21, 1978, six applications of Chipco 26019 were made to each green at approximately 3 week intervals and disease control was excellent at both the 2 and 4 oz rates of product per 1000 sq ft. Starting on September 28, 1978, 3 applications of Chipco 26019 were applied to both greens at 3 week intervals. The level of disease control decreased after the third application and an application of an alternate fungicide was made on November 27, 1978 to bring disease development under control.

The fungicides used on these greens during the 1979-80 disease season prior to disease development consisted of applications of Chipco 26019 on August 24, Fore on September 4 and Chipco on September 20. Disease developed on 3 to 5% of these greens following the application of Chipco on August 24 and September 20. Samples of diseased turf were collected from the 2 greens on

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1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

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October 17 and 21 of the 24 isolates of Fusarium nivale obtained from these two greens were found to be tolerant to Chipco 26019. These tolerant isolates were able to cause disease on Penncross bentgrass whether or not it had been sprayed with Chipco 26019 at the highest labelled rate as shown in Table 1.

The occurrence of tolerance to Chipco 26019 by F. nivale and the subsequent loss of control on these greens after two years of repeated applications of this fungicide emphasizes the importance of using different fungicides in your disease control program. Although data are limited with regards to this, alternate or tank mix applications of unrelated fungicides will hopefully eliminate or delay the appearance of tolerance to this fungicide at other courses. Where tolerance has not developed, applications of Chipco 26019 should still provide excellent control of Fusarium patch.

TABLE 1. Pathogenicity of three Chipco 26019 sensitive and three Chipco 26019 tolerant isolates of _Fusarium nivale_ on 'Penncross' bentgrass.

	Rate	Percent area diseased[a]					
		Sensitive			Tolerant		
Treatment	oz/1000 ft^2	1	2	3	1	2	3
None	-	78.7	80.0	40.0	62.5	48.7	56.3
Chipco 26019 50W	4.0	2.0	6.3	6.5	60.0	42.5	47.5

[a] Average of 3 pots per isolate per treatment. Pots of 21-day-old turf were inoculated with conidial suspensions containing 10^6 conidia per ml. Inoculated pots were incubated in a dew chamber at 20°C for 48 hours. Data was taken 20 days after inoculation.

1980 NEMATODE-TURFGRASS SURVEY AND CONTROL TEST[1]

Gary A. Chastagner[2], Fred McElroy[3],
and Worth E. Vassey[4]

During 1979 we initiated a study to determine the possible role of nematodes in the loss of turfgrass, principally *Poa annua*, during our summers. A limited survey during 1979 revealed high populations of plant parasitic nematodes on greens in western Washington. Lower total numbers of fewer kinds of nematodes were found on greens which were sampled in eastern Washington.

During 1980 we expanded the number of greens sampled in western Washington and we initiated a test to evaluate the effectiveness of two different nematicides for control of nematodes on a putting green. Between the end of July and the beginning of September, samples were obtained from 23 greens on 8 courses from Anacortes, Washington to Portland, Oregon. Samples from poor and good areas were obtained from each green and the differences in the numbers and kinds of nematodes present were determined. Table 1 shows the populations of the various kinds of plant parasitic nematodes found in the samples. The 7 different types of nematodes found during this year's survey are basically the same kinds found during our 1979 survey.

1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

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The number of greens that each nematode occurred on and whether it was associated with the poor area on the green is shown in Table 2. Most of the greens sampled had 3 or more plant parasitic nematodes on them as seen in Table 3.

During November, 1979 we initiated a nematode control trial on one green at Ballinger Park Municipal Golf Course. The turfgrass on this green was principally Poa annua. We wanted to determine the effectiveness of two nematicides, Nemacur 15G and Dasanit 15G, in reducing nematode populations. Granular formulations of each material were applied at 3 lb of product per 1000 sq ft on November 20 and/or March 11, 1980. Applications of Tersan 1991 50W were applied on July 15 and August 7, 1980, to determine if nematodes played any role in predisposing the turf to anthracnose. Each treatment was replicated 4 times and each replication consisted of a plot 4 ft by 10 ft. Nematode samples were collected on November 20, March 11 and August 7, 1980.

Control of the spiral (Helicotylenchus) and ring (Cricomemoides) nematodes following fall and/or spring applications of Nemacur or Dasanit are presented in Table 4. Reductions in nematodes populations from the fall application of either nematicide were not evident in March. Reduction in nematode populations were evident from fall and/or spring applications of either nematicide during August. No anthracnose occurred during 1980, thus it was not possible to determine if nematodes have a role in the development of this disease.

Our survey results during the past two years show that plant parasitic nematodes were present on all of the greens sampled and that higher populations of some of these nematodes were associated with problem areas on some of the sampled greens. Plots will be established at Western Washington Research and Extension Center's Farm 5 next spring so that we can determine what the threshold population is of some of the more commonly found nematodes before we see a reduction in turfgrass quality. We will also continue our sampling from our nematode control plot to determine the length of residual activity of each of the nematicides.

TABLE 1. Results of nematode/turfgrass survey - 1980[a].

Course code	Green No.	Condition[b]	Relative no. of nematodes per pint of soil						
			Pratylenchus (pin)	Criconemoides (ring)	Tylenchorhynchus (stunt)	Paratylenchus (lesion)	Longidorus (needle)	Helicotylenchus (spiral)	Meloidogyne (root-knot)
80103	P	G	135	-	-	90	-	-	♀
	P	P	-	-	-	90	-	-	♀
	3	G	315	-	45	180	-	-	-
	3	P	-	-	-	-	-	-	-
	15	G	225	-	-	945	-	-	♀
	15	P	90	810	-	2385	-	-	♀
80104	1	G	-	-	-	90	-	855	-
	1	P	-	-	-	-	-	90	-
	2	G	-	-	-	-	-	135	-
	2	P	-	-	-	-	-	-	-
	15	G	-	-	-	-	-	-	-
	15	P	-	-	-	45	-	-	360L
	17	G	-	-	-	-	-	810	-
	17	P	45	630	-	45	90	180	-
	18	G	-	2520	135	90	135	900	-
	18	P	-	3600	1800	-	90	4950	-
80105	5	G	-	990	-	-	-	360	-
	5	P	45	900	45	-	135	540	-
	10	G	-	855	-	-	-	45	-
	10	P	-	855	-	45	45	1170	-
80106	10	G	-	315	360	270	-	225	-
	10	P	450	5850	-	450	-	3600	-
80107	9	G	-	450	-	2700	-	450	450L
	9	P	-	4050	5850	1800	-	3150	450L
80108	P	G	-	450	-	-	-	2700	-
	P	P	-	5850	-	-	45	4050	-
	3	G	-	135	-	-	45	450	-
	3	P	-	1350	450	-	225	4050	-
	5	G	-	900	-	-	-	3600	-
	5	P	450	5400	-	-	-	8100	-
	14	G	-	900	-	-	-	1800	-
	14	P	-	6750	-	-	540	27000	-
	17	G	-	4050	-	-	-	5400	-
	17	P	-	8100	-	-	-	4050	-
80109	3	G	450	-	-	3150	-	-	-
	3	P	900	-	-	2250	-	450	-
	5	G	-	-	-	900	-	-	-
	5	P	-	-	-	450	-	16650	-
	8	G	900	-	225	450	-	-	-
	8	P	1800	450	-	1800	-	-	-
	14	G	-	-	-	450	-	-	-
	14	P	450	-	450	2255	-	-	-
	15	G	-	-	225	900	-	-	-
	15	P	-	-	2250	450	-	15300	-
80137	7	G	-	2250	1000	1000	-	-	-
	7	P	-	1250	1500	250	-	740	-

a Samples collected between July 29 and September 20, 1980.
b Condition of turf: G = good; P = poor.

TABLE 2. Frequency of nematodes on greens and their association with poor areas.[a]

Nematode	No. of greens with nematodes	Associated with poor area
Helicotylenchus (spiral)	17	13
Paratylenchus (pin)	16	7
Criconemoides (ring)	14	11
Pratylenchus (lesion)	10	7
Tylenchorhynchus (stunt)	10	6
Longidorus (needle)	7	6
Meloidogyne (root-knot)	4	1

a 1980 survey of 23 greens on 8 golf courses in western Washington and Portland, OR.

TABLE 3. Number of different nematodes (genera) found per green sampled during 1980.

No. of genus	No. of greens
1	1
2	4
3	8
4	5
5	5

TABLE 4. Effectiveness of nematicide applications in reducing populations of *Helicotylenchus* (spiral) and *Criconemoides* (ring) nematodes on *Poa annua* putting turf.

		Number of nematodes per pint of soil					
		Spiral			Ring		
Treatment[a]	Application[b]	11/79	3/80	8/80	11/79	3/80	8/80
None	-	8219	2594	7875	5782	3125	3141
Nemacure 15G	F	8516	3438	1000	3344	1313	407
Nemacure 15G	S	-	3094	94	-	2875	94
Nemacure 15G	F & S	8719	3219	0	3594	2782	0
Dasanit 15G	F	13500	4438	344	3344	2094	94
Dasanit 15G	S	-	4094	219	-	2844	32
Dasanit 15G	F & S	10501	5532	32	3438	2563	63

[a] Each nematicide was applied by drop spreader at 3 lb product/1000 ft^2.

[b] Applications were made on November 20, 1979 (F) and/or March 11, 1980 (S).

REGIONAL TEST OF KENTUCKY BLUEGRASS VARIETIES AT PUYALLUP, WASHINGTON[1]

Stan Brauen, Roy Goss, Gary Chastagner, John Law, Marc Abraham, Stan Orton, and Worth Vassey[2]

In late summer of 1978 a cooperative regional test of Kentucky bluegrass cultivars was established at Puyallup, Washington and a number of other locations throughout the western United States. The test at Puyallup, Washington was seeded in September 1978 at the Western Washington Research and Extension Center's Farm 5. Plot size was 2 x 2 m with 3 replications of each entry. The test is located on a moderately well drained Puget silt loam with a pH of about 6.0.

The test receives 4 lb nitrogen (N) per 1000 sq ft annually. The nitrogen is applied in 4 equal applications of 1 lb nitrogen per 1000 sq ft in March, June, September and December. All nitrogen is applied as ammonium sulfate. The test area receives 2.68 lb of K_2O per 1000 sq ft as muriate of potash and 1.33 lb of P_2O_5 per 1000 sq ft from treble super phosphate annually. Weed and disease control pesticides have not been applied.

The plots are cut twice weekly at a cutting height of 1-1/4 inches with rotary mowers. One-half of each plot is cut with a mulching rotary mower and the other half is cut with a rotary rearbagging mower. The test

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1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

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is irrigated regularly with a time clock controlled irrigation system beginning in June and ending in September or October, depending on fall moisture conditions.

The data of performance is presented in Table 1 and 2. Cultivars are listed from high to lowest average turf quality ratings that were conducted from the spring of 1979 through August 1980. The turf quality rating takes into account such factors as disease resistance, density, color and growth habit. During the year the cultivars change in comparison to one another with regard to turf quality, color, density and infection by disease. Also, because these evaluations are only two years old at this time, it is very likely that some of the varieties that perform the best or near the best in average turf quality rating at this time may rank in some other position in succeeding years. It is not uncommon for the varieties that perform the best in the first one, two or three years to decline in performance in the third, fourth and fifth year.

The portion of the plots that were mowed with the mulching mower generally received higher turf quality ratings during the winter months as compared to the portions of the plots that were mowed with the clippings removed. During the summer months many cultivars performed best when mulched while others performed best with clippings removed. Likewise, the density of the turf seemed to be somewhat improved where the clippings were mulched.

TABLE 1. Performance of Kentucky bluegrass varieties in regional turf trials seeded September 1978 at Puyallup, Washington.

Variety	Turf Quality[1]	Texture[2]	Color[3]	Thatch[4]
Touchdown	6.6	7.0	7.5	8.7
Enaldo	6.3	7.3	7.2	7.5
Bristol	6.1	6.3	7.3	9.7
Sydsport	6.0	6.7	7.8	9.2
Cheri	6.0	7.7	7.3	8.8
Holiday	6.0	6.3	7.5	9.7
Birka	5.9	7.7	7.0	9.2
Trenton	5.9	7.0	7.8	8.7
Parade	5.8	7.0	7.7	8.2
H-7	5.8	5.3	6.8	6.8
Brunswick	5.6	7.3	8.5	9.2
Bonnieblue	5.6	6.7	7.7	7.3
A20-6	5.7	7.7	7.5	9.0
America	5.5	7.7	7.3	10.0
Majestic	5.5	7.3	8.5	9.3
RAM I	5.5	8.0	8.5	9.8
Columbia	5.5	6.7	7.8	8.0
A-34	5.5	8.0	7.0	7.3
Baron	5.5	7.0	7.0	8.8
Glade	5.5	8.0	7.5	9.2
Merit	5.4	7.0	7.3	9.7
Aquila	5.4	7.0	7.5	8.5
Geronimo	5.4	7.0	7.2	7.7
Adelphi	5.4	7.3	7.7	9.2
Rugby	5.3	7.3	7.8	7.7
Harmony	5.3	6.7	7.5	7.8
Enmundi	5.2	8.3	7.3	6.8
Merion	5.2	7.7	6.8	8.0
Plush	5.2	6.3	7.0	9.0
Victa	5.2	7.0	7.7	8.8
Fylking	5.0	8.3	7.8	9.2
Scenic	4.8	6.0	7.7	8.0
Welcome	4.6	7.7	7.8	10.7
Bluebell	4.5	7.3	7.3	8.2
Dormie	4.1	8.7	7.5	9.8

[1] Average of monthly turf quality ratings from June, 1979 to August, 1980. 9 = best.

[2] Texture rating on June 19, 1979. 9 = fine texture.

[3] Color rating on August 15, 1980. 9 = dark green.

[4] Thatch measured in mm one year after seeding.

TABLE 2. Winter and summer performance[1] of Kentucky bluegrass varieties in trials at Puyallup, Washington with clippings removed and mulched.

Variety	Summer Turf Quality		Winter Turf Quality		Density	
	Mulched	Clip. Rem.	Mulched	Clip. Rem.	Mulched	Clip. Rem.
Touchdown	7.3	7.3	6.7	5.0	7.0	6.0
Enaldo	7.0	7.0	6.7	4.7	7.0	5.3
Bristol	7.3	7.7	5.7	4.0	5.7	4.3
Sydsport	7.7	8.3	5.3	3.7	7.0	5.3
Cheri	7.3	8.7	5.7	4.3	6.7	5.3
Holiday	7.0	6.7	6.0	3.7	6.7	4.0
Birka	6.3	7.3	5.7	4.0	6.0	4.3
Trenton	7.3	7.7	5.3	4.0	5.7	5.3
Parade	7.0	7.7	5.3	3.3	6.3	4.7
H-7	7.3	7.3	5.7	3.7	6.7	4.3
Brunswick	8.0	8.3	4.3	3.7	5.0	4.0
Bonnieblue	7.3	7.3	3.7	3.0	5.0	3.7
A20-6	7.7	8.0	4.3	3.3	5.7	4.3
America	6.7	7.7	4.7	3.7	5.3	4.3
Majestic	7.3	8.3	4.0	3.3	4.7	3.3
RAM I	6.7	7.7	3.3	2.3	4.0	3.0
Columbia	7.7	7.7	4.7	3.0	5.3	4.0
A-34	7.3	8.0	4.0	2.7	6.3	4.0
Baron	6.3	6.7	4.3	3.7	6.0	5.0
Glade	6.7	7.7	4.7	3.3	4.7	4.0
Merit	6.7	6.7	4.7	3.3	5.3	3.7
Aquila	7.7	8.0	4.0	3.3	4.7	3.7
Geronimo	6.7	7.7	4.7	3.3	5.0	3.0
Adelphi	7.0	7.3	4.3	3.0	5.0	3.3
Rugby	7.3	7.7	4.3	3.0	5.7	4.0
Harmony	6.3	7.0	4.0	3.3	5.0	3.7
Enmundi	7.0	7.0	3.7	2.7	5.0	3.7
Merion	6.7	6.7	4.0	3.0	6.0	4.3
Plush	7.3	7.3	3.7	3.3	4.7	4.3
Victa	7.3	7.0	4.0	3.3	5.0	4.0
Fylking	7.3	8.3	3.0	2.0	4.0	3.0
Scenic	6.0	5.6	4.3	3.7	5.0	4.0
Welcome	7.3	7.7	2.7	2.7	3.0	2.0
Bluebell	6.7	7.0	3.0	2.0	4.3	3.3
Dormie	7.0	8.0	1.3	1.3	2.3	2.0

[1] Performance ratings from 1-9 with 9 = best.

PERFORMANCE OF TURFTYPE PERENNIAL RYEGRASS CULTIVARS IN REGIONAL AND SUPPLEMENTAL TRIALS AT PUYALLUP, WASHINGTON[1]

Stan Brauen, Roy Goss, Gary Chastagner, John Law,

Marc Abraham, Stan Orton, and Worth Vassey[2]

Two trials of turftype perennial ryegrass cultivars and selections are being conducted at Puyallup, WA. The first is a regional ryegrass evaluation which is conducted in the same manner as was outlined in the previous paper for the Regional Bluegrass Evaluations.

The second study consists of 28 cultivars and experimental selections that are currently being evaluated prior to their potential release. The fertilization treatments are similar to those of the Regional trial but the plots are mowed twice weekly with a reel mower with the clippings retained on the experimental site. These selections were seeded in late September of 1978 on methyl bromide fumigated soil and turf evaluations were begun in the spring of 1979. Broadleafed weeds were controlled with a mixture of 2,4-D and dicamba in April of 1980.

Table 1 and 2 lists the performance of selected perennial ryegrass varieties in the Regional turf trials that were seeded at the Western Washington Research and Extension Center's Farm 5 location at Puyallup, WA. Cultivars are listed from the highest to the lowest

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1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

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average turf quality rating during the period from June 1979 to August 1980. There is considerable difference among the varieties in mowing quality. Diplomat, Elka, Regal, Fiesta, Loretta, and Servo ranked highest in mowing quality while Hunter, Sprinter, and Caravelle ranked the lowest.

Whether the clippings were removed or mulched at the time of mowing had a significant influence upon the turf quality and the density of varieties. During this first two years of test, the mulching treatment usually was associated with a higher level of turf quality and increased density of turf in comparison to where clippings were removed. During the less growthy periods of the year this difference became quite noted and often resulted in grass with 20% better quality.

Table 3 lists the monthly turf quality performance of experimental ryegrass selections and standard cultivars. For these evaluations Barry and Premier provided excellent turf throughout most of the season. These cultivars also showed considerable improvement in mowing quality over Derby and Manhattan (Table 4).

TABLE 1. Performance[1] of perennial ryegrass varieties in regional turf trials seeded September, 1978 at Puyallup, Washington.

Variety	Turf Quality	Summer Texture	Summer Color	Mowing Quality	Thatch
Diplomat	6.8	8.3	7.7	8.0	7.2
Ensporta	6.8	8.7	8.7	5.8	7.0
Yorktown	6.7	8.0	7.7	7.7	5.3
Hunter	6.7	9.0	6.7	5.4	7.2
Blazer	6.7	8.0	7.3	7.7	6.2
Omega	6.7	7.0	7.7	7.3	6.7
Score	6.6	7.7	7.3	6.4	8.5
Derby	6.6	7.3	8.0	7.9	5.5
Bellatrix	6.6	7.3	7.7	6.4	8.2
Pennfine	6.5	7.0	8.0	7.8	7.2
Acclaim	6.5	7.0	7.7	7.9	5.8
Elka	6.4	9.0	7.3	8.4	5.7
Yorktown II	6.4	7.3	7.7	7.9	6.7
Pennant	6.3	7.0	7.0	7.6	7.5
Player	6.3	8.7	8.3	6.1	6.8
Citation	6.3	7.0	7.7	7.8	6.0
Pippin	6.3	7.0	6.7	6.2	5.7
Regal	6.2	7.0	7.7	8.1	7.5
Fiesta	6.2	7.0	7.3	8.0	5.7
Loretta	6.2	8.3	6.3	8.2	6.0
Manhattan	6.2	8.7	7.0	6.2	4.8
Birdie	6.1	7.0	7.0	7.3	6.5
Sprinter	6.1	7.7	7.0	5.2	6.3
Goalie	6.1	6.7	7.0	6.0	6.0
Aristocrat	6.1	6.7	7.0	8.1	5.8
Venlona	6.1	7.0	7.3	5.7	6.5
Runner	6.0	7.3	7.0	6.2	7.7
Sportiva	5.9	8.0	7.0	5.9	6.0
Compas	5.6	7.3	6.7	5.7	5.8
Caravelle	5.4	7.3	7.3	5.2	6.0
Servo	5.0	7.3	6.3	8.0	5.0

[1] Performance ratings from 1-9 with 9 = best. Thatch units in mm.

TABLE 2. Spring and summer performance[1] of perennial ryegrass varieties in trials at Puyallup, Washington with clippings removed or mulched.

Variety	Summer				Spring			
	Turf Quality		Density		Turf Quality		Density	
	Mulched	Clippings Removed	Mulched	Clippings Removed	Mulched	Clippings Removed	Mulched	Clippings Removed
Diplomat	7.8	6.9	7.7	7.3	6.0	4.3	6.7	5.0
Ensporta	7.9	7.1	8.3	8.3	6.3	5.0	6.3	5.0
Yorktown	7.4	6.8	7.7	7.0	6.0	4.0	6.3	4.7
Hunter	7.8	6.9	8.0	7.3	5.6	4.0	7.0	5.3
Blazer	8.2	7.2	8.3	8.0	5.7	3.3	6.0	4.0
Omega	7.3	6.4	7.7	7.0	7.3	5.0	7.0	5.0
Score	7.2	6.7	8.0	7.2	6.3	4.7	7.3	6.3
Derby	7.3	6.8	7.7	7.0	5.3	3.7	6.3	4.0
Bellatrix	7.6	6.9	8.0	7.7	5.3	5.3	5.0	5.0
Pennfine	7.9	7.2	7.3	6.7	5.3	3.7	5.3	3.3
Acclaim	7.6	7.0	8.3	7.3	4.6	3.0	5.7	3.7
Elka	7.7	7.1	8.0	7.7	5.3	4.0	6.0	5.0
Yorktown II	8.0	7.4	8.7	8.3	4.0	3.3	5.3	4.7
Pennant	6.7	6.1	7.0	7.0	6.0	4.0	6.7	5.3
Player	7.9	7.1	8.0	8.0	5.0	3.0	5.3	3.3
Citation	6.9	6.3	7.3	7.0	4.7	4.0	5.0	4.3
Pippin	7.0	6.2	7.0	7.0	6.3	4.0	6.0	4.3
Regal	6.4	6.1	7.3	6.7	4.7	4.0	5.3	5.0
Fiesta	7.4	7.0	8.3	7.3	5.0	3.3	5.3	3.7
Loretta	6.8	6.1	8.3	7.7	6.0	3.3	6.3	4.3
Manhattan	7.3	6.9	8.0	7.7	5.0	3.7	6.0	4.3
Birdie	6.8	6.6	7.3	7.0	5.3	3.3	5.7	4.3
Sprinter	7.6	6.8	7.0	6.7	5.6	3.3	5.3	3.7
Goalie	7.3	6.6	7.3	7.0	5.0	3.3	5.7	3.7
Aristocrat	6.9	6.2	8.0	7.0	5.0	3.7	5.7	4.3
Venlona	6.9	6.3	6.7	6.7	5.3	4.0	6.0	5.0
Runner	7.0	6.6	7.3	7.3	5.0	3.0	5.7	4.0
Sportiva	6.7	6.2	6.7	7.0	4.7	3.3	5.3	4.7
Compas	6.1	5.9	6.0	6.0	5.3	3.7	5.7	4.3
Caravelle	6.1	6.1	7.3	7.3	4.3	2.7	4.0	3.3
Servo	5.7	5.0	6.3	6.0	4.7	2.7	5.0	3.7

[1] Performance ratings from 1-9 with 9 = best.

Table 3. Turf quality performance[1] of perennial ryegrass cultivars and selections at Puyallup, Washington, 1980.

Cultivar	2/79	6/79	7/79	11/79	12/79	1/80	2/80	5/80	8/80	9/80	Mean
Barry	6.0	7.7	9.0	7.0	7.3	6.6	6.7	9.0	8.7	8.3	7.6
Yorktown	7.3	7.3	7.7	8.0	8.3	6.6	5.7	7.3	7.7	8.3	7.4
HE 129	7.3	7.7	8.0	6.3	7.3	6.0	6.7	8.0	7.7	8.3	7.3
Premier	7.3	8.0	8.0	7.0	6.6	5.3	6.0	6.3	7.3	8.0	7.0
969	7.3	8.3	8.0	7.0	6.0	6.3	4.7	7.7	7.7	7.3	7.0
R38H	7.0	8.3	7.0	7.0	7.3	6.0	6.3	6.0	7.3	7.0	6.9
Acclaim	6.7	8.0	8.7	6.3	6.3	5.7	5.3	6.7	7.7	7.3	6.9
R-35	6.3	8.3	8.3	6.7	6.3	5.7	5.3	6.0	8.3	8.0	6.9
Diplomat	7.0	7.0	7.3	6.3	6.7	6.3	6.0	7.3	7.3	7.0	6.8
MOM Lp 204	7.0	6.0	7.7	6.7	7.3	6.3	6.3	6.7	7.0	6.7	6.8
Dasher	7.0	7.7	7.7	6.3	6.0	5.7	5.7	6.0	8.0	8.0	6.8
N-35	5.3	6.7	7.0	7.0	6.3	5.7	6.3	8.3	7.7	6.7	6.7
Manhattan	7.7	6.3	7.7	5.7	5.7	5.3	6.3	8.0	6.3	7.3	6.6
Citation	7.0	9.0	8.3	6.3	5.3	5.3	5.3	5.7	7.3	7.0	6.6
Derby	7.0	8.0	7.7	6.3	6.3	6.3	6.7	4.7	6.7	6.3	6.6
R-37M	7.3	8.7	6.7	6.7	6.3	6.0	6.3	5.0	6.3	6.0	6.5
EER 654	7.0	7.3	7.0	7.0	7.3	6.0	5.0	5.3	5.7	6.7	6.4
BAR Lp 78-Tc	3.7	6.7	8.0	5.3	5.3	5.0	5.0	6.7	6.0	7.3	5.9
HE 132	7.0	6.3	6.3	5.3	4.7	4.7	4.3	7.3	6.0	6.3	5.8
HE 138	6.3	8.0	7.7	5.3	4.7	4.3	5.0	5.3	5.0	5.7	5.7
Bianca	6.0	7.0	6.3	5.7	5.7	5.3	4.7	6.0	4.0	4.7	5.5
Zw-42-80	3.7	5.0	5.7	6.7	6.3	5.0	5.3	6.0	4.7	5.3	5.4
Zw-42-81	3.7	5.3	6.3	5.0	5.0	5.0	5.0	7.3	5.3	6.0	5.4
Silian	6.3	5.7	6.7	6.3	4.7	4.6	4.7	5.7	4.0	3.2	5.2
Romney	5.7	5.0	5.3	6.0	6.0	4.3	4.7	4.3	4.0	4.3	5.0
Jennifer	5.3	5.7	5.7	5.0	4.7	4.0	4.0	5.7	4.3	4.7	4.9
Rudo	4.3	6.0	6.7	5.0	4.7	4.0	2.3	5.7	4.3	6.3	4.9
Causeway	4.0	4.7	5.3	5.0	4.7	3.7	3.0	4.0	4.3	3.7	4.2

[1] Performance ratings from 1-9 with 9 = best.

Table 4 . Mowing quality[1] of turftype perennial ryegrass cultivars and selections at Puyallup, Washington, 1980.

Variety	6/79	8/80	9/80	Mean
969	9.0	8.0	8.0	8.3
Premier	8.7	8.3	7.3	8.1
Barry	7.3	9.0	7.7	8.0
Citation	9.0	7.3	7.3	7.9
Yorktown	7.7	8.0	7.7	7.8
HE 129	7.3	8.3	7.7	7.8
Acclaim	8.0	7.7	7.7	7.8
Dasher	7.7	8.0	7.7	7.8
R-38H	7.7	8.0	7.3	7.7
R-37M	8.3	7.3	7.3	7.6
R-35	8.0	7.3	7.0	7.4
Diplomat	7.3	7.0	7.0	7.1
BAR Lp 78-Tc	7.7	7.0	6.7	7.1
EER 654	8.3	6.7	6.3	7.1
Derby	8.0	6.7	6.0	6.9
Zw-42-81	6.0	7.0	7.0	6.7
HE-138	8.0	6.3	5.7	6.7
Manhattan	6.3	7.0	6.7	6.6
HE-132	6.7	6.0	6.7	6.5
N-35	5.7	7.3	6.0	6.3
MOM Lp 204	6.0	6.7	5.7	6.1
Bianca	6.0	4.7	5.0	5.2
Zw-42-80	4.3	4.7	5.3	4.8
Rudo	5.0	4.3	4.7	4.7
Causeway	6.0	5.0	3.0	4.7
Jennifer	4.3	4.7	4.0	4.3
Silian	4.0	4.3	4.7	4.3
Romney	3.3	3.7	3.0	3.3

[1] Performance ratings from 1-9 with 9 = best.

AGRONOMIC RESEARCH REPORTS[1]

Roy L. Goss[2]

The research reports included in this paper will be brief summaries of ongoing and new research projects. Some of the older research projects are nearing their term and new research will be initiated in the spring of 1981.

TURFGRASS MIXTURE STUDIES

This study has been carried out now for two years. It is composed of mixtures of Highland bent, Penncross creeping bent, and Emerald creeping bent as the bentgrass constituents either alone or in mixture and with additions of various percentages of red fescue, Kentucky bluegrass and turftype perennial ryegrasses.

The purpose of the study was to determine the effects of mixtures of Highland bentgrass with these other varieties and types and how they will stand up under mild to severe traffic conditions. A portion of each plot was heavily trafficked during May, June and July and evaluated for color and quality. The plots have been fertilized since planting with 4 lb of nitrogen per 1000 ft^2 per year as a complete formulation in a 3-1-2 ratio. Irrigation has been practiced as needed and they have been maintained at a mowing height of 1/2 inch.

RESULTS

Penncross bentgrass ranked highest in color on June 24, 1980, with a rating of 8 out of a maximum 9. Although Highland bentgrass alone ranked 6.5, when it was blended

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1/ Presented at the 34th Annual Northwest Turfgrass Association Conference, September 22-25, 1980, Sunriver, OR.

2/ Agronomist/Extension Agronomist, Western Washington Research and Extension Center (WSU), Puyallup, WA.

with a mixture of 50:50 with Penncross bentgrass, it had a rating of 7.8, almost as good as Penncross alone. Both bluegrass and ryegrass added some color contribution to the plots, but not significantly.

Quality ratings indicated that a blend of Highland, Penncross, red fescue, Kentucky bluegrass and ryegrass gave the highest quality rating. The lowest quality rating was recorded with Highland bentgrass alone, but only slightly less than Emerald and Penncross.

Percent surface cover was estimated following heavy traffic and again, the mixtures of Highland, Penncross, red fescue, Kentucky bluegrass and turftype ryegrass ranked highest. Highland and Penncross in a 50:50 blend ranked only 3% lower than Penncross alone and somewhat better than 50:50 mixtures of Highland and Emerald. Winter evaluations may reveal additional differences. It is known that Penncross usually has superior summer color, whereas Highland loses some color quality during the highest temperature. Highland, on the other hand, regains color quality during fall, winter and early spring as opposed to some color loss from Penncross at that time.

At the time of preparation of this report all traffic areas have 100% cover and have completely healed from the severe traffic test.

SAND GREEN FERTILIZER STUDY

The best color ratings as evaluated in June, 1980 occurred with plots receiving 10 lb of nitrogen, 0.5 lb phosphorus, 3 lb potassium and 2.5 and 3.5 lb sulfur per 1000 ft^2, respectively. Nitrogen for the highest rating plots was supplied from urea. Plots receiving ammonium sulfate ranked nearly as high as the urea plots. Ammonium sulfate plots receiving the same P and K treatments but with 4.5 lb of added elemental sulfur dropped about 1/2 color point at the time of this rating. All Milorganite plots rated between 5.3 and 6.3 on a scale of 1 to 9 in June, but the color increased to an average over 8 by July and August.

The lowest Poa annua percentages occurred with urea treated plots at 1/2 lb P, 3 lb K, and 3.5 lb S. Overall Poa annua ratings showed ammonium sulfate plots averaging less Poa annua as compared to overall averages of all urea treated plots.

Fusarium patch disease evaluations made in the fall and winter of 1979 showed significantly less Fusarium patch in the ammonium sulfate treated plots vs the urea treated plots. Milorganite plots were significantly better than urea treated plots but contained significantly more disease than ammonium sulfate treated plots. Ammonium sulfate plots (receiving 10 lb N) treated up to 4.5 lb sulfur had essentially zero Fusarium patch disease. The greatest amount of Fusarium patch disease was recorded in a urea plot with a low level of sulfur, but with increasing levels of sulfur up to 4.5 lb Fusarium patch disease decreased down to 2% of the area.

Precise pH and soil nutrient evaluations will be made during the winter of 1980-81 and quality and Poa annua evaluations during the spring and summer of 1981. The treatments have been continuing now for 4 years and it is anticipated that the test should run one or two additional years before terminating.

SURFACTANT INVESTIGATIONS

The summer of 1980 produced fewer hydrophobic conditions (localized dry spot) than in most years due to the lower temperatures and higher precipitation. Nonetheless, many areas were affected by summer conditions. Three surfactants, R54 Soil Penetrant, Amway Spray Adjuvant, and Aqua-Gro, were applied to hydrophobic areas where turfgrasses were established on sand. All surfactants were effective in correcting surface tension and inducing infiltration of water. Aqua-Gro treated plots accepted water more readily than the other two materials.

The exact nature of localized dry spot is not well understood, but experiences have shown us that surfactant applicaton commencing before wilting first appears is much more effective as a preventative than to correct the dry spots after they have formed. Our results indicate that surfactants should be started as early as the first of May and repeated on at least monthly applications during June, July, August and September on difficult areas.

POA ANNUA POST EMERGENCE TRIALS

Plots were established in August 1980 to determine the effects of 42% Nortron flowable and 2.5% granular, Endothall, and an experimental compound on selective post-emergent control of Poa annua and the phytotoxicity of these compounds. No phytotoxicity was observed in any of the plots with rates of up to 1 lb active ingredient per acre of Nortron nor 1 lb active ingredient per acre of endothall on Highland bentgrass putting green turf. A 60% reduction in Poa annua was estimated in both the Nortron and endothall treated plots 30 days after application. Repeat applications at lower rates have just been completed and data are not available at this time. Additional tests will be conducted with Nortron to determine any seasonal differences in Poa annua and phytotoxicity.