James B. Beard

Proceedings Of The 32nd Northwest Turfgrass Conference

Sept. 26 - Sept. 28, 1978
Holiday Inn
Richland, Washington

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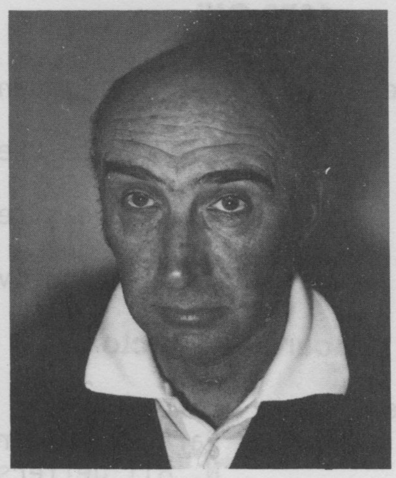
PRESIDENT'S MESSAGE



By the time you read this, Northwest Turfgrass Association will have a new president - Joe Pottenger.

As I reflect back on my year as president, I see two areas in which the Northwest Turfgrass Association has made some real gains. The first is in the area of research. I believe Bob Wick's committee is functioning at peak efficiency and is a great credit to the Association.

Secondly, I think NTA has made great strides in convincing the "powers that be" at Washington State University that turfgrass and the problems associated with turf are significantly important enough to warrant additional fulltime professional help to our industry.

It has been a pleasure serving as your president. I wish the new President and Board a great deal of success and, of course, will be available to help as they deem it necessary.

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CHEMICAL SOIL AMENDMENTS FOR ESTABLISHED TURFS[1]

Paul E. Rieke[2]

This discussion is to deal with the non-fertilizer and non-pesticide chemical additives to the soil which could be used in turf management. The amendments to be considered are: 1) liming agents, 2) acidifying agents, 3) gypsum, 4) soil conditioners, and 5) wetting agents.

Many of the principles of soil management which apply to agricultural crops also apply very nicely to turfgrass soil management. But unlike most farmers the turf manager normally does not have the opportunity to mix chemical soil additives with the soil by plowing. This results in some unique situations for turf.

Fertilizers and other chemicals applied to established turfs are left at the surface of the soil or in the thatch layer. Nutrients which are in a water soluble form (like nitrate nitrogen) can be readily leached down into the rootzone. Other nutrients, like phosphate, are much less soluble and are left at the surface. Gradually the applied material may move downward with water. Thus when using

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1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Richland, WA, September 25-28, 1978.

2/ Dept of Crop and Soil Sciences, Michigan State University, East Lansing, MI.

low solubility, persistent chemicals the turf manager must exercise caution to prevent a potential harmful buildup of the chemical in a concentrated zone near the surface.

LIMING AGENTS

The objective of liming is to raise the pH of an acid soil to a more desirable level. Most grasses grow well between pH 5.5 and 7.5 with the ideal range from 6.0 to 7.0. Above 7.5 some grasses exhibit micronutrient deficiencies, especially iron. Below pH 5.5 the effects of high acidity tend to reduce root growth. In very acid soils certain elements become highly soluble and can reach toxic levels for plants. Raising soil pH to reduce the toxic level of these elements is a practice which costs little and is easily practiced.

Soil pH has a number of effects on soil and plants including affecting nutrient transformations in the soil, soil macro and microorganism activities, organic matter (and thatch) decomposition, development of toxic levels of certain nutrients, turfgrass rooting, and competition among the plant species in the turf. Obviously, soil pH can have a very significant effect on what happens in the soil and therefore, influences the management practices required.

Since liming agents are applied to the soil surface the turf manager should be careful to note whether the lime recommendations are based on mixing the lime with a given depth of soil. Recommendations for liming agricultural soils often call for mixing the lime to a depth of 9 inches of soil or more. If the same rate of lime were applied to established turf a pH well above the desired range would result in the surface layer. Be sure your recommendations are made with established turf in mind.

In selecting a liming agent one should evaluate particle size, speed of reaction in the soil, cost, magnesium content, ease of handling, whether the material is caustic, and purity of the material. A list of liming materials is given in Table 1.

TABLE 1. Liming agents for turf.

Liming agent	Chemical composition	Equivalent pounds*
Calcitic limestone	$CaCO_3$	100
Dolomitic limestone	$CaCO_3.MgCO_3$	92
Calcium hydroxide (hydrated lime)	$Ca(OH)_2$	76
Calcium oxide (quick lime)	CaO	56
Slag	Variable	Variable

*Pounds of pure liming agent needed to attain the same pH change as 100 lb of calcitic limestone.

When applying liming materials if one desires a rapid pH change a finer grind of limestone is suggested (higher percentage of materials to pass through the 60 and 100 mesh sieves). If magnesium is low in the soil, dolomitic limestone is recommended if available. Our recommendation in Michigan is apply no more than 25 to 50 lb limestone/1000 ft^2 per year on established turf if the soil test shows lime is needed. Then the soil should be retested in a year or two to determine if more lime will be needed.

Use of hydrated or quick lime materials is suggested only in unusual circumstances where rapid pH change is essential. These materials are hard-to-handle powders and can be caustic.

The slag materials vary widely in chemical content with variable content of magnesium, phosphorus, and manganese, among other nutrients, as well as in neutralizing value. Be sure you know the chemical content of the slag before using on turf. This is true for any liming material, of course. The cost and trouble to reestablish a turf make it imperative that only good liming materials be used and only when needed. Questionable materials should not be used even though they are cheaper.

One means of applying liming agents which golf course superintendents have used is to mix the appropriate amount of lime with topdressing soil and topdress after coring. This allows some of the lime to be applied somewhat lower in the soil.

In several parts of the country, liming agents are not needed because soil pH is naturally high or is increased due to irrigation with water high in bases. We have found a soil pH increase from 6.4 to 7.2 in a sandy soil after 6 years of intensive irrigation. Soil testing is the only dependable means of being sure of the need for pH adjustment. When sampling the soil under established turf conditions the depth of sampling is very important. Follow the recommendations of the laboratory which is conducting the soil tests.

ACIDIFYING AGENTS

In many areas soil pH is much higher than desired, leading to reduced availability of certain micronutrients, especially iron. Some turf managers are interested in reducing soil pH. Although means of reducing pH are available, the potential for turf injury from improper application is high. Any attempt to reduce pH should be approached very carefully.

Acidifying agents include the use of acidifying nitrogen fertilizers, elemental sulfur, or possibly ferrous sulfate or aluminum sulfate. The latter two can be highly toxic to turf so I would not recommend their use to reduce soil pH with these materials. Ferrous sulfate is used, of course, to provide iron to the turf as a foliar treatment, but at much lower rates than are needed to lower soil pH.

Acidifying nitrogen fertilizers include ammonium sulfate, ammonium phosphate, ammonium nitrate, urea, and any slow release fertilizer which forms ammonia in the soil. As the ammonia is nitrified to nitrate by soil microorganisms, hydrogen ions are released in the soil causing acidification.

As an example of using acidifying fertilizers effectively, one superintendent in Michigan used ammonium sulfate on a green at the rate of 4 lb nitrogen/1000 ft^2 annually. After 3 years the soil pH in the 0-2 inch depth was 6.8; at 2-4 inches, 7.4; and at 4-6 inches, 7.6. In another study applying 14 lb nitrogen/1000 ft^2 annually to a loam soil over a 6 year period reduced soil pH in the 0-2 inch depth to 5.2, while it was 6.8 at 2-4 inches, and 7.4 at 4-6 inches. When such high rates of acidifying nitrogen carriers are utilized it is essential to test the soil more often to prevent developing serious pH problems in the surface layer.

Using acidifying nitrogen carriers may not change pH, however. In another study ammonium nitrate rates as high as 16 lb nitrogen/1000 ft^2 annually for 7 years did not change pH because this was offset by irrigating with water drawn from a limestone acquifer. Throughout the study the soil pH remained at 7.5 to 7.7 on all plots. Each irrigation produced a "mini-liming".

Elemental sulfur has been used effectively to lower soil pH, but must be used very carefully. A study was conducted on a silty clay loam bentgrass tee in Michigan. After 2 years the pH values shown in Table 2 were reached.

Obviously too high applications of sulfur can result in drastic pH change in the surface layer with serious injury or death of the turf. In this study some injury occurred on the plots receiving 60 lb sulfur/1000 ft^2 in the one application. The turf did ultimately recover, but one could not risk such high application rates.

TABLE 2. Effect of elemental sulfur on soil pH two years after application.

Soil depth	Sulfur rate, lb/1000 ft^2		
inches	0	20	60
0-2	7.3	7.1	5.4
2-4	7.3	7.3	6.9
4-6	7.4	7.4	7.2

There are several different types of sulfur materials which could be applied to lower pH. These include crystalline, granular, powder, or sulfur mixed with complete fertilizers. The powder form reacts very rapidly so lower rates should be used per application. The large granular crystals may take more than a year to decompose and react in the soil. It is essential that the turf manager be familiar with the reaction of a given product in the soil before using that product on his turf. I like to encourage turf managers to do a little experimenting with such products on turf which is not necessarily visible to the public before adopting their use wide scale.

It is wise to use no more than 5 to 10 lb sulfur/1000 ft^2/application with the 5 lb rate being preferred. Applications could be made spring and fall with a maximum of 10 to 15 lb/year. It may take several years to lower pH, but it is better to be cautious.

Sulfur applications should only be made during non-stress periods, such as spring and fall. Do not lower pH on turf where calcium arsenate has been used in the past for annual bluegrass control. If the soil becomes quite acid, the arsenate becomes more available and serious turf loss could occur.

As more sophisticated systems are developed for fertilizer injection into the irrigation water, there arises the possibility of injecting acid into the water for lowering soil pH. I would not recommend this practice unless you very carefully check to be sure that the proper rate of acid is being applied and that the irrigation system will tolerate the acid.

GYPSUM

For soils high in exchangeable sodium (sodic soils), gypsum (calcium sulfate-$CaSO_4$) has been used effectively to replace the sodium on the soil cation exchange sites. The sodium can be leached as sodium sulfate. Good drainage and excess irrigation water (or rainfall) are needed to move the sodium well out of the rooting zone. When this occurs there can be a dramatic improvement in soil physical properties resulting in better turf.

There has been a suggestion that gypsum can be used to improve the physical properties of fine textured, non-sodic soils under turf conditions. This should be evaluated carefully. Few of our fine-textured soils in Michigan have appreciable exchangeable sodium. Most of them contain free lime with pH values above 7.0. Exchangeable calcium values of 5,000 to 10,000 lb/A are common. Applying gypsum to these soils has had no effect on soil physical properties in our studies. Check your sodium levels by soil testing to determine the need for gypsum.

SOIL CONDITIONERS

There has been occasional interest in the use of soil conditioners for improving the physical properties of turf soils. Although there is some promise with the use of such materials there are many problems to be solved as yet, so soil conditioners cannot be recommended for turf at this time.

WETTING AGENTS

Localized dry spots can be a deterrent to maintaining a beautiful, uniform turf. There can be a number of causes of localized dry spots on turf.

One of these is the development of a hydrophobic condition on sandy soils. Water does not penetrate into such soils, but runs off to adjacent areas.

Suggested solutions to the hydrophobic soil problem are to use wetting agents and cultivation, primarily by coring. We have had a series of studies on a hydrophobic sand in northern Michigan. There was considerable variability among the wetting agents studied in terms of their ability to bring about rewetting of the hydrophobic sand. The most effective among the group studied was Hydro-Wet, followed by Aqua-Gro. Other materials had to be used at considerably higher rates to achieve even some rewetting.

Wetting agent treatment responses varied from one application date to another so repeat applications in the same growing season were found to result in the most consistent responses. The localized dry spot problem tended to recur from one year to the next. It is important to identify areas which are prone to the problem and treat early in the season to prevent serious development of the hydrophobic condition. Treatments applied in July and August sometimes did not result in turf recovery until the next spring even though the soil was rewet by the treatment the first year.

Wetting agents should also be used carefully since they can cause injury to the turf, especially if treated during heat or moisture stress periods. Treatments should always be watered in to aid in moving the wetting agent into the soil and to reduce the potential for phytotoxicity to the turf.

SOIL CULTIVATION IN ESTABLISHED TURF[1]

John M. Roberts[2]

The benefits and principles of cultivation under sod have been repeatedly discussed and several observations and opinions have been formed by turf managers regarding the practice of cultivation. In particular, questions regarding the frequency and timing of cultivation, the influence of cultivation on the turfgrass vigor and subsequent weed invasion, and the effects of cultivation on soils having compacted surfaces have been of concern.

Most of the cultivation research under sod has been conducted on soils having compacted soil surfaces. However, what about cultivation (Greensairing) on those soils which a) do not have a thatch problem, and b) have a desirable surface soil structure? In the field some turf managers will cultivate the soil regardless of its physical condition in the spring and/or fall of the year to retard compaction and reduce the organic layer that can accumulate under sod. However, the desirability of this practice on well structured soils is still a question among turf managers.

In this study annual and monthly cultivation frequencies were made using a Ryan Greensaire (aerifier) on two well structured soils having a desirable organic layer thickness (1.0 cm) in the surface. The Ragsdale soil, having a silty clay loam texture, had an established Merion bluegrass sod while the medium textured sand root zone had a vigorous Evansville bentgrass sod. The soil cores removed by the

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

Greensaire were shred by a vertical mower and returned to the test plot. Some of the physical changes in the soil structure in and below the tine penetration depth (7.6 cm) are reported.

It is interesting to note that while there was some loosening action of the soil particles in the zone of cultivation (Table 1) impaired water infiltration rates on the Ragsdale soil following cultivation (Table 2) were recorded. This rather unexpected result was attributed to the (sealing) of the exposed shredded soil cores following irrigation and/or rainfall. Consistently improved water infiltration rates were recorded following cultivation on the sand root zone plots. In general only slight increases in the bulk density occurred below the tine penetration depth after 7 monthly cultivations (Table 3).

The duration of the loosening action in the 2.5 to 7.6 cm zone derived from cultivation was relatively short-lived following annual aerification (Table 4-6) on the well structured Ragsdale soil. The amount of rainfall following aerification was an important factor on the longevity of the soil loosening action derived from aerification in the 2.5 to 7.6 cm depth.

SUMMARY

Aerification under sod can and does destroy the soil structure in the zone of cultivation thus temporarily counterbalancing the physical benefits derived from a vigorous rooting system and earthworm activity. This questions the desirability of annual or monthly aerification on well structured soils under turf that do not have an excessive organic layer accumulation.

On the other hand, vertical penetration (aerification) on soils having compacted soil surfaces is certainly one effective method which allows for improved water and air movement into the root zone.

TABLE 1. Changes in bulk density following monthly cultivation in the upper 2.5-7.6 cm.

			No. of monthly cultivations							
			1	2	3	4	5	6	7	
			Month							
	Soil	Cultiv.	1974				1975			Year
Machine	texture	freq/mo	Aug.	Sept	Oct.	Nov.	May	June	July	avg.
			g/cc							
Greensaire	SiCL	1X	1.24	1.32	1.07	1.18	1.39	1.33	1.32	1.26
"	"	2X	1.22	1.21	1.07	1.21	1.41	1.39	1.30	1.26
"	"	4X	1.15	1.19	1.16	1.17	1.42	1.39	1.31	1.26
		Control	1.31	1.31	1.17	1.15	1.38	1.30	1.36	1.28
Greensaire	M. sand	1X	1.52	1.53	1.51	1.55	1.57	--	1.75	1.57
"	"	2X	1.44	1.45	1.52	1.56	1.59	--	1.77	1.56
"	"	Control	1.55	1.55	1.54	1.61	1.66	--	1.81	1.62

TABLE 2. Water infiltration rates following monthly cultivation.

			No. of monthly cultivations							
			1	2	3	4	5	6	7	
						Month				
Machine	Soil texture	Cultiv. freq/mo	Aug.	Sept	Oct.	Nov.	May	June	July	Year avg.
			cm/4 min.							
Greensaire	SiCL	1X	2.2	3.6	4.2	1.9	10.6	5.0	5.5	4.7
"	"	4X	2.5	1.3	3.3	1.0	3.8	2.1	4.3	2.6
		Control	8.3	7.6	3.6	1.1	11.7	9.6	3.7	6.5
Greensaire	M.sand	1X	7.8	5.5	7.7	5.8	5.2	6.8	7.4	6.6
"	"	2X	7.4	6.1	7.5	5.8	5.1	7.7	7.5	6.7
		Control	5.0	4.7	2.9	2.0	2.5	2.4	4.4	3.4

TABLE 3. Changes in bulk density following monthly cultivations in the 7.6-12.6 cm depth.

Machine	Soil texture	Cultivation freq./mo	No. of monthly cultivations							Year avg.
			1	2	3	4	5	6	7	
			1974				1975			
			Aug.	Sept.	Oct.	Nov.	May	June	July	
			g/cc							
Greensaire	SiCL	1X	1.30	1.31	1.26	1.40	1.57	1.55	1.61	1.43
"	"	2X	1.31	1.35	1.30	1.37	1.59	1.49	1.53	1.42
"	"	4X	1.39	1.37	1.36	1.37	1.60	1.49	1.58	1.45
		Control	1.32	1.32	1.29	1.33	1.53	1.43	1.53	1.39
"	M.Sand	1X	--	1.57	1.49	1.56	1.70	1.78	1.79	1.65
"	"	2X	--	1.57	1.59	1.55	1.72	1.83	1.84	1.68
		Control	--	1.49	1.59	1.58	1.76	1.75	1.86	1.67

TABLE 4. The influence with time of mechanical cultivation on bulk density in the upper 2.5-7.6 cm depth.

Machine	Soil texture	Cultiv. frequency	No. of days following cultivation 1	17	30	60	90	120
			g/cc					
Greensaire	SiCL	1X	1.33	1.34	1.34	1.42	1.39	1.37
"	"	2X	1.32	1.44	1.35	1.37	1.40	1.38
"	"	4X	1.29	1.47	1.37	1.46	1.39	1.42
		Control	1.34	1.44	1.32	1.35	1.33	1.34

TABLE 5. The percent of non-capillary pores with time following annual cultivation in the 2.5-7.6 cm depth on a Ragsdale silty clay loam.

Machine	Cultivation Frequency	No. of days following cultivation 1	17	30	60	90
				%		
Greensaire	1X	17	11	9	15	18
"	2X	17	10	8	14	13
"	4X	17	6	8	13	15
	Control	14	8	13	15	19

TABLE 6. The influence of annual cultivation with time on water infiltration rates.

Machine	Soil texture	Cultivation frequency	No. of days following cultivation				
			4	17	30	60	90
			cm/2 min.				
Greensaire	SiCL	1X	3.5	3.1	3.3	4.7	4.2
"	"	2X	3.4	2.9	2.4	2.5	2.9
"	"	4X	2.6	1.7	2.2	1.9	2.7
		Control	2.1	2.9	2.6	1.8	2.0

AQUATIC WEED CONTROL - AN UPDATE[1]

R. D. Comes[2]

When your program chairman asked me to visit with you today about aquatic weed control, I was hesitant because there have been no major changes in this area since I spoke to you in 1971. The major changes that I have observed over the past 7 years are the proliferation of aquatic plant growth, especially submersed species, and the public's awareness of the problems associated with such growth.

I do not intend to infer that all aquatic plants or densities of aquatic plants are a nuisance. These plants play a vital role in the development and maintenance of a balanced aquatic community. Planktonic algae play an especially important role in the conversion of mineral nutrients, carbon dioxide, and light energy into organic matter which provides energy for other aquatic organisms. Vascular or higher aquatic plants provide food and/or shelter for aquatic insects, zooplankton, ducks, geese, and other aquatic life. In many cases, a few cattail,

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This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation by the USDA nor does it imply registration under FIFRA.

2/ Research Plant Physiologist, Federal Research, Science and Education Administration, U.S. Dept. of Agriculture, Prosser, WA.

bullrush or other emergent species provide a pleasing appearance to a pond or lake. Therefore, attempts to control aquatic plants should be limited to nuisance areas; they should not be eliminated from every body of water, even if this were possible.

I have used the word "nuisance" to broadly define situations in which it might be desirable to control aquatic plants. What does nuisance mean? According to Webster, a "nuisance is a highly obnoxious or annoying thing or person; something offensive or annoying to individuals or the community." Because water has so many uses, and people differ in their opinion as to what constitutes an annoyance, designation of an area or species to be controlled is frequently more difficult than the control process itself. Most of you own or manage ponds or lakes in their entirety, so designation of areas where plants are to be controlled may not be a problem for you. However, on larger bodies of water that have multiple uses it is a major concern.

After determining that aquatic plants are causing a problem and that control measures are desirable, considerable planning is required in selecting the most suitable approach. Some of the questions that must be asked are: Which species are causing concern? Which species are a part of the plant community that is not causing a problem? What are the growth habits and modes of reproduction of the various species present? What is the temperature, turbidity and hardness of the water? What fish species are present in the impoundment? What are the uses of the water in the impoundment? If the impoundment has an outflow, where does the outflow go, and what are the uses of this water? Can the water be quarantined from various uses and, if so, for how long? Other questions may need to be answered, depending on the individual situation. However, I feel that these questions must be addressed for nearly all areas where aquatic plant control is considered. Usually after these questions are answered, the method of control that can be used safely will be dictated by the circumstances.

In discussing control methods, I will limit my remarks to ponds and lakes because I believe this is your sole area of interest. Principal methods of controlling unwanted aquatic vegetation can be placed into four broad categories - mechanical, environmental, chemical, and biological.

The development of mechanical devices to mow and/or harvest aquatic vegetation has accelerated considerably during the past few years. Various underwater weed mowers or harvestors are available for mowing vegetation at depths of 6 inches to 6 feet beneath the water surface. Such equipment is available in a variety of models that range from portable units that can be mounted on a small pontoon boat to large and self-propelled units. Some manufacturers have developed complete systems of handling aquatic plants that include harvestors, transports, and shore conveyors.

Advantages of mechanical control methods are that they present no direct hazard to fish, humans, livestock or wildlife. A few small fish may be trapped in dense plant growth and become removed with the severed plants, but this is not a major problem. Most, if not all, of the mechanical devices that I am aware of are not suited for use in the small ponds associated with golf courses and small parks. The time and cost required to get the equipment into and back out of small ponds, and to collect and remove the severed growth to a disposal site is high in relation to the area mowed. Another disadvantage of mechanical control is that many plant fragments are generated. Fragments of some submersed aquatic plants will form new roots and develop into individual plants. These plants may drift about the impoundment, sink and develop new colonies, or be transported in the outflow to various locations downstream where they may root and grow.

Environmental controls are most easily and economically applied during the construction phase of pond development. Deepening the edges so that no water is less than 2 or 3 feet deep and complete removal of topsoil and organic matter from the basin render the basin inhospitable to many aquatic plants. Installation of a bypass system to prevent drainage water high in organic matter or sediment from entering the basin may also reduce the rate of invasion and/or growth of aquatic plants. Another advantage of a bypass system is that water may be isolated in a pond should treatment with herbicides be necessary in future years.

In many situations, a periodic drawdown of 5 feet or more reduces the incidence of rooted aquatic plants. Plants are exposed to desiccation during the summer, whereas they are exposed to freezing in the winter during the drawdown cycle.

Chemicals have been used to control aquatic plants for the past 75 years, but it was not until the late 1940's or early 1950's that there was a choice of more than one or two products. Several herbicides were registered for the control of submersed species between 1950 and 1963, but to my knowledge only one has been registered since 1963. Simazine (2-chloro-4,6-*bis*(ethylamino-*s*-triazine) was registered for the control of algae in 1976, and several submersed and floating species were added to the label early this year. Various formulations or chelates of certain herbicides previously registered for aquatic use have reached the marketplace during the past 15 years. I have not considered these to be new herbicides.

There are two herbicides now under testing that I consider to have potential utility and sufficient interest by the manufacturers to develop. These herbicides are glyphosate (*N*-(phosphonomethyl) glycine), and fluridone (1-methyl-3-phenyl-5-(3-(trifluoromethyl)phenyl)-4(1*H*)-pyridinone). Glyphosate is effective on many emergent species and has been under public and private testing since about 1971. Fluridone is effective on a number of submersed and emergent species and has been under test in aquatic environments for 2 or 3 years.

Neither is registered for use in the aquatic environment at this time. Thus, it appears probable that not more than one or two herbicides may be registered for aquatic uses in the next decade. This is a very optimistic view based on the past 15 years.

Herbicides currently registered for use in various aquatic situations in lakes, ponds, and/or marshes include copper sulfate and a number of copper chelates, diquat (6,7-dihydrodipyrido(1,2-a:2´,1´c)pyrazinediium ion), three salts of endothall (7-oxabicyclo(2.2.1)heptane-2,3-dicarboxylic acid), the butoxyethanol ester of 2,4-D (2,4-dichlorophenoxy)acetic acid), dichlobenil (2,6-dichlorobenzonitrile), simazine, dalapon (2,2-dichloropropionic acid) and amitrole (3-amino-s-triazole). Other herbicides are registered for use in aquatic sites in certain states, but they cannot be used in our region.

Restrictions on the uses that may be made of the water after treatment vary widely for the various herbicides. In general, restrictions on the use of treated water for irrigation are the most severe. Thus, it is imperative to read and understand the label of each prospective herbicide before making a decision to use a chemical method of control.

Most of the herbicides registered for the control of submersed plants in ponds and lakes are not toxic to fish at concentrations needed for vegetation control. However, when submersed or floating aquatic plants are destroyed by herbicides, they fall to the bottom of the impoundment and decay. The decaying process requires oxygen dissolved in the water. If a large portion of a moderate to heavily infested lake is treated at one time, the dissolved oxygen will be depleted below the level needed for the survival of a fish. No more than one-third of a heavily infested impoundment should be treated at a time. Ten to 14 days should elapse between successive treatments within a given impoundment.

Control of aquatic vegetation with other living organisms is considered to be the ultimate and most environmentally acceptable method of control. Several scientists with federal and state agencies are very active in seeking and developing biological agents for several aquatic plants. Much of this work is aimed at the control of certain introduced weed species common in the southeastern part of the country. Herbivorous fish, insects, and plant pathogens are the principal organisms being studied.

An herbivorous fish, the white amur (*Ctenopharyngodon idellus*) consumes large quantities of aquatic vegetation and could survive in many of the impounded waters of the Pacific Northwest. However, the effects that the white amur would have on native fish and on the total aquatic ecosystem are not fully understood. For these, and perhaps other reasons, the white amur has been outlawed in many states, including those in the Pacific Northwest.

To my knowledge, the only biological control agent presently being evaluated, that may have utility in our region, is dwarf spikerush (*Eleocharis coloradoensis*). This plant attains a height of only a few inches and grows in dense beds in some lakes and canals. In certain sections of some canals in California it has replaced pondweed species. Federal research personnel at Davis, California are continuing their studies on seed production, seed germination, seedling establishment, and the effects of soil and water parameters on the growth and survival of dwarf spikerush. Until these parameters are understood more fully, dwarf spikerush cannot be recommended as a method for the control of aquatic vegetation. Thus, we in the Pacific Northwest do not have any biological control agents to aid in reducing populations of troublesome aquatic plants.

Many of you have probably read about the infestations of Eurasian watermilfoil (*Myriophyllum specatum* var. *spicatum*) in Union Bay and in the Okanogan Valley of British Columbia. This is a very agressive submersed aquatic plant that apparently was unknown in Washington and British Columbia until about 1971. Eurasian watermilfoil forms dense mats of vegetation at the water surface and displaces most of the native submersed vegetation in waters of impoundments that are less than 18 to 20 feet deep. The plant will grow in relatively pure water with few dissolved salts as well as in water containing up to 10,000 parts per million salts (1/3 strength sea water). It grows on nearly all types of substrates and therefore has the potential of infesting many of our lakes, ponds, reservoirs, and river systems. Last year it was discovered in Banks, Evergreen, Billy Clapp, and Scootney Reservoirs in the Columbia Basin. I understand that Eurasian watermilfoil caused the State Parks Commission to designate a different area for swimming at Banks Lake State Park this summer. They were concerned that someone would get tangled in the Eurasian watermilfoil growth and drown at the former swimming area.

Reproduction of Eurasian watermilfoil is primarily through plant fragmentation. Apical portions of the plant detach from the mother plant, float on the water surface, and eventually sink to establish new colonies. Rootlets are formed at the nodes along the stem of the mother plant at certain seasons of the year, and at other seasons the fragments form rootlets while floating. Propellers of motor boats drastically increase the rate of fragmentation. These fragments may be moved to other bodies of water through stream flow, plant parts clinging to motor boats or boat trailers, and on the plumage of waterfowl.

The Tennessee Valley Authority has spent millions of dollars for the control of Eurasian watermilfoil over the past 10 or 12 years, and the British Columbia government had about 200 people working on various aspects of this problem in the Okanogan Basin this past summer. I believe these two examples demonstrate the potential danger of Eurasian watermilfoil to our water resources.

Hydrilla (*Hydrilla verticillata*), another submersed aquatic plant that we do not have in Washington, has the potential to become more troublesome than any species we now have. Hydrilla was first noted in this country in about 1960 near Miami, Florida. It is now present in several states, including Florida, Georgia, Alabama, Mississippi, Louisiana, Texas, Iowa, and California. Last year approximately $8,000,000 were spent for the control of this species in Florida alone.

Hydrilla has the gross outward appearance of Elodea (*Elodea canadensis*), a submersed species found in many of our waters. Hydrilla can be distinguished from Elodea by its serrated leaf margins with pointed spines and spines along the midrib on the underside of the leaf.

Hydrilla has four means of vegetative reproduction - fragments of foliage, rhizomes, turions, and subterranean tubers. It also flowers, but only pistillate or female plants have been reported in the United States. The efficiency of these reproductive structures was exhibited in Orange Lake, Florida where 12,000 acres were completely infested within 4 years.

I urge each of you to watch for and report the location of plants which you believe to be Eurasian watermilfoil or Hydrilla to your local County Extension Agent. The old adage "An ounce of prevention is worth a pound of cure" surely applies to introduced aquatic plants.

INNOVATIVE EQUIPMENT[1]

By Larry Gilhuly[2]

Before I begin I would like to thank the committee for the opportunity of speaking before such an esteemed group.

In 1975 I graduated from Washington State with a degree in Agronomy. At that time I felt that practical experience was fine but that a college education was really the way in which to learn the processes involved in maintaining quality turf. While I still feel college does provide an excellent doorway to knowledge in our field, I now realize that it is practical experience which is the key to our business. With this in mind I would like to thank those superintendents who have had the guts and foresight to hire college graduates so that they may also gain a valuable education in furthering their knowledge of turfgrass maintenance.

Today I will be speaking about innovative equipment. Before anyone can consider modifying a piece of equipment or constructing a new one from scratch, he must first ask himself, "Will the modified results warrant the cost of labor while keeping within safety standards?" If so, get started and have a good time. If not ...... (see slide).

1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

2/ Assistant Superintendent, Seattle Golf Club, Seattle, WA.

Thanks to the following superintendents for their cooperation in making this presentation possible.

Seattle Golf Club	Milt Bauman
Broadmoor Golf Club	John Monson
Overlake Country Club	Sam Zook
Tumwater Valley	Doug Weddle
Inglewood Country Club	Chuck Nolan
Wayne	Art Kain
U.S.G.A.	Bill Bengeyfield

If you have further questions or interests in any of the equipment shown, feel free to contact the superintendent.

MAINTENANCE PHILOSOPHIES' EFFECT[1] ON BUDGETS

By Bob Wick[2]

Rather than discussing golf course budgets in the terms of dollars and cents, it would be far more profitable and more fair for us to look at the contrasting factors at different courses which dictate where the dollars go. I'd like to break these factors into two groups, physical factors and club philosophies, and take a look at a few items which cause differences in maintenance budgets. Some items could be in both categories, as you will see, but most are distinctly separated.

This is not a guessing game as to where the slides were taken or which course does what procedures, but rather an objective view of the subject. Please do not try to figure out where the slides were taken or you'll prejudice your objective thinking. Remember, we are talking about tracts of property under various ownerships, used to play the game of golf. Therefore, there is no set standard of maintenance other than the owner's wishes and the observation of the rules of golf.

1/ To be presented at the 32nd Annual Northwest Turfgrass Association Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

2/ Superintendent, Capilano Golf Club, W. Vancouver, BC, CANADA.

What are some physical factors over which a golf course superintendent has little or no control that affect the maintenance budget? A few are:

- number of acres maintained;
- number of traps and their size;
- size of greens and tees;
- source of irrigation water;
- amount of area requiring special maintenance;
- number of deciduous trees;
- vandalism;
- etc.

The contrasts of the physical factors are quite straightforward if one assesses them honestly. But the contrasts caused by a club's philosophy can be somewhat more subjective.

At this point I want to reiterate that there is no practice which is necessarily a "better maintenance" than another. Often economy is an influencing factor on a maintenance procedure, but that does not mean that more money makes a better finished product, but rather to meet the specific desires of a membership more or less money is required in certain areas. A golf club must assess its own goals within the means of its budget, and be satisfied having achieved its goals, regardless of any other golf course.

Comparing North American golf courses to many of the current and original great golf courses in Scotland, where the game began, we are over maintaining by a large percent. The game of golf is played in both places and enjoyed equally. Therefore, we may conclude there is no norm or standard that needs to be met other than the owner's wishes.

Having interrupted with that parenthetical thought, let's move on to the maintenance procedures that are affected by the philosophy of the golf club. Some of these areas of maintenance are:

- greens: frequency of mowing, method of mowing, height of cut, collars;

- tees: frequency of mowing, method of mowing, height of cut, area around tees;

- fairways: fertilizer program, frequency of mowing, height of cut, irrigation practices;

- roughs: no roughs, natural roughs, two-step roughs, height of cut;

- sand traps: number, method of raking, frequency of raking, type of edge;

- cart paths: natural or vegetation free;

- entry to club and clubhouse area;

- disease control other than greens;

- triming around trees: hand rotary, chemical control;

- lakes: natural growth, vegetation free, shores;

- weeds.

A goal of a profit-making golf course is to make money which is done by taking in more than it spends.

Theoretically, only enough maintenance has to be done to keep the money coming into the till. If not enough money is coming in then changes must be made to entice the golfer. It's just pure merchandising like any company selling a product. Sounds simple, doesn't it? Or is it?

Unfair comparisons are made which compare golf courses that have different sets of goals to meet. The goal of many clubs is to provide service to their members and to not make a profit. The amount of service, the aesthetics and the philosophies required by the membership dictate the amount necessary in the budget.

The golf course has been terribly North Americanized to the point where people forget it is for the game of golf which is supposed to be a challenging sport. This is where the unfortunate dilemma appears. A golfer says he wants a challenge but at the same time he complains when he is met with a challenge. The game is played in every instance and the important consideration is whether the golfer is happy when he or she drives out of the parking lot.

Just as beauty is in the eyes of the beholder, so is there satisfaction in the achievement of a club's individual goals, provided they are specifically defined. With an honest approach, both the golfer and the management of the golf course can be satisfied.

THIRD INTERNATIONAL TURFGRASS CONFERENCE MUNICH, WEST GERMANY, JULY 11-13, 1977[1]

D. K. Taylor[2]

Last July it was my privilege to attend the Third International Turfgrass Conference held in Munich, West Germany. There were 240 delegates attending from some 19 countries, coming from as far as Australia and Japan. Professor Peter Boeker of the Institute of Agronomy at Bonn was the Chairman, host and chief interpreter during the tours in connection with the Conference.

The aim of the International Turfgrass Society in sponsoring the Conference was to improve communication among turf researchers by exchanging information on techniques and procedures on how to improve turfgrass production. A total of 91 papers were presented in 13 sessions over a three-day period, each dealing with a particular topic. Communication at the Conference was facilitated by simultaneous translation in 3 languages, German, French and English, the cost of which was borne by the Bavarian and West German Departments of Agriculture.

At the business session, the Society voted to hold the next Conference in Canada in 1981 and Dr. Clay Switzer was elected president. Presumably the Conference will be held at Guelph and the International Committee of nine is already making plans for

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1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

2/ Head, Crop Science Dept., Agriculture Canada, Agassiz, BC, CANADA.

that event. My attendance at Munich was a great educational experience and it was a distinct pleasure to travel with other turfgrass scientists and learn that Europe and North America have many turfgrass problems in common.

Rather than reviewing the papers presented at the Munich Conference itself, I would prefer at this time with the aid of slides, to give you a few of my impressions of the turfgrass production and research shown to us throughout West Germany, Switzerland and France during the Conference tours.

In West Germany, for example, their biggest turfgrass concern is having good grass in their many stadiums, since soccer is of prime interest. Much research is going into soils and media on which to grow sportsturf. Perennial ryegrass is by far the most popular grass for this type of seeding, and just as Manhattan has become a standard of excellence in North America, Loretta is receiving similar attention in Europe. There is also a growing awareness of the usefulness of Kentucky bluegrass and the limitations of fescue, timothy and crested dogstail for sportsfields. Most researchers were applying a simulated wear treatment not only to their variety trials but also their management studies.

Active plant breeding programs were observed in both West Germany and France. Roadside seeding research programs were active in all three countries visited. At least two major commercial firms were promoting the idea of renovation of home lawns and actively promoted the use of specialized equipment and products to do the job. Everywhere we went we sensed a developing interest in turfgrass.

The Cologne-Mungersdorf stadium built in 1975 is a very modern facility which includes a synthetic running track surrounding the soccer pitch. The soil for the soccer pitch was modified to 85% sand but the initial seeding was a failure. The turfgrass sod, procured from a heavy soil site near Bremen, also gave problems in management. However, following frequent coring together with sand top-dressing and overseeding with perennial ryegrass, a respectable playing surface has resulted.

West German researchers such as Professor P. Boeker at the Institute in Bonn and Dr. Skirde at the University of Giessen are investigating the usefulness of synthetics, plastic foam, hygromull and flygropor to improve the aeration and drainage of heavy soils. In France specialized equipment has been developed for opening up slit trenches and automatically filling these with granular synthetic materials.

Dr. Skirde had an impressive series of experiments to investigate the effectiveness of various drainage layers, modified subsoils and rootzones. Dr. Skirde also showed us the results of some of his roadside seeding experiments. Chewings fescue did well on south slopes while creeping red fescue was more adapted to north slopes. Other species which were promising included Kentucky bluegrass, colonial bentgrass, birdsfoot trefoil and lupins. His studies of salt tolerance indicated the superiority of Dawson fescue. Less tolerant but best of their respective species were Skofti Kentucky bluegrass and Penncross bentgrass.

At Betsdorf, we visited the Wolf-Gerate trial grounds and were given a tour by Dr. Pietche. This company is associated with O. M. Scott and has operations in West Germany, Netherlands, Luxembourg, Belgium, Switzerland, Italy and Scandinavia. Excellent variety trials were observed along with various renovation and management trials. *Poa supinia*, a relative of *Poa annua*, was among those entries under trial. *P. supina*, originating at high altitudes, is an attractive dense low growing grass which is early green, "winter" green, resistant to disease, and produces roots and shoots at the nodes. Owing to its short culm height, commercial seed production would be difficult with this grass.

The BASF research facility at Limbergerhof was most impressive. This company spends $300 million annually in agriculture research in several countries developing such products as slow release fertilizers, pesticides and growth retardants. One-half its sales are of products developed within the last 10 years. This company rolled out a green carpet to welcome the group. It consisted of grass growing on one of their synthetic granular products.

At Steinach in Bavaria we visited an old seed firm originated by Dr. M. von Schmieder. At one stage it was a grass breeding school. Mr. Frank, now retired, was responsible for selecting and increasing the variety Loretta, one of the most promising ryegrasses observed in European trials. Close by at Strasskirchen we observed a new sportsfield featuring a seedbed modified with 40% sand, 10% peat, 10% hygropor, and a 2 cm topdressing of sand applied prior to seeding. The seeded mixture containing Loretta perennial ryegrass and Parade and Enmundi Kentucky bluegrasses showed excellent vigor.

A visit to Eder Am Holz featured the Federal Cultivar Testing program. This is one of five locations in West Germany and the Netherlands where varieties of cereals, forage (turfgrass), potatoes and fiber are grown for descriptive purposes. Each new variety must be uniform, stable and distinctly different from those already described, to qualify for registration under a system which takes into consideration Plant Breeders Rights. In addition a cultivar testing program featured seedings in two successive years at 5 locations with regular observations and wear treatments.

The Olympic stadium in Munich is an impressive sports complex covering 45 hectares in area. Although the main stadium receives intensive management, the many practice fields are less intensively managed under contract. The surface layer (10 cm) of the main stadium was constructed out of 60% sand (0-3 mm) and 40% decomposed peat. The nature and high content of peat proved to be a problem in spite of good drainage layers below. Heating pipes were also installed at intervals of 40 cm. The original seed mixture was composed of 70% Merion, 15% S50 timothy, and 15% crested dogstail. In 1977 a botanical count indicated a cover of only 9-13% Kentucky bluegrass, 1-2% timothy, no crested dogstail, 66-43% *Poa annua*, 1-26% *Poa trivialis* and 23-16% perennial ryegrass. The range in percentage indicates areas of heavy and light wear respectively. Annually since 1974 the stadium has been overseeded with perennial ryegrass along with an aerifying and topdressing program.

Three golf courses were visited in Switzerland ranging from a hillside improved natural pasture course located near Gstaad to a well seasoned 53 year old course at Lausanne, to a modern Trent Jones designed course built in 1972 at Geneva. The Gstaad course is only open from June 15 to October 30 and is located at 5000 ft elevation. Fairway roughs featured an unique array of flowering plants at the time of our visit.

At Lausanne the fairways were also improved natural pasture while the greens were seeded in the post war period to New Zealand browntop. One exception was the 15th Green which featured a 1935 seeding of German bent, obtained from indigenous bentgrasses which produced seed crops following logging operations in the Black Forest. Many of our modern bentgrass varieties trace their origin to bentgrass seed gathered in this manner.

The course at Geneva was comparable in appearance and maintenance procedures to a top North American course. Tees, fairways and greens were all seeded to Penncross bentgrass. The greens observed were *P. annua*-free but appeared to be on the verge of having a thatch problem. The magnificent club house overlooked a double green for the 9th and 18th holes which measured 1800 square meters in size. Beyond the green Mt. Blanc could be seen in the distance.

Edgar Schweizer of the Eric Schweizer Seed Company was our tour host in Switzerland. This company has trial grounds for testing varieties, mixtures, herbicides and renovation procedures, and considerable experience in roadside seedings. Ten years ago it was a common practice to insist on top soil for roadside seedings, now with the use of slow release fertilizers and straw mulch good stands have been obtained. Recommended mixtures contain a variety of fescues, perennial ryegrass, mildew resistant Kentucky bluegrasses, colonial bentgrass, red clover, trefoil and shrubs on slopes over 15°.

Our first stop in France was at Lusignan, an INRA station supported by the Federal Government. Under the direction of Paul Mansat this station has an active grass breeding program with an interest in ecological adaptation; resistance to wear, herbicides and disease; as well as color, density and year-around appearance. For drought resistance they have found the fescues to survive short duration droughts well but after a long drought perennial ryegrass recovers faster with little killing. Waldorf fescue was superior for its wear tolerance.

Vilmorin-Andrieux is one of the long established seed companies of France which sends its seeds to some 90 countries. In 1728 Vilmorin had a retail seed outlet in Paris which has continued in business to this day. Their breeding program at La Menitre is actively producing new varieties of vegetables, flowers and turfgrasses. Their new perennial ryegrasses are particularly attractive and could be of interest to the Pacific Northwest since the most attractive varieties of turfgrass at Agassiz are those which perform well at this location in France.

One of the interesting stops in Paris was at La Defense, an older area of the city, which has under constructiona 150 ha complex of business and commercial enterprises. In order to alleviate the mass of concrete, plane trees have been planted in concrete tubs, ground cover and shrubs in smaller containers and turfgrass in a Purr-wick type of installation. Fortunately they have research trials under way to investigate watering systems, rooting media, species and varietal adaptation.

The Chantilly Race Track featured another aspect of turfgrass maintenance. This complex has 100 km of sand tracks, 124 ha of turfgrass and facilities for training 3500 horses. The soils for grassed tracks have been modified with 75-95% sand. The aim is to have well rooted turf with some cushion effect. The latest seeding mixture includes 25% perennial ryegrass, 35% creeping red fescue and 40% Kentucky bluegrass. Each year a mixture of perennial ryegrass varieties is used to overseed the grassed areas. Divotting by horses is more extensive than by golfers and these marks are repaired by workers using hand tools followed by treading or rolling.

These are a few of the many experiences of which I had the privilege of sharing with my fellow turfgrass researchers. Papers from the Munich Conference itself will be published this year by the American Society of Agronomy. To have attended the III International Turfgrass Conference and its tours was an exciting educational experience for me and a chance for all those interested in turfgrass to communicate more effectively with one another.

MICRONUTRIENTS IN TURFGRASS MANAGEMENT[1]

Paul E. Rieke[2]

There are 16 different elements usually considered essential for turfgrass growth. Carbon (C), hydrogen (H), and oxygen (O) are provided mostly from water and gaseous forms. Nitrogen (N), phosphorus (P), and potassium (K) are the important primary fertilizer nutrients. Calcium (Ca), magnesium (Mg), and sulfur (S) complete the list of macronutrients or those nutrients needed in larger quantities by plants.

The micronutrients are those nutrients required in small quantities by the plant. But it is just as important that they be present in adequate concentrations in the plant. These include iron (Fe), manganese (Mn), copper (Cu), zinc (Zn), boron (B), molybdenum (Mo), and chlorine (Cl). Occasionally, sodium (Na), silicon (Si), and a few others are suggested as providing some benefit for plants, but data are not available to prove their essentiality for turf. Micronutrients are also called minor elements, minor nutrients, microelements.

Concentrations of macronutrients we have found in Kentucky bluegrass clippings given as averages over the growing season are 4.2%N, 0.4%P, 2.5%K, 0.4%Ca, and 0.2%Mg. Concentrations of micronutrients found were 280 ppm Fe, 41ppm Mn, 40ppm Zn, 17ppm Cu and 9ppm B. The micronutrient concentrations are usually listed in ppm (parts per million) because of

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1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

2/ Dept. of Crop and Soil Sciences, Michigan State University, East Lansing, MI.

their very low percentages present. By contrast, the 4.2%N is the same as 42,000 ppm N compared to the 280ppm Fe, etc. Although concentrations of micronutrients are considerably lower than for the macronutrients, their presence in adequate quantities are equally essential. Careful attention should be given to management of the micronutrients when it is known they are needed for the turf.

Evaluation of micronutrient needs for turf presents some unique challenges. A complicating factor is that some nutrients, like iron, are present in soils in relatively high quantities but are in a form that is unavailable to plants. Applying iron in a form like ferrous sulfate may result in rapid fixation in a form that is unavailable. Effective soil testing should be able to test the form available to the plant but should not extract the unavailable forms.

Deficiencies of micronutrients are more difficult to diagnose with soil tests than for macronutrients since there has been little soil test correlation research for micronutrients on turf. Clipping analyses are not especially useful because of variation of nutrient concentration through the season and because of soil contamination of the clippings. Most visual nutrient deficiency symptoms are associated with a yellowing (chlorosis or loss of chlorophyll) of the leaf tissue making it difficult to differentiate among the nutrient deficiency symptoms or from other causes associated with yellowing of the turf.

The micronutrient most often limiting in turf is iron (Fe). When iron is limiting it can often be associated with one of the following conditions: high pH soil; high soil levels of phosphorus; manganese or zinc; high soil organic matter levels; clipping removal; compacted soil conditions; waterlogged soils; a heavy thatch condition; and short roots. Since iron is quite insoluble in water and readily converts to unavailable forms when applied to the soil, any condition which results in short root systems will increase the probability of iron deficiency: nematodes, short mowing, high temperature (on cool season grasses), high nitrogen fertility, or disease, insect, soluble salts, or chemical injury.

Deficiencies of other micronutrients in turf have not often been reported. Since manganese, copper and zinc react somewhat similarly to iron in the soil, deficiencies of these nutrients might be predicted under the same conditions for which iron might be deficient. Based on experiences with other crops one might predict that manganese responses on turf would become more common in the future.

Iron can be applied to turf as a foliar application of ferrous sulfate, ferrous ammonium sulfate, iron chelates, or other soluble iron sources. Ferrous sulfate is most frequently used and is applied as a foliar application. This is usually applied foliarly at the rate of 1.5 to 3 oz of ferrous sulfate in 3 to 5 gal of water per 1000 ft^2. When applied to actively growing bentgrass on our research plots the improved color of the turf lasted from 3 to 8 days depending on how rapidly the turf was growing. Rates as high as 12 oz/1000 ft^2 were applied every two weeks on a research green and improved the green color, but there was some injury to the turf especially at the 12 oz rate. This resulted in browning of older leaves and some thinning of the turf.

Manganese, copper and zinc can also be applied in the sulfate form. If the need for these nutrients is suspected one could use foliar applications at somewhat lower rates than for ferrous sulfate. Be careful to apply these when the turf is not in a temperature or moisture stress condition for they can cause injury.

Certain sewage sludges contain appreciable iron. The iron in Milorganite is one of the factors in turf response to applications of that fertilizer. Zinc and other micronutrients may also be high in some of the sewage sludges. Some fertilizer companies include iron and other micronutrients in their fertilizers for convenience of the turf manager.

Iron, manganese, copper and zinc can all be applied as chelates. Since the chelates vary widely, follow the manufacturer's directions. Success with chelated forms has been varied. Some materials have given good results while others have been ineffective. Some work only when applied to the foliage. Others, reportedly keep the micronutrient available to the plant when applied to the soil.

If the micronutrients are mixed in with a complete fertilizer there may be certain percentages which must be guaranteed according to state law. This varies by state, but the concentrations should be such that when the complete fertilizer has been applied at the rate appropriate for nitrogen then the micronutrients will be applied at an appropriate rate.

If there is need for boron or molybdenum on turf these can be applied as borax or sodium molybdate, respectively. The sodium molybdate need would be at very low rates. Borax, if needed, should be applied very carefully. Borax can cause injury to turf at very low rates.

The use of "shotgun" applications of micronutrients has been suggested as a means of being sure that there is not a deficiency of micronutrients. The concern with this approach is that even as only a small amount of these nutrients is needed by the plant, only a small excess could potentially develop and result in a toxicity. It might be wise to treat a smaller area experimentally with micronutrients before treating your entire turf area. Better yet, apply specific nutrients in different places. Then you will be better able to determine which nutrient is giving the response if one occurs. If you get a response to the "shotgun" mixture there is no way to be sure which nutrient is causing the response. Even as you would not correct a shortage of phosphorus by applying potassium, by the same token you would not apply zinc to correct a manganese deficiency. In fact, it is possible to induce a deficiency of a micronutrient which was not previously a problem by applying an excess of another. So micronutrients should be used wisely in good turf management.

PURR-WICK AND P.A.T. SYSTEMS IN TURFGRASS MANAGEMENT[1]

John M. Roberts[2]

THE PURR-WICK SYSTEM

A large majority of the turfgrass under cultivation in the world is on naturally occurring physically unamended soils. Due to the intense traffic that putting greens undergo, most natural soils do not have the physical properties necessary to maintain a stable root zone with time to meet the turf quality requirements golfers desire. Under natural soils having inherent structural instability compacted soil surfaces, impaired drainage and root growth occur resulting in weakened turf more susceptible to environmental and stress factors.

Recent management practices have favored the use of sand alone or in combination with natural soils for the root zone medium to minimize soil compaction in turf areas subject to heavy traffic. One of the main advantages of pure sand is its structural stability which once settled, provides ample pore space for water and air movement into the root zone thus maintaining a uniform and well drained playing surface. This is essential, for good surface drainage is a key factor for maintaining a uniform turf stand on heavily used areas.

A need to increase water retention in sand is required due to the relatively low water retention

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1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

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

capacity. The most effective way of conserving moisture in pure sand is to underlay the root zone with an impermeable barrier, such as plastic sheeting. This provides a potential saturated reservoir zone thus allowing water to move upward to the plant roots by capillary action.

Plastic lined sand root zones are referred to as Purr-wick root zones (plastic under reservoir root zone) which utilizes the principle of wick (capillary) action. The essential features of Purr-wicks are the pure sand rooting medium which utilizes the large pores of compacted sand above an impermeable plastic barrier, accompanied by drain tubes and adjustable outlets which can remove, conserve or redistribute water as needed.

Due to the slope desired in putting greens internal dividers up to 30 cm high are installed at every 20 cm change in contour to maintain a more uniform water reservoir level throughout the putting green. However, field reports from turf managers of Purr-wick putting greens have cited that imbalance in the water reservoir has developed with the majority of the reservoir concentrating in the lowest compartment of the putting green. Most of the water movement over the internal divider has been observed following heavy rainfall when the sand was under low soil moisture tension.

One design modification under consideration in construction of future Purr-wick putting greens is to increase the height of the internal dividers in hopes of retaining a larger water reservoir especially in the upper compartment. The main objective of this investigation was to study the rate and amount of water movement in sand medium separated partially by internal dividers of varying height. The sand used in both the laboratory and field studies consisted of 50% fine and 50% medium textured sand.

As shown in Figure 1, the reservoir levels were depleted in a short time period using internal dividers 20 or 40 cm high. After 3 hours following saturation to the top of the 20 cm internal dividers under laboratory conditions, the reservoir had been completely exhausted. After 24 hours following saturation to the top of the 40 cm internal divider, 95% of the reservoir had been depleted.

The rate of water movement over the internal divider was markedly reduced with only slight moisture reductions from saturation. For example, the hydraulic conductivity decreased 90 to 95% as the percent of saturation in the Michigan dune sand was reduced from 100 to 75%. The data in Figure 1 indicate that rapid reservoir depletion rates in the upper compartment in Purr-wick putting greens are to be expected even if the internal divider heights are increased to within 6 cm from the surface. This is providing that there is no assistance from the rooting system. The question remains unanswered, what influence the rooting system has on retarding water movement over the internal dividers.

It is believed the net result of using higher (40 cm) as compared to lower (20 cm) internal dividers in the upper compartments is that (i) a greater quantity of water will move nearer the surface where the majority of the roots are located, and (ii) there will be a faster reduction in the moisture content from saturation at the top of the internal divider thus reducing the rate of water movement over the internal dividers.

As shown in Figure 2, water reservoir levels at different elevations will try to seek similar levels until a state of equilibrium exists even when separated partially by an internal divider. This information when applied to Purr-wick putting greens where sub-base slopes exist thus creating potentially large differences in the reservoir levels adjacent to the internal dividers indicates that only when the reservoir levels adjacent to the internal dividers are at similar elevations will the movement of water over the divider be minimized.

Under field studies, the rate at which the water reservoir levels in the upper compartment (Figure 3) depleted was rapid especially at low soil moisture tension. With a sub-base slope of 7%, 69% of the reservoir was depleted within 24 hours following saturation to the top of the 30 cm internal divider. The soil moisture content at this time was 86% by volume of the saturated value as measured at the top of the internal divider. The rate of water movement over the internal divider had practically ceased 60 hours following saturation when the soil moisture content at the top of the internal divider was 66% by volume of the saturated value.

The net result of this rapid water movement over the internal dividers was an imbalanced distribution of water throughout the putting green with the majority of water accumulating in the lowest compartment. For example, 24 hours following irrigation a 36 cm water reservoir accumulated in the lowest compartment whereas a 0 cm reservoir existed in the upper portion of the uppermost compartment.

SUMMARY

Excessive water movement over the internal dividers in the Purr-wick method of constructing putting greens was created by an imbalanced water reservoir level adjacent the internal divider and was accelerated at low soil moisture tensions. In order to retard this water movement design modifications of future Purr-wick putting greens believed to be beneficial include: (i) the elimination of sub-base slopes exceeding 3%, and (ii) the extension of the internal dividers to within 7 cm of the final surface.

THE P.A.T. SYSTEM

The P.A.T. system (Prescription Athletic Turf) is one method of constructing an athletic playfield. In 1970 Dr. Bill Daniel and Mel Robi of Purdue University were the co-inventors of the P.A.T. system with the first P.A.T. football field being completed in 1972 at Goshin High School, Indiana.

The P.A.T. system includes (a) suction pumps, (b) collector drains, (c) sand, (d) plastic sheeting, (e) peat and vermiculite, (f) moisture sensors and controller, plus other potential additives such as soil heating cables and vented plastic covers and power rollers. When you put these features together, the athletic field can be a pleasure for both players and turf managers alike.

Probably one of the main advantages of the P.A.T. system (by using an all-sand root zone with suction pumps connected to the numerous drain lines above the plastic lining) is the rapid removal of water from the playing surface even if it rains <u>during</u> the game. No longer does rain during the game mean muddy, slippery footing for the players.

In 1976 there were 3 high schools, 3 pro (Washington Redskins, Miami Dolphins, Denver Broncos), and 5 University fields with suction pumping installed.

As I was a graduate student for nearly 4 years under Dr. Daniel, I was able to hear and see how the various P.A.T. fields were responding under various play and management. In general, the system has been popular among both players and turf managers. I saw the Purdue football team (having the P.A.T. system) play under a heavy rainstorm yet maintain firm footing. The one aspect of this system that the turf managers have had a tendency to do is to <u>overwater</u>. It should be kept in mind the that plastic barrier prevents water loss from the root zone thus the need to water is reduced.

What about the cost? In general, the P.A.T. system costs <u>1/3</u> that of artificial surfaces. It is my personal opinion and hope that the P.A.T. system will increase in popularity with time.

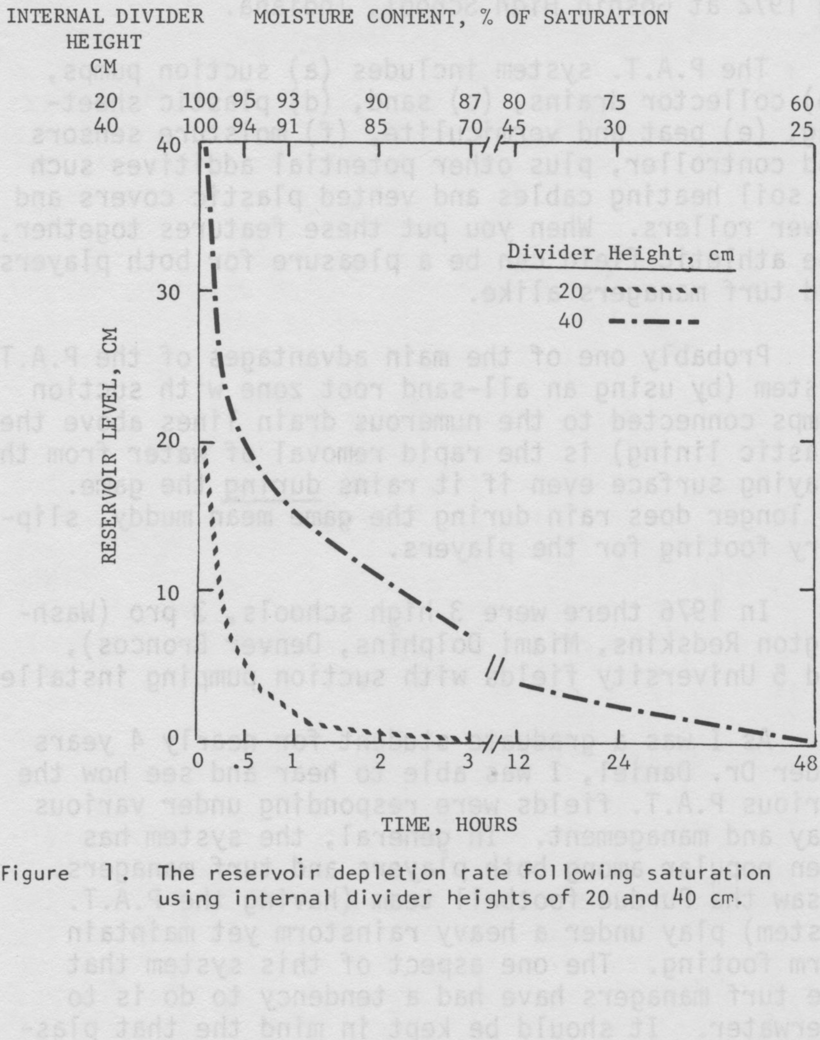

Figure 1. The reservoir depletion rate following saturation using internal divider heights of 20 and 40 cm.

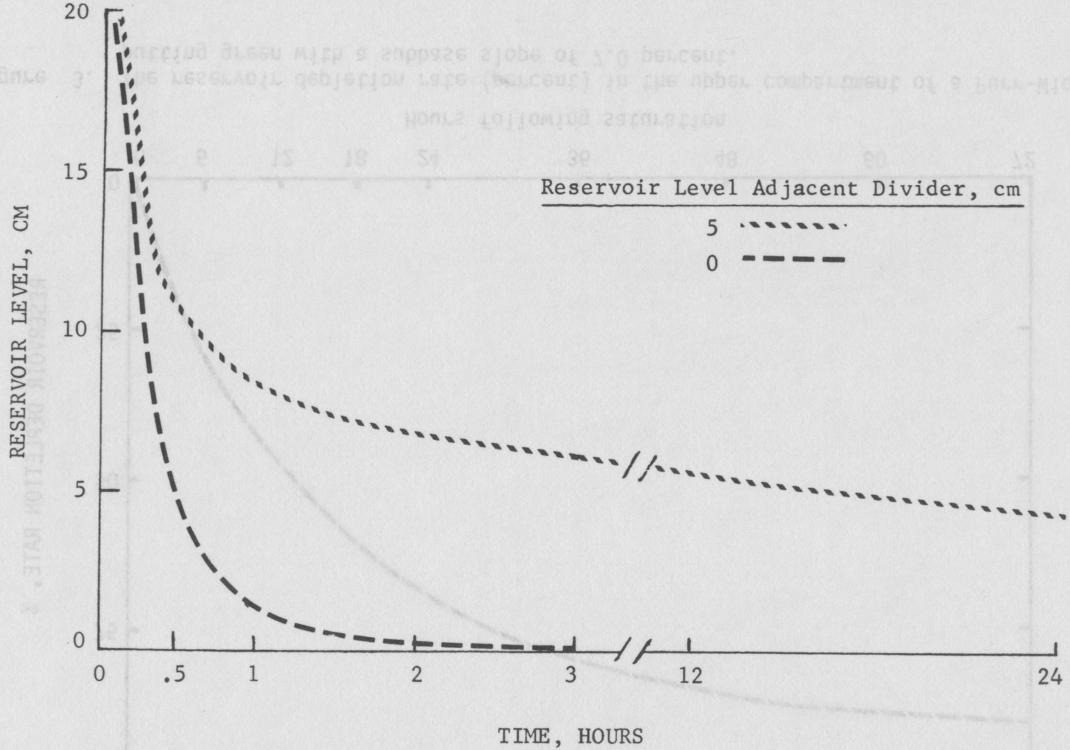

Figure 2. The reservoir depletion rate as influenced by differences in the reservoir levels adjacent a 20 cm divider.

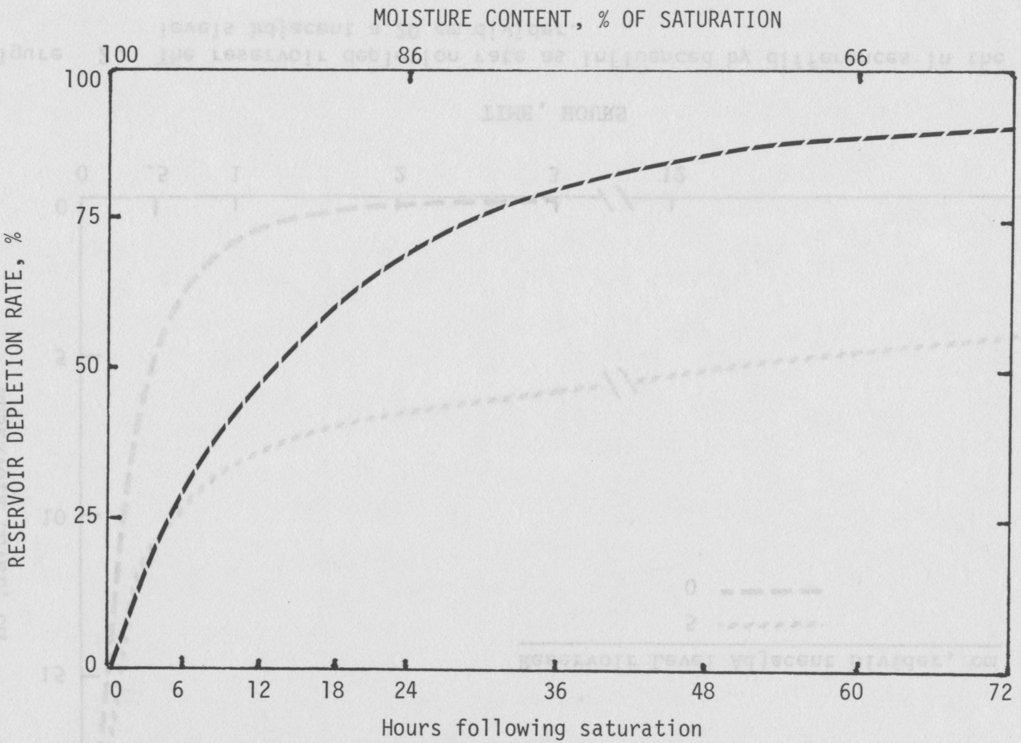

Figure 3. The reservoir depletion rate (percent) in the upper compartment of a Purr-Wick putting green with a subbase slope of 7.0 percent.

GYPSUM FOR TURF, TREE AND SHRUB MANAGEMENT[1]

Donald H. Kocher[2]

Unhealthy plant life can quickly develop when any important facet of soil analysis, or soil conditions and drainage characteristics are out of balance. Soil texture and soil fertility are distinctly different aspects of soil science. Yet in practice they are frequently confused in the processes of good horticulture. Soil texture and drainage may be the cause or an effect of chemical, physical and biological properties of soils.

Gypsum ($CaSO_4.2H_2O$) is a very suitable and economical inorganic material for reclaiming poorly structured soils, maintaining an existing good soil structure, or a corrective treatment for high pH and/or soils deficient in sulfur. Its use is very often recommended in conjunction with organic soil amendments for maximizing soil texture.

1/ To be presented at the 32nd Annual Northwest turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

2/ United States Gypsum Company, Orange, CA.

GYPSUM AS A SOIL AMENDMENT

Any of the following beneficial properties from gypsum application experienced in agriculture would relate for soils of turf and ornamental plants.

1. Correction of hard pan clays.
2. Counteracting alkali and salt soil conditions.
3. Improve drainage conditions or rate of water penetration.
4. Increase more effective use of fertilizers.
5. Provides two of the major macronutrient requirements:
   a. soluble calcium
   b. soluble sulfate sulfur.
6. Ecologically safe and non-toxic.

Chemically, gypsum ($CaSO_4.2H_2O$) is calcium sulfate combined with two molecules of water. Its slow solubility in water provides calcium ions and sulfate ions which render very specific functions for good soil texture. It is an abundant soft and crystalline mineral which is quarried or mined, with color varying from white to shades of pink, gray or tan. High quality gypsum should average 87 to 95% pure calcium sulfate; nearly neutral pH and is non-toxic. Each 100 pounds of 90% pure gypsum supplies 21 pounds of elemental calcium and 17 pounds of elemental sulfur, the latter being available in a soluble sulfate form for immediate soil and plant requirements. In addition to customary N-P-K nutrients, proper amounts of calcium and sulfur are required for a balanced soil analysis. Raw ground gypsum is most commonly available as 100 mesh material; but coarse screened sizing, sand type, pellet or compacted granular forms are economically available in localized marketing areas.

Gypsum should never be confused with lime ($CaCO_3$). Although similar in appearance, lime is a completely different mineral having high pH characteristics making it a good material for the treatment of acid (low pH) soil conditions.

If soil analysis indicates good fertility, some soils by nature or when badly handled become heavy, poorly drained and tight, and fail to support reasonable plant growth for lack of good soil texture. Invariably these are high clay soils which we attempt to aggregate and obtain porosity. Soil structural improvement is greatly influenced by the nature and proportions of cations in the soil. Each soil cation exchange capacity is known to vary according to clay type, percent clay and percent organic matter present in the soil.

Soils saturated with sodium ions resulted in poor textured soils which are normally difficult to cultivate leaving growing plants to suffer from restricted root penetration and limited supplies of air, water and plant nutrients. Sodium ions in the soil will deflocculate clay particles, an action directly opposite of what is required to obtain good soil texture.

Gypsum has long been recognized as one of the important soil conditioning agents to flocculate fine high clay soils; plus the ability to counteract the excess exchangeable sodium ions prevalent in saline and alkali soils. The calcium ions from dissolved gypsum replaces the undesirable sodium ions permitting them to leach away. This results in correcting the high pH problem and permits formation of flocculated clay particles which in the presence of a suitable cementing agent such as organic matter renders the formation of stable soil aggregates.

The following different soil types would require varying amounts of gypsum for obtaining the desired soil structure improvement:

(1) Acid Soils (pH 4.0 to 6.0) will no doubt require high calcium or dolomitic lime application. Frequently for purposes of soil balance structure a mixture of lime and gypsum could be very desirable.

(2) Saline Soils (pH less than 8.5) or White Alkali soils containing highly soluble salts can be frequently dissolved and carried away by excessive irrigation providing suitable drainage is available. Gypsum application ranging 1,000 lb per acre will in most cases correct pH and improve the texture and drainage of these soils.

(3) Alkali Soils (pH above 8.5) known as Black Alkali and Slick Spots where the exchangeable sodium in the soil exceeds 15% would require greater amounts of gypsum ranging 3 to 4 tons per acre.

What gypsum is chemically and how it functions may not be of particular interest to many people. However, everyone connected with the development or maintenance of private, commercial or municipal landscaping and turf will find after appropriate soil texture and fertility analysis that many of the following suggested practical applications of gypsum will correct current or future commonly experienced soil problems.

1. Prior to establishing new turf by seeding, or the transplanting of grass sods, gypsum and mulch should be tilled 4 to 6 inches into the topsoil. This provides a good soil texture base for the development of healthy plant root systems, good drainage, moisture retention and permits more effective use of fertilizer nutrients.

2. For reasons above, the same amendments should be thoroughly mixed into soil used around freshly planted ornamentals.

3. For surface application of established turf or plants, gypsum may be used separately or in conjunction with mulches, fertilizers or lime, but must be followed with regular irrigation procedures to yield the following benefits:

   a. Improves soil texture providing the same benefits mentioned above under new turf preparation.

b. Supplies sulfur requirements which provide better plant color and minimizes some of the common turf disease problems.

4. Gypsum's non-toxic, neutral pH and good color characteristics have made it the most acceptable material for athletic even line marking.

5. Only gypsum is reported as the most suitable material to correct the damage which turf and ornamentals suffer from winter road salt splash. Such affected areas require above normal gypsum application for quickly leaching out the excess sodium buildup. To some extent, similar excess sodium buildup can develop from high salt content irrigation water.

Before any large scale gypsum use, a practical visual method for soil texture improvement can be made in 100 sq ft bare soil test plots treating half with gypsum and using the balance as control area. For treating of small problem areas or test plots without soil analysis, a suggested gypsum application for clay or low sodium soils would be 7 lb per 100 sq ft; but for very poor soils the minimum amount would be 15 lb per 100 sq ft.

Many golf superintendents now apply gypsum each year to complete golf course acreage, but only after they discovered that it had resolved the persistent turf problems which all other recommended treatments had failed to correct. If you're a skeptic! It's really a very inexpensive process to treat a couple of selected greens, tees and large test plot areas of fairway turf with two (2) gypsum applications during the next twelve (12) months. Gypsum isn't a miracle drug, but some obvious turf and drainage benefits should appear noticeable in treated areas within 6 to 12 months from date of initial application.

Gypsum applications can be made at anytime but good irrigation practices should always follow. Late fall and early spring treatment are frequently dominant taking advantage of seasonal rainfall and melting snow. Although excess gypsum application has never been found detrimental, economic and functional considerations regulating treatment quantities for a specific soil is best determined from a complete soil texture and chemical analysis.

THE GOLF COURSE SUPERINTENDENT: JOB, IMAGE, ASSOCIATION MEMBER[1]

Palmer Maples, Jr.[2]

To say that a golf course superintendent is involved in the running of the golf facility at which he works is a very true statement, when involved means getting connected or bound up with something from which it is difficult for him to extricate himself. The superintendent composes one third of the management team at most courses and as much as 50% at others.

His basic responsibility is to prepare and maintain the area of the course within the budget limits and policies of the club so that the game of golf can be played by the rules of golf and enjoyed by all who play.

Without the golf course, the club would be just another place to play cards, or have lunch or dinner.

The superintendent's involvement includes not just the management of the turf, but the total golf picture, including scheduling of tournaments, capital purchases, changes in the architecture of the course, and the business management of the golf course budget. If the facility or golf club is to prosper or satisfy its members, then the superintendent plays a big part in the success by his involvement, by his dedication.

1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

2/ Golf Course Superintendents Association of America, Lawrence, KS.

By listing a few of his responsibilities, we can see the extent of his involvement.

1. Golf Course Management - all of the course

2. Area Management - entrance roads, parking lots, club grounds

3. Landscaping - planning, planting, maintenance

4. Structure - buildings, bridges, shelters, fences

5. Equipment - purchases, storage, inventory, upkeep

6. Personnel - procurement, training, supervising

7. Material - purchase, storage, inventory

8. Budget - preparation, explanation, execution

9. Record Keeping - expenses, weather, application

10. Reporting and Advising - reports to committee, article in Newsletters, advising and cooperating with golf pro and club house manager.

Because of the many widely differing circumstances in location, some responsibilities will get greater attention than others, but most will get some attention during the year.

Results from a recent survey of Golf Course Superintendents Association members indicate that average age is 40 yrs old, has had 2 yrs of college training, has been a superintendent for 14 yrs and averages over $20,000.00 salary per year.

This individual has had an effect on golf. By supporting research, inventing new techniques, and taking advantage of the latest supplies of fertilizers, machinery and pesticides, he has produced a course that is playable longer in the season, better conditioned than previously possible, and more consistent from one hole to the next.

Along with responsibility for the course has come authority. Most superintendents have the say on when a course is open for play or closed because of rain, frost, freezing conditions, or dryness. Most superintendents have the authority to halt the use of electric cars or 'buggies'. As mentioned, the superintendent develops a budget, and after approval has the authority to make expenditures, purchase equipment, hire workers, and make trips to educational seminars and conferences.

The Golf Course Superintendent's personal characteristics must include integrity, understanding and humility. As the trusted manager of much of the course's property and future, he will do what is best for the course and the golfer.

As was mentioned earlier, the Superintendent is involved in the total operation of the club. Certainly he cooperates with the club manager, coordinates with the golf professional and communicates with all members. No one individual has all the knowledge and experience to completely control and operate all stages of management necessary for the club to run smoothly. It takes a team approach of the individual department heads, each working within their training and experience.

The Superintendent is a man of many hats. His qualifications, responsibilities, and requirements will vary tremendously from course to course, but the basic aspects will always be present. Producing the highest quality playing conditions in the most efficient manner is the dedication of the golf course superintendent.

In my remarks today I'd like to define some terms so that we all have an understanding of the words used, talk a little about how the image got where it is today, and some points on maintaining that image. Some ABCs of things to work on: attire, attitude, actions, build, balance, belong, communication, cooperation, complete, are a few of the ABCs I'll mention.

Let's start with some definitions. Maintain means to keep in existence or continuous; preserve; retain. If we are to maintain, to me it implies we had something there to start with. Irregardless of how it came into being, the other people we are trying to influence have an image of a golf course superintendent. Now it could have come from a magazine article, poster, newspaper article, T.V. announcer, the former Superintendent, or yourself. This image could be good--or it could be bad.

Having talked about it, let's define image. One definition is a physical likeness or representation of a person; a counterpart; a copy. If the image came from the former Superintendent, one aspect could be in the size alone. He could have been a man 6'7" tall, weighed 260 lb, had red hair, and was left-handed. To the people, this was their size image. Now here I come at 5'10", 190 lb, some hair, and I'm right-handed. There is no way that I am going to maintain the size image of that former superintendent. This is where the ABCs come in, as I will explain later. As I stated, this is a size image. I don't think we're much concerned with that one aspect because people come in different sizes. What we do want to do is to look at the Golf Course Superintendent and talk about what kind of professional man he is.

If we are to maintain the superintendent's image through good P.R., we must ask what is good P.R., or public relations? We can define P.R. as the efforts of a corporation or individual to promote goodwill between itself and the public. And another definition would be the methods used to promote such goodwill.

This brings us to the meat of the discussion. What are some methods we may use to establish goodwill with our public, our P.R.

Our public can be several different groups of people. It can be club members, fellow superintendents, business associates, our employees, the green committee or the press. All of these groups are very important and we would wish to have them look at us with goodwill, with a feeling of "there is an individual that knows how to act, knows his job, gets along with people, reasons problems out, is a good counselor, a good boss, and a friend in times of need, and all the while being a golf course superintendent." There are items on my list that would be used to influence the group of people I am working with. The list would differ from group to group, from employee to employer.

One basic item for a golf course superintendent as he establishes his image and one that he should try to maintain is that he is responsible for the golf course and should maintain it within the limits of the budget available and the policies of the club so that the members can play the game of golf by the rules of golf. This is a simple statement but it entails a lot of study and work. And in so doing, we create an image, specifically one of a golf course superintendent.

Each area of responsibility the superintendent has, is an opportunity for either continuing the image he has or changing his image. I think it is quite natural for an individual to improve with time. Certainly he has more experience, more education and the combination of these two will make him a different person and he will have a different image. He will change from being <u>the new man</u> on the job. He will have become friends with the members, the employees and his associates. But basically he is still the Golf Course Superintendent--the one in charge of the golf course and this is the image we are working on.

Let's look at some of the ABCs now and see just when they fit in the picture.

Some A's:

<u>Attire</u>: How do we present ourselves as far as dress is concerned. Can a visitor tell the difference

in the superintendent and his workers if he were to visit and see a group doing some work on the course or visit the office? I don't necessarily mean to wear a coat and tie all the time, but we must relate to the group--those groups I mentioned before: club members, fellow superintendents, business associates, employer, committee members, the press. If we're at a board meeting, then coat and tie are necessary; if on the course during the working day, then an open shirt. If at a chapter meeting, a coat and tie. Often we hear of a golf superintendent not being respected by certain clubs or groups and really how can they be, if they present themselves at a less than professional level.

Action: Now this could be in many directions. One is the action of helping employees understand their job. If you have to correct a worker, do so in private, not before the other workers. This builds an image of you in the worker's mind of just supervisor. Another action is seeing a problem on the course and getting it fixed. So, evaluate the problem, define the objective, establish a plan, assign responsibilities, and reevaluate the project as work progresses. These are just good old every-day management concepts that we apply. "Plan your work--then work your plan" is a saying that really works. Along the action bit is another saying: There are three kinds of individuals: 1. Those who make things happen; 2. Those who observe what is happening; and 3. Those who wonder what happened. That superintendent who takes action and wants a good image to maintain or make better--is the one who makes things happen.

Attitude: Now here's a good one. We get into this business of wanting to do the best job we can, to make those members happy; keep the employees satisfied; help that fellow superintendent with his problem. There are so many areas of our everyday life that our attitude affects, now only us but those we come in contact with.

Now how about a few B's:

Build: I mentioned earlier that if we are to maintain, you must have something there to start with. You have to build in order to have in order to maintain. But go a step further and don't just keep what you have now, but review what is there, get rid of the bad, and build on the good and always be looking for something new. Maintain does not mean that you cannot improve. As we build, and make things happen, then our image as golf course superintendent, our image as a professional, will look better in the eyes of all these groups that look at us and judge us.

Balance: When we refer to balance, it means staying in the middle or not having too much or too little. By balance I mean in giving information or thinking of solutions. Give both sides. Be fair in your judgments, and don't just always give positive points or just always negative points. Just as the grass plants need a balanced fertilization program, we need balance as we try to promote goodwill between us and the public, our P.R.

Belong: Everybody has to belong to something. Why not belong to your local chapter of superintendents, to the Golf Course Superintendents Association of America, to the Rotary Club, Kiwanis Club, Toastmasters, PTA, city government? Take part in these associations and show people that, yes, those golf course superintendents are a good group, with good ideas and a willingness to help.

Some other B's to think about are BACKGROUND--know your subject, get all the facts and then present; BELIEVE--kind of goes with attitude, but believe in what you do; BALLYHOO--yes, blow your own horn. If you've accomplished something, let it be known. It's good for P.R.

In the C category, COMMUNICATION has got to be No. 1. What more could I say that you haven't heard? But don't let it stop at the hearing. Get a little action into it, build, watch for new ideas. Let the people know about the golf course. Communication!

Along with Communication comes COOPERATION. At our recent conference and show in San Antonio, we had presentations from a green chairman and a golf professional about cooperation of the superintendent with these individuals, and some worthwhile points were discussed. But don't stop here--cooperation goes right down the list of all the people we come in contact with and if you're going to maintain or build an image through good P.R., then cooperation is a must.

Complete: You take all these pieces--all these ABCs and you're complete. That is "having all its parts or elements; whole, entire." Good P.R. isn't going to happen if you miss a couple of items. Best man we ever had, BUT:

He doesn't plan
He makes the same mistakes over and over
We never know what he's going to do next
His attire isn't what we expect at this club
His attitude is the worst we've ever seen
His actions don't match his responsibility
He never changes
He lacks a balance of whatever
He just doesn't belong
He can't communicate
He is just not a complete superintendent.

Let me say that maintaining the superintendent's image through good P.R. is a job for all of us in the profession. As we, collectively, do all those things to develop goodwill with our public, then we, collectively will benefit from our efforts. Don't be the weak link in a strong chain. But let me caution you--don't be satisfied with the present condition. Don't maintain a poor image. Maintain and improve.

GCSAA is working to help the superintendent receive his just rewards. We present material for education and self-improvement in many ways. Take advantage of these materials. Work out your own situation and let's all present to our public an image of a Golf Course Superintendent that we can be proud of.

This brings us to our third consideration of a Superintendent, that as an Association member.

There are many questions that can be asked about joining an Association and the benefits received. I would like to answer the question of "What do I get for my dues money?" and make a comparison to demonstrate the advantage of Association membership.

First--"What do I get for my dues money?" One answer is--here are the items you can hold in your hand.

1. 30 issues (3 subscriptions) of the most respected journal in golf course turf management.
2. a membership directory
3. a math manual
4. a membership certificate
5. a membership card
6. an insurance policy for $1000
7. two window decals
8. a copy of the annual meeting minutes
9. a copy of the proceedings of the turf conference
10. six newsletters
11. certification brochure
12. reference material order form
13. business card order form
14. blazer order form
15. booklet on How to find a job.
16. Conference & Show brochure
17. additional insurance coverage brochure
18. Seminar brochure
19. OSHA handbook
20. Job title and Organization chart

These are the items you can actually hold in your hand. It doesn't list the advantages of reduced fees for reference materials, seminar costs, conference registration, and golf tournament spectator free tickets. Nor does it list the additional brochures and employment referral service available with membership. You will also find missing the advances made available through research that GCSAA supports. The biggest factor or benefit, that you can't hold in your hand, is the togetherness that you would have with the other 4,500 members dedicated to the profession and improvement of the golf course superintendent.

Now let's look at a gallon of gasoline. You can pay $.70 for a gallon of gas, put it in a can and hold it in your hand.

The Association is just like that gasoline--as long as you hold it in your hand, you get nothing in return, Nothing! You have to put the gas in a car and drive the car. You can mix a little oil with the gas and put it in a chain saw and cut some wood for a home fireplace.

You can put the gas in a mower and cut your lawn or a green. My point is that you have to use the gas to get any use out of the gas and a return on the money you spent for it. The same applies to the Association. You have to use it. Start with the magazine. Ten issues will have about 40 articles that you can read. The issues will also have information on new products, turf conferences, research reports, questions answered by specialists, and what's happening at other chapters. You also have 2 subscriptions to give to your club official, that's 30 issues total.

You may wish to get additional insurance coverage at a group rate through the Association. There are over 30 reference items listed that are available to you to help make your job easier. There are the proceedings of the annual conference and show. At the Conference and Show itself, there are over 40 speakers and 180 exhibitors that you can ask questions and get the latest up-to-date information from.

Like that can of gas, if you don't use it, you've wasted your time and money.

My argument for Association membership is that it's not what you can hold in your hand that counts, it's the total use you can get out of all the variables offered by the Association.

Think of the food you buy, the car you have, the medicine the doctor prescribes, the light switch on the wall, the can of gas, the Association. You have to use them all to derive any benefit and get any usefulness after holding them in your hand.

And so I say, become a member of the Golf Course Superintendents Association of America and put it's assets to your use.

Thank you.

PRUNING LANDSCAPE TREES[1]

David Halstead[2]

The current emphasis on landscape beautification has heightened the interest in cultural treatments for plants on many areas. Pruning is an important practice--not only for shaping and enhancing plants used in parks and gardens, but also for forming native vegetation growing along highways and on wildland recreation areas.

As pressures to manage the landscape increase, so do the demands for information on proper vegetation management. Research is being conducted to improve techniques. However, many problems stem from a lack of familiarity with existing practices and their application to new situations.

This publication on pruning is a compendium of existing procedures and practices. It may be used as a guide to capitalize on the natural characteristics of each tree species to add interest, beauty, and utility to the landscape. Selection of the right tree for the right place is essential. Correct pruning will help to produce structural strength and will accentuate a tree's natural features.

Trees grow in many varied forms. Some have central leaders with a tall straight trunk (excurrent). Others develop a wide-spreading crown after forming a short trunk (diffuse or deliquescent). Between these extremes every intermediate form is to be

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1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

2/ Halstead's Tree Surgery, Oak Grove, OR.

found. The natural characteristics of the different kinds of trees should be brought out through landscape use and maintenance practices. Pruning can do much to enhance tree health and appearance.

Chemically controlling the size of plants offers promise of more efficient tree maintenance, particularly for trees growing under or near utility lines. In California maleic hydrazide has given control of shoot growth in certain species of plants. Best control with the least injury resulted when trees were sprayed after the basal leaves had fully expanded but before there was much shoot elongation. The terminal growing point is killed. Prune the trees the fall or winter before the first spray application. Spray effectiveness depends on the species, tree condition, and stage of growth. Low humidity will reduce spray effectiveness. Spray concentration and application also influence spray effectiveness. In certain situations, this may be a desirable growth control procedure. Use it wisely, however. Consult your county Agricultural Extension Service for more detailed information.

Crowded trees can result in misshapened trees with branches weakened by shading and rubbing. In many situations you can remove the smaller, more deformed, or less desirably located trees. The remaining trees will grow into the new space with improved health and beauty.

Trees are often planted closer together than would be desirable when they are mature size. As these trees begin to crowd, those that are to be removed should be pruned back more severely each year until they are removed. This will allow proper development of the more permanent trees while still retaining the value of the temporary trees.

Flowering and fruiting response to pruning depends on the flowering habit, age, and vigor of the plant. Severe pruning delays the onset of flowering in trees that flower on one-year-old spurs(e.g. crabapples, pear, cherry). In fact, no pruning may be needed in some cases. After the tree has begun flowering, an annual light thinning (10 to 15 percent of the leaf area) to reduce crowding or weak branches will usually be enough to maintain a balance between tree vigor and flowering.

Plants flowering on current-season's growth (e.g. crape myrtle) or on one-year-old shoots (e.g. peach) usually flower at a young age and profusely when vigorous growth is maintained. Pruning is one way to stimulate vigorous growth. Plants with such flowering habits should be pruned more severely than those flowering from one-year spur buds.

Pruning is not enough to ensure adequate fruit size or prevent limb breakage on trees setting heavy crops of fruit (e.g. plums and apricots). For these, fruit thinning may be necessary as well.

Some flowering trees set buds on one-year wood but do not need pruning to maintain vigor and good flower display.

PRUNING OBJECTIVES

There are a number of objectives in pruning, any one or several of which may be your concern. Since, however, pruning will affect the tree from root to crown, you should be familiar with what pruning will accomplish throughout the tree before you begin to prune.

Compensation for root loss. Root loss often occurs when planting bareroot trees or from mechanical damage. Proper pruning can restore nutrient and, particularly, water balance in the tree.

Training young trees for a desirable arrangement, attachment, and size of scaffold branches that will produce vigorous, mechanically strong, healthy trees. The particular tree form you seek will depend on the tree's natural growth habit and its landscape purpose. In most places, pruning should take advantage of the tree's growth habit, at times accentuating its natural tendencies but seldom greatly modifying them.

Unusual plant forms are often created through pruning, including topiary, espaliered, bonsai, pleached, and pollarded forms, but for success you must be familiar with the individual plant species and their responses to pruning.

Maintaining tree health and appearance by removing dead, diseased, injured, broken, rubbing, or crowded limbs. You may need to thin a dense top to allow light into and air circulation through the tree. For adequate growth, light is needed in the interior parts of the tree, as well as for the plants beneath it. Air circulation reduces the buildup of certain diseases and allows a more effective penetration of sprays. Proper thinning of the top reduces wind resistance that can create deformities or break the trunk or branches.

Control tree size to reduce shade, the danger of windthrow, and interference with utility wires, to simplify pest control, and to prevent the obstruction of views and passages. Choose trees that will be an appropriate size at maturity to minimize this need for pruning. Withholding nitrogen fertilizer and the growing of lawns under the trees will slow growth and reduce the need for pruning as a tree reaches the desired size.

Influence flowering, fruiting, and vigor by changing the balance between vegetative growth and flower bud formation. On young trees that flower on one-year-old wood, pruning will delay the age at which trees will flower and fruit. On mature trees, pruning helps to maintain balance between vegetative growth and flowering, which helps maintain tree vigor, minimizes overcropping that results in small blossoms and fruit and broken limbs, and encourages annual flowering and fruiting.

Pruning trees flowering on current season's growth stimulates shoot growth. Fewer and larger flowers will usually result.

Invigorating stagnated trees that are doing poorly but show no symptoms other than lack of vigor.

PRUNING RESPONSES

Pruning removes leaves and buds that would develop into leaves. Two apparently opposite effects occur from pruning young plants or those that do not have a heavy flower and fruit load.

Invigoration is the universal response to pruning. Pruning leaf areas and buds that would be leaves allows the root system (which is not immediately affected) to supply each remaining leaf and bud with more water and nutrients than previously. Individual shoot growth is stimulated, and these grow more rapidly and later into the season. Leaves grow larger and are greener in color. Even with larger leaves, total leaf area will be less on more severely pruned trees since there will be fewer shoots. The leaf area of a pruned tree will transpire less water than that of an unpruned tree.

Dwarfing results from pruning of young plants and those that do not have a heavy flower and fruit load. Pruning actually removes part of the plant, resulting in fewer leaves, or buds to develop into leaves.

Even though individual leaves on a pruned tree may be larger, total leaf area will be smaller than if the tree had not been pruned. Shoots of pruned trees grow later in the season, using for their growth foods produced by the leaves. A pruned plant has less time after shoot growth stops to use the food produced by leaves for the rest of the plant's growth and for storage or reserves for the next season. Less total growth will result. This can be easily observed or measured by the relative size of the trunks of trees that have been pruned more severely than others.

For a young plant at the end of the growing season following pruning, the following usually is the case: 1) top and root systems are in balance; 2) top and roots will be smaller than if the tree had not been pruned; 3) there will be less stored food in the pruned plants since these will have a smaller leaf area to have been active and active for a shorter time.

Invigoration and dwarfing effects depend upon how severely you prune. Removing dead, weak and heavily shaded branches has little effect while removing a like amount of healthy, well-exposed branches has a much greater influence.

Mature plants expected to set a heavy flower and fruit crop may become more vigorous without dwarfing. Pruning off a number of flower buds leaves a fixed number of flowers to develop into fruit. Remaining leaf buds have more food available for the shoots which will be more vigorous and have a greater leaf area per fruit than those of unpruned trees.

To subdue a tree or branch within a tree, prune more severely to reduce the total growth of a branch relative to another which is pruned only lightly or not at all.

To encourage a branch, prune it lightly or not at all. Prune other branches severely, particularly those that shade or compete with the branch you wish to encourage.

TYPE OF PRUNING CUT

The type of pruning cut you use influences the plant's response. Head or head-back pruning means cutting to a stub, lateral bud, or small lateral branch. New growth comes from one or more buds near the cut and is vigorous. Lower buds usually will not grow. Depending on the severity of pruning, the new growth is usually vigorous, upright, and dense. The foliage and branches may be so thick that lower leaves, as well as plants under the tree, are shaded out.

When large branches in mature trees are headed, the practice is called stubbing. Shoots growing on older branches come from latent buds and are attached only by a thin layer of new wood formed by the cambium. These branches, especially when young, are weakly attached and can easily break out.

Thinning or thinning-out is the removal of a lateral branch at its point of origin or a shortening of a branch's length by cutting to a lateral large enough to assume the terminal role. A tree's response to thinning is spread fairly evenly throughout--more open but retaining its natural growth habit. With more light penetrating through the tree, foliage will grow deeper in it.

PROTECTION

Protecting pruning cuts by applying an asphalt emulsion or other materials to pruning wounds is of doubtful value. The purpose of these emulsions is to protect the cut surface from woodrotting organisms and checking upon drying. However, upon exposure to the sun, the protective coating often cracks. Moisture from rain, sprinklers, or dew can then enter the cracks and accumulate in pockets that may occur between the wood and the wound covering. Such a situation will be even more inviting to woodrotting organisms than one with no wound cover application.

In some situations, for aesthetic reasons or for maximum protection the practice may be justified. If a pruning wound is to be protected, allow it to dry before applying the coating. This will improve chances for good bonding. Examine the coating several times the first year. Re-treat if the coating has cracked.

Black-colored coatings like asphalt emulsions can become very hot if exposed to the sun. These high temperatures may prevent or seriously reduce callus formation. To reduce this risk it is a good idea to paint the dried asphalt with a white water-base paint, wherever treated pruning wounds are exposed to the sun.

Growth retardant chemical has been added to some asphalt emulsion and aerosol paints. It is painted or sprayed on pruning cuts as described above. The chemical, naphthalene acetic acid, reportedly decreases the number of watersprouts as well as the vigor of those that grow.

The bark on the trunk and branches of newly planted or pruned trees may sunscald and die when exposed to the direct sun. Insects or pathogens may invade the wood of such damaged areas.

Painting white water-base paint on the exposed portions of the trunk and branches, particularly those exposed to the southwest, usually will reduce the bark temperature enough to prevent injury. Water-base paint is more durable than whitewash.

STRUCTURAL STRENGTH

Certain features contribute to the structural strength of the trunk and main branches of trees. Wide-angled branch attachments are stronger than those with narrow angles. A wide angle between branch and trunk allows connective wood to form in the crotch as well as on the sides and the lower portion of the branch attachment. A narrow angle of attachment may result in bark becoming imbedded between the branch and trunk. Little or no connective wood forms in a sharp-angled crotch, which is inherently weak. Such narrow-angled branches may be strongly attached and in their early years most of the weight will be nearly parallel to the axis of the branch and trunk. In later years, these branches become heavier and more spreading, and are apt to split out during a storm. Such losses not only deform the tree but are dangerous.

In training a young tree, a potential primary scaffold branch developing with a narrow angle of attachment should be removed as soon as possible. You may be able to choose another branch with a wider angle of attachment. If not, a second branch may grow from the same node and will usually have a much wider angle of attachment than the first. Also, since its growth begins later, it will have a smaller diameter in relation to the trunk than the first branch, permitting the branch attachment to be stronger.

Most broadleaved plants have more than one bud at a node, but usually only one develops unless growth is quite vigorous. The wider angle of attachment of a branch from a second bud at a node is particularly evident when the buds are superposed (one above the other) as in ash and walnut.

Trees of some species may occasionally have branches forming extremely narrow angles of attachment. Their attachment may be acute enough to cause indentations in the trunk, or they may twine around the trunk and look picturesque. But to avoid the possibility of later splitting out, they should be removed. Certain trees--for example, Lombardy poplar-- have been selected for their erect branching (fastigiate) habit. The upright branches of such trees are not removed. Usually they are relatively small compared to the trunk.

Laterals should be smaller than the trunk or branch from which they arise. Whenever a trunk or branch forks, one branch of the fork should be larger than the other. If the angle of attachment is wide, the larger trunk or branch can form supporting wood completely around the smaller branch so that the limbs will fit together like a dowel in a chair leg. The branch attachment will grow stronger with each year of growth.

Estimate the size (diameter) of trunk and lateral just beyond the point of attachment. If the lateral is too large in relation to the trunk, remove some of its leaves or leaf buds. If the branch has none or few, it should be headed.

In many trees, the lowest branch outstrips the growth of the trunk and the upper branches. In developing a trunk, therefore, check regularly during the growing season to see that the lower laterals do not outgrow the leader.

Branches from latent buds are usually weakly attached to the trunk. If you wish to keep such branches, thinning will slow growth and permit the attachment to strengthen.

Tapered trunks will withstand greater stress (wind, vandals) than those that have little or no taper. A tapered trunk decreases in diameter with height. When a tapered trunk bends, the curvature is fairly uniform throughout its length and allows more uniform distribution of stress. Tops of well-tapered trunks bend under the wind further from the vertical than those with less taper, reducing the danger of broken trunks or other deformation from exposure to the wind and uneven stress distribution. During the growing season, the tip of the leader may bend so far that it is parallel to the wind load, which relieves almost all stress on the immature wood of the tip.

Temporary branches on the trunk will strengthen the trunk and protect it. The trunk will increase more rapidly in base diameter if laterals grow along it. The leaves and growing points provide food and auxins (hormones) for more rapid trunk growth. Temporary branches shade the trunk and reduce the likelihood of sunburn injury to the bark and cambium particularly on the southwest side of the trunk. This low growth acts as a guard and reduces the possibility of injury to the trunk from mowers, cars, animals, and vandals. Temporary growth often enhances the attractiveness of a young tree, increasing its landscape effect by providing a more massive appearance.

Temporary branches will increase total tree growth, even though the tree may not grow quite as rapidly in height as it would with no temporary branches along the trunk. This slight reduction in height growth is a definite advantage in developing a structurally strong tree. Leaving temporary branches along the trunk and allowing the trunk to flex in the wind not only will increase trunk caliper near the base but will increase trunk taper. This will greatly reduce and sometimes eliminate the length of time a tree must be staked.

PRUNING MATURE TREES

Mature trees may need to be pruned for several reasons. Tree health and appearance can be improved by removing limbs that are dead, weak, diseased, and insect-infested. Sources of future infection and infestation also can be reduced. Many species of insects more readily attack weak trees and limbs than vigorous ones. Some diseases, too, are more serious on weak trees than on healthy ones.

Pruning can remove new or holdover sources of some diseases. For example, pruning can reduce the spread of fireblight, a serious disease of many landscape apple, pear, and hawthorn trees as well as pyracantha and cotoneaster. Be careful to make the cuts in healthy wood well below the infection--12 to 18 inches if possible. If many trees need attention the shears should be disinfected after each cut with common household bleach, sodium hypochlorite. Dip the shears in a 1 part bleach to 9 parts water solution for a couple of seconds. Household bleach will corrode tool metals with prolonged use. To minimize corrosion, rinse the tools in running tap water after each day's use, then dry and oil all surfaces.

Remove broken, low, and crossing limbs for appearance and safety.

Open the top of the tree to light so interior leaves and branches can stay healthy and function properly. High light intensity is necessary for active and productive leaves.

The structural features of a tree may be emphasized by moderate thinning to open the tree to view. Just another tree may be transformed into a picturesque feature in the landscape. Pittosporum, dogwood, olive, ginkgo, and many others are particularly suitable.

To open up a medium- to large-size tree (40 to 60 feet), moderate-size (1 to 2 inches in diameter) thinning cuts of limbs are effective. Somewhat smaller cuts for smaller size trees are appropriate. These should be made in the top and around the sides of the tree. Remove branches that are close to others. In some large trees, cuts may remove limbs up to 6 inches in diameter. However, such large cuts indicate the tree has not been properly pruned or that its use to the landscape has changed.

Size control of plants is commonly attempted by pruning. You can most effectively control size by pruning the plant as it begins to reach the desired height. Delaying pruning until the tree is much larger than wanted makes pruning more difficult, cuts harder to hide, and encourages excessive regrowth.

Thinning-out pruning can be used to reduce the height and spread of a plant. Cut branches to lower laterals (drop crotching). Some limbs may be removed completely. A thinned tree retains its natural shape and is less subject to vigorous watersprouts than a headed tree.

Heading or stubbing is the most common way to reduce tree size. While more rapid than thinning, the results are in most cases much less desirable. Regrowth is vigorous and upright from the stubs. The new branches form a compact head, cast dense shade and are weakly attached to the older ones.

For pruning of equal severity, regrowth following heading is more vigorous than that after thinning. The influence of thinning is spread throughout the tree, while that of heading is concentrated near the cuts.

Pruning for size control should be done while the tree is small so that not more than 25 percent of the leaf area must be removed. Otherwise, no matter how carefully the tree is pruned, excessive growth results.

TIME OF PRUNING

The time to prune depends on the kind of tree and the desired results. Light pruning can be done anytime. The removal of unwanted growth while it is small is easier and will have less dwarfing effect than if done later. The removal of broken, dead, weak, or heavily shaded branches will have little or no dwarfing effect on the tree no matter when they are removed.

Rapid plant development can best be maintained if the required pruning is done before the period of rapid growth usually occurring in the spring. Most deciduous trees can be pruned during the dormant period between leaf fall and spring growth. Evergreen plants will be set back the least if pruned just before spring growth starts.

A few broadleaved evergreen plants make their most rapid growth after the weather warms later in the season. Pruning of these plants can be delayed. Pruning just before the period of most rapid growth will keep the most leaves productive for the longest time. Also, pruning cuts will be quickly concealed by new growth.

To retard plant development prune when growth is about complete. The pruning should not be so severe nor so early as to encourage new shoot growth. For many plants, the time to prune for maximum dwarfing usually would be in late spring to middle summer.

Leaf area will be reduced for the longest period of time. Pruning cuts should be made so they are not easily seen.

Directing the growth of a young tree can be done effectively during the growing season. Branches in desired positions can be encouraged by pinching back or by removing competing shoots in less desirable positions.

Corrective pruning may be easiest during the growing season. Branches that are too low because of the weight of leaves and fruit can be partially or completely thinned. Dead and weak limbs are easily spotted for removal.

Time of pruning to maximize flowering depends on the flowering habit of the tree. Plants flowering on current-season's growth should be pruned during the winter before growth begins. Moderate to severe pruning will favor larger blossom clusters.

Plants flowering in the spring from buds on one-year wood, particularly the flowering fruit trees, should be pruned at or near the end of the bloom period. The blossoms can be enjoyed and then removed before they set fruit that may compete with new shoots. Vigorous growth will be encouraged on which to bear next year's bloom.

Bleeding of pruning wounds can be heavy on mature trees such as maples and elms. Bleeding of susceptible trees can be minimized if the cuts are small (less than 3 inches) and made in the fall or early winter. Bleeding is much more likely if severe pruning is done just before growth begins in the spring. Bleeding usually is not harmful to the tree. However, if it is heavy and persistent, it may cause bark injury below the pruning cut.

Cold injury may be increased by pruning. Some plants (e.g. roses, sub-tropicals) may be stimulated into new growth by pruning in the fall and early winter. A pruned plant may begin growth during a warm period in the winter only to be injured when it turns cold again. These plants should be pruned close to the time growth begins in the spring.

At high elevations where temperatures below $0^{o}F$ may occur, it is best to delay pruning until just before growth begins in the spring. Even though growth is not stimulated, pruning may reduce plant hardiness somewhat.

RESEARCH REPORT[1]

D. K. Taylor[2]

RESPONSE OF TURFGRASSES TO SIMULATED WEAR

After two winters of simulated wear in a replicated study of cultivars and mixtures of turfgrasses for sports fields, perennial ryegrass and Kentucky bluegrass have shown outstanding survival. Diploid timothy and rough-stalked meadow grass had good survival while other grasses such as creeping red or hard fescue, bentgrass, Canada bluegrass and crested dogstail were almost eliminated from the stands.

Manhattan was the best of the perennial ryegrass varieties tested, superior to Pennfine, NK200, Game and Norlea both in pure stands and mixtures. Among the Kentucky bluegrasses, Sydsport and Merion were superior to Baron, Fylking and Nugget in pure stands and in combinations with Manhattan ryegrass.

In general, mixtures of the better species were superior to single grasses in pure stands. The best mixture included perennial ryegrass, Kentucky bluegrass and diploid timothy. Timothy was attractively winter green and although basically a soft textured grass and occasionally subject to disease in pure stands, it had excellent recuperative ability.

1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

2/ Head, Crop Science Dept., Agriculture Canada, Agassiz, BC, CANADA.

RECOVERY FROM SIMULATED DIVOTTING AMONG TURFGRASS CULTIVARS

Two years' results have been summarized on the speed of recovery from simulated divotting by various cultivars of bentgrass, Kentucky bluegrass and perennial ryegrass maintained at 1/4 and 1/2 inch mowing height. Following divotting three treatments were carried out, topdressing, topdressing plus seed, and no treatment followed by notes on recovery at 3- and 6-week intervals.

Among the bentgrasses maintained at 1/4 inch, Emerald was poorer than five other varieties at 3 weeks and poorer than Highland and Penncross at 6 weeks. Under the 1/2 inch management Penncross, Seaside, Astoria and Highland were superior to Emerald at 3 weeks, while Highland and Penncross were superior to Emerald, Seaside and Astoria at 6 weeks. In combination with Kentucky bluegrass, Highland was superior to Seaside at both 3 and 6 weeks while Penncross was equal to Highland at 6 weeks. Small differences were observed among cultivars of Kentucky bluegrass. Merion was inferior to Fylking, Sydsport and Nugget in mixtures with bentgrass, but superior to Nugget and Fylking in pure stands or mixtures with Manhattan.

Topdressing alone did not enhance recovery up to six weeks and it would appear that its only benefit would be to level an uneven surface.

RATES AND FORMS OF NITROGEN FOR PENNCROSS BENTGRASS

This fertility trial has now had three years of light sand topdressing with every fertilizer application (10/season). Since the topdressing treatment was initiated there is less thatch and less nitrogen is required for an attractive appearance. The 6-8 lb rates are better than 9 lb/season. Even high rates such as 15 lb/season do not show as much puffiness as previously. Sand, therefore, seems to mask problems created by excessive nitrogen.

The most attractive treatments were 21-0-0 + (6-3-0 summer only)>21-0-0>34-0-0, 38-0-0 complex> 38-0-0>46-0-0. Highest yields were obtained from 34-0-0>46-0-0>21-0-0>38-0-0. Late fall applications of nitrogen increased winter and spring greenness without increasing disease. *Fusarium* patch incidence increased with high nitrogen (15 lb), high lime (pH 7.0 plus) and the use of 46-0-0 as a source of nitrogen.

POA ANNUA CONTROL STUDIES

Competitive differences with *P. annua* among three bentgrass varieties continue to be evident, Penncross>Seaside>Highland. All plots receiving regular applications of bensulide have less *Poa annua* than other treatments.

Differences owing to high sulfur or low phosphorus were not evident in 1977. Four treatments using various rates and timing of endothall were applied. Rates of 0.75 lb ai/A were temporarily phytotoxic. The bentgrass recovered quickly, however, in mid-summer applications but too slowly from September applications.

As much as 2.5 lb ai/A was applied to varieties of Kentucky bluegrass with a good reduction in *P. annua*. This rate was not effective on weedy creeping bentgrass. Linuron was also promising for use on Kentucky bluegrass at the higher recommended rate (0.1 lb ai/1000 ft^2). Both products were completely phytotoxic to *P. trivialis*.

A great variation was observed among Kentucky bluegrass varieties in their resistance to these herbicides. Fylking was most susceptible followed by Birka. Baron, Sydsport and Cheri were among the most resistant. Merion was average while Bristol was resistant to linuron but susceptible to endothall.

RESULTS OF COMPETITION AMONG THE COMPONENTS OF FESCUE-KENTUCKY BLUEGRASS MIXTURES

Variety is an important consideration in formulation mixtures of turfgrass species for home lawns. Some varieties such as Highlight may be so agressive that they crowd out competing Kentucky bluegrasses in simple mixtures.

Seedings made in 1972 and 1973 of mixtures of high and low density fescues and Kentucky bluegrasses were studied in 1977 to see what the survival had een under 3 fertility levels (1, 3, 5 lb N/1000 ft^2) and 2 heights of cut (3/4 and 1-1/2"). A count of the number of tillers per unit area showed the following order of density among fescues-Highlight>Durlawn>Boreal, and Kentucky bluegrass - Nugget>Merion>Sodco. All mixtures of Boreal fescue with varieties of Kentucky bluegrass gave close to a 1:1 tiller count whereas comparable Highlight mixtures were at best 9:1, fescue:bluegrass. At Kamloops the results were equally pronounced although bluegrasses, and Nugget in particular, were somewhat more competitive.

In general, increases in fertility and lower cutting height increased the number of tillers, giving increased density. Increased fertility reduced tiller weight for fescue but not for Kentucky bluegrass. At Kamloops where Kentucky bluegrass is better adapted, tiller weight was 80% greater than at Agassiz, at the 3/4 inch cutting height. Higher density also resulted in higher thatch measurements.

Therefore, in formulating simple mixtures of species for home lawns where survival of both components is important, it appears necessary to consider the competitive ability of the varieties used. Highlight, a very attractive Chewings fescue when grown alone, may be too competitive in mixtures with Kentucky bluegrass for survival of the bluegrass. Although the use of Boreal in mixtures gave a better survival of both species, perhaps a more disease resistant variety should be chosen such as Pennlawn.

SNOW MOLD CONTROL IN THE B. C. INTERIOR

Four years of trials in the B. C. Interior have shown the usefulness of Caloclor, chloroneb and quintozene for the control of snow mold on putting green turf caused by *Typhula* spp. and *Fusarium nivale*. All products were applied in one application prior to snow fall. Caloclor was highly effective at the 5 oz rate but showed slight temporary toxicity in the spring. The 3 oz rate was not completely effective in a one year trial. Of the non-mercurials chloroneb at 6 and 9 oz was most effective although quintozene at 8 oz gave almost as good results. Granular applications have given good basic disease control but were slightly less effective than spray applications. For example, in a one-year trial (1976-77) RP 26019 at 2 or 4 oz gave good disease control as a spray but 4 or 6 oz were required to be equally effective as a granular product.

SLOW-RELEASE NITROGEN STUDIES — IDAHO[1]

R. D. Ensign, V. C. Hickey, R. E. McDole[2]

Several slow-release nitrogen fertilizers were evaluated in 1978. The purpose was to determine response to rate of N, rate-combination, time and form of the nitrogen materials upon the growth and quality of bentgrass in Idaho. These fertilizers were compared with a highly soluble ammonium nitrate formulation. The materials used are given in Table 1.

The experiments were conducted on two distinctly different types of golf greens. The green at the University of Idaho Golf Course was constructed with 18 inches of sand and seeded to Seaside bentgrass in 1968. The green at the Moscow Elks Golf Course was an old putting green which was constructed from fine silt loam typical of the Moscow region. Highland bentgrass was planted on the green in 1946. It has a deep thatch-mat layer.

The winter and spring of 1977-78 recorded above normal moisture levels, thus these greens were very low in available N at the time of the early spring N treatment.

The results of the applications on color response of the bentgrass are summarized in Table 2.

1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

2/ University of Idaho, Moscow, ID.

TABLE 1. Slow-release nitrogen fertilizer materials and ammonium nitrate

Treatments	Materials	Source of N	Rates and Dates*
1	Scotts 29-3-3	22.4% WS** Methylene Urea 5.8% WIN Methylene Urea 0.8% Ammonical N	2+2+2
2	Scotts 22-0-16	14.0% WS Methylene Urea 7.5% WIN Urea and M.V.	2+2+2
3	Nitroform-M 38-0-0	Organic Urea Formaldehyde (UF) 27.5% WIN UF 10.5% WS UF	2+2+2
4	IBDU 31-0-0	Isobutylidene Diurea 27.9% WIN 3.0% WS	2+2+2
5	IBDU 31-0-0	Same	3+3
6	IBDU 31-0-0	Same	4+4
7	Milorganite 6-2-0	Natural organic activated sludge 5.5% WIN	2+2+2
8	Ammonium Nitrate 34-0-0	Nitric N 17% Ammonic N 17%	2+2+2

* 2+2+2 = 2 lb N/1000 ft^2 April + 2 lb Mid-June + 2 lb September;
4+4 = 4 lb N/1000 ft^2 April + 4 lb September, etc.

** Note: WS = Water Soluble Nitrogen

TABLE 2. Average grass color readings for the eight nitrogen treatments.

Treatments		Seasonal Average Color** U of I G.C.	Seasonal Average Color** Elks G.C.
1	Scotts 29-3-3 2+2+2*	6.9	6.8
2	Scotts 22-0-16 2+2+2*	5.6	4.9
3	Nitroform 31-0-0 2+2+2*	5.0	4.6
4	IBDU 31-0-0 2+2+2*	5.0	5.8
5	IBDU 31-0-0 3+3	4.6	5.3
6	IBDU 31-0-0 4+4	4.8	5.9
7	Milorganite 6-2-0	5.2	5.3
8	Ammonium nitrate 34-0-0 2+2+2	7.1	6.3

* Means 2 lb of actual N applied in April, June and September.
** Dark green = 9; light green = 1.

Summary and Conclusions

1. Both greens were very low (below 5 ppm NO_3) in available N in April at the beginning of the experiment.

2. Four slow-release nitrogen fertilizers were evaluated for grass growth on two distinct kinds of greens in Moscow, Idaho. The fertilizers had different water-soluble (WS) components. (See Table 1)

3. The nitrogen was applied at a seasonal total of 6 lb of actual N/1000 ft^2. Treatments were applied at 2 lb of actual N in early April, mid-June, and mid-September. An additional treatment consisted of IBDU applied at 3 lb N in April plus 3 lb N in mid-September, another treatment consisted of IBDU at 4 lb of N in April plus 4 lb of N in September. No summer application was made for those two treatments.

4. Rapid green-up responses were noted with Scotts 29-3-3 and ammonium nitrate and to a lesser degree with Scotts 22-0-16, Nitroform-M and Milorganite. The IBDU carrier is thus 27.9% water insoluble (WIN) and only 3% water soluble N. Thus rapid green-up was not observed as with Scotts 29-3-3 and ammonium nitrate fertilizers. The plots in which IBDU was applied gradually improved as the summer progressed. It appears that several annual applications are needed for these slow-release materials to buildup adequate N for plant growth.

5. Some balance between WS and WIN forms of N seems to be a practical answer to proper grass nutrition and appearance. Such formulations may vary depending upon the season and other environmental conditions.

6. These experiments will continue with the same applications in 1979.

EVALUATIONS OF TURFGRASSES UNDER IDAHO CONDITIONS[1]

R. D. Ensign, W. R. Simpson
and V. G. Hickey[2]

Since 1972 numerous turfgrasses have been evaluated for adaptability and performance in two areas of Idaho. Evaluations were conducted on irrigated fine silt loam near Moscow, Idaho, where the climate is generally moist and cool in the late fall to early June. Mid-summer is usually semi-arid with relatively cool nights. The second location was in southwestern Idaho at the Parma Research and Extension Center. The irrigated soil is a deep Greenleaf fine silt loam relatively high in pH. The climate is arid and the summer temperatures which frequently exceed 95^{o}F are generally higher than at Moscow. Summer stress on turfgrass is usually greatest in southwestern Idaho.

Moscow Location

During 1978 the following species were evaluated at Moscow:

63	Kentucky bluegrass cultivars
13	Perennial ryegrass
18	Fine-leaf fescue
1	Tall fescue
11	Bentgrass
3	Timothy
2	Canada bluegrass
1	Zoysia grass
112	Total

1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

2/ University of Idaho, Moscow, ID.

These grasses were planted in 5' x 20' plots and mowed weekly at one inch, 2 inches, and 3 inches mowing heights. The annual fertility program consisted of 6 lb N, 2 lb P, and 4 lb K per 1000 sq ft. The grasses were irrigated as required for growth. Notes were taken on spring green-up, texture, color, and diseases. A summary of these scores is available from a separate handout.

Kentucky bluegrasses with the best color (scores 8 or above) during the May-September period at the 2 inch mowing height were:

Adelphi	Continental	Nugget
Aquilla	Galaxy	Sodco
Baron	Glade	Sydsport
Belturf	Majestic	Victa
Bonnieblue		

The Kentucky bluegrasses generally have a better color score than do the fine-leaf fescues, although the cool fall period is favorable for excellent growth of the fine-leaf fescues.

The perennial ryegrasses do exceptionally well in this area. They are almost equal to the Kentucky bluegrasses in turf quality. They do exhibit a lighter green color than the bluegrasses listed above. They probably have a higher N requirement than bluegrasses and look best at the 3 inch mowing height.

The bentgrasses are maintained at lawn height (1/2 inch). The species of *Agrostis* show considerable differences in appearance. The texture of 'Velvet' bent is fine and overall quality is excellent. The cultivars 'Stranhem' and 'Penncross' perform well under these conditions. The bentgrasses are fertilized more frequently (8 lb annually) and watered and mowed bi-weekly during summer growth periods.

Tall fescue may have a place in the Northwest where a coarse-textured turf is desired. It will require a 3 inch mowing height and 8-10 lb N annually to maintain desirable color. It is relatively drought tolerant and will green-up in the fall after prolonged summer drought.

Zoysia grass is widely advertised in magazines in the Northwest as being hardy and durable. Tests after 2 years in this area of the Northwest indicate it is hardy, very tough to mow and produces abundant stolons. It is a transitional zone grass and becomes off-color early in the fall-winter and does not green-up until early summer. It desires long summer periods with 85-90^{o}F temperatures.

Diseases are not a critical problem with most grasses in this area with the exception of leaf-rust and *Helminthosporium* leaf spot on some bluegrasses. Stripe sprout can also be a problem in some years. Winter snowmold diseases are destructive on all bentgrasses. 'Merion' bluegrass is very susceptible to leaf rust and some lawns exhibit a brownish color in the cool fall periods. Other bluegrasses also show relatively high degrees of rust although most new cultivars are highly resistant to rust. Grasses having high susceptibility *Helminthosporium* readings include: Adelphi, Belturf, Galaxy, K1-132, Prato, Six, Sydsport, Troy, Touchdown, Victa, Warren's A-34.

Mowing height affects the quality of turf. Plots mowed at the 1 inch level generally are inferior in quality and color to those mowed at the 2 or 3 inch level. This is especially true using the rotary mower. The reel mower is much better for maintaining turf at the 1 or 2 inch levels.

Conclusions

Turf managers have available many fine improved grasses for the Northwest. Many new bluegrasses are outstanding when managed properly. Also, the Northwest produces nearly 100% of the seed of these grasses; thus, high quality seed is available. The perennial ryegrasses do well in turf plantings in Idaho. They appear to exhibit good growth and acceptable color.

Plantings observed for the past 6 years indicate they have sufficient winter hardiness for this area of the Northwest.

Many fine-leaf fescues are likewise available. Although these grasses generally have more drought tolerance than Kentucky bluegrass, they do exhibit their best color and quality during the cool, moist and somewhat shady environments.

Parma Location

Twenty turfgrasses were established in April 1975 at this location. They included 15 selected Kentucky bluegrasses, 2 fine-leaf fescues, and 1 perennial rye which were all planted in a monoculture. A tall fescue-creeping red fescue mix and a bluegrass-creeping red fescue mixture were also included. These grasses were planted in 5' x 20' plots replicated three times. Each plot was mowed weekly at 1.5 inch and 3.0 inch mowing height. The plot area received 8 lb of actual N annually and was flood irrigated. Color readings were taken and are summarized in Table 1.

These data indicate that the improved Kentucky bluegrass cultivars perform well under these conditions. The monoculture of the bent-bluegrass is superior to the mix of this grass with other species. The single perennial ryegrass did not produce as good color as most of the bluegrasses. The same can be said for the fine-leaf fescues.

There is a general lowering of turf quality in this area as the summer weather progresses. These grasses improve in color and growth after mid-September and the cooler spring periods.

No diseases were recorded in 1978 although rusts are usually abundant on most susceptible varieties during cool, moist periods.

TABLE 1. Color readings on turfgrasses in southwestern Idaho - 1978.

	Grass	Average Color (9 readings)		
		6/2	9/5	9/23
1.	Baron K.B.	9.0	9.0	7.8
2.	Kl-187 K.B.	8.5	6.0	7.2
3.	Merion K.B.	8.5	6.0	6.0
4.	Touchdown K.B.	8.3	6.3	7.0
5.	Belturf K.B.	8.3	5.7	6.3
6.	Nugget K.B.	8.3	7.0	8.3
7.	Pennstar K.B.	8.2	6.7	7.5
8.	Victa K.B.	7.7	7.0	7.2
9.	Cougar K.B.	7.7	6.3	6.3
10.	Garfield K.B.	7.1	5.7	5.3
11.	Newport K.B.	7.0	7.0	6.8
12.	Sydsport-Baron-Garfield K.B.- Cr. Red Fescue	7.0	5.7	5.8
13.	Biljart C-26 Hard Fescue	6.3	6.3	6.7
14.	Arboretum K.B.	6.0	6.0	5.8
15.	Tall Fescue - Cr. Red Fescue	5.7	5.7	6.5
16.	NK-200 Perennial Ryegrass	5.5	6.0	5.2
17.	Barfalla Ch. Fescue	5.3	6.0	7.5
18.	Park K.B.	5.2	5.7	5.2
19.	Delta K.B.	5.2	7.3	5.0
20.	South Dakota K.B.	4.8	6.3	4.7

CONTROL OF *POA ANNUA* IN LAWN AND PUTTING TURF IN THE PACIFIC NORTHWEST USING ENDOTHALL[1]

Tom Cook[2]

NOTE: The following is an edited version of the summary that was submitted along with necessary table data in support of a special label for endothall on *Poa annua*. Keep in mind when reading the conclusions that the examples are just that and the actual timing is not sacred as long as the general requirements for each grass are met. Please remember that until a special label is granted for the program outlined below, endothall cannot legally be used at the rates stated in this summary.

Research at a variety of locations has shown that endothall has potential for *Poa annua* control in turf (1,2,3). Most researchers add that their tests did not result in long term *Poa annua* control, and that control has been inconsistent and unpredictable at best. Turgeon (3) also indicated that certain *Poa annua* variants appeared to be resistant to endothall. A general conclusion seems to be that endothall doesn't really work that well and its too "hot" to handle, meaning it may injure desirable turf.

In searching for chemicals that might be suitable for *Poa annua* control in the Pacific Northwest I noticed that all research on endothall in the U.S. of America had been done under climatic conditions that are much more severe than we experience west of

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1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

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the Cascade mountains in Washington and Oregon. For example Michigan and New Jersey where the most endothall research has been done are both characterized by hot humid summers and moderately cold to severe winters. Under these conditions turf is dormant during winter and is under considerable heat stress during summer. Turf normally goes through a spurt growth phase in spring and a smaller but similar phase in fall. In contrast the climate west of the Cascade mountains from the Willamette Valley of Oregon to the Canadian border is characterized by mild wet winters and moderate to hot dry summers. Turf normally grows at reduced rates through winter and enters an accelerated growth phase during spring that may continue through most of the summer and into fall. Prolonged severe stress periods are not common during either winter or summer. Periodic summer heat stress rarely lasts for more than a few days at a time. The end result is a relatively long growing season during which turf is under very little stress compared to areas such as the Midwest and Northeast. We felt that our peculiar low stress environment might be more conducive to success with endothall and allow more variety in both rates and timing of applications, than the other areas where earlier research had been done. With that in mind we initiated research into the feasibility of endothall for *Poa annua* control in the Pacific Northwest.

The summary and recommendations that follow are based on research and observations made over a three year period from 1975 through 1977. Additional work is ongoing.

GRASSES

The grasses commonly used in the Northwest were tested for tolerance to endothall. On a relative scale I would rank their tolerance as follows:

HIGH TOLERANCE	Kentucky bluegrass
	Perennial ryegrass
MEDIUM TOLERANCE	Creeping bentgrass
	Colonial bentgrass

LOW TOLERANCE	Velvet bentgrass Fine fescues

An interesting observation is that some of the chewing types of fine fescues such as Highlight and Jamestown showed good recovery from endothall treatments even though initial injury was rather severe. On the other hand no drastic differences in tolerance among varieties of Kentucky bluegrass, perennial ryegrass, or colonial and creeping bentgrass were noted.

RATES

Right from the beginning it was apparent that label rates were too low to be effective in controlling *Poa annua* as single treatments and caused unacceptable thinning of desirable grasses when used in repeat applications. Repeated applications were not always effective in enhancing *Poa* control since young undamaged tissue was often shrouded by dead tissue so additional sprays did not contact it. Based on my work I settled on the following rates for each grass:

Kentucky bluegrass 2.5 kg ai/ha = 2.25 lb ai/A
Perennial ryegrass 2.5 kg ai/ha = 2.25 lb ai/A
Colonial bent lawn turf 2.0 kg ai/ha = 1.75 lb ai/A
Colonial bent putting turf 1.25 kg/ha = 1.0 lb ai/A
Creeping bent putting turf 1.25 kg/ha = 1.0 lb ai/A
Velvet bentgrass putting turf - not recommended
Fine fescues - not recommended, will survive 1 application at 2.5 kg ai/ha ≃ lb ai/A.

In attempting to evaluate the effects of different rates of endothall on desirable grasses it became apparent that at rates that controlled *Poa annua* some discoloration of desirable grasses was inevitable. Most of the rates listed above will cause about a 2 point color loss on a scale of 1-9. However, in all cases with the addition of nitrogen fertilizer, color returns very quickly. In my opinion this small loss of color is little price to pay for effective *Poa annua* control.

While most testing was done on single species stands of turf, some tests were conducted on mixed swards. Kentucky bluegrass-fine fescue mixtures, for example, have been successfully treated with endothall at Kentucky bluegrass rates without severe loss or injury to the fine fescues. However, color loss in turf containing fine fescues is greater than in turf containing only tolerant species.

SPRAY ADJUVANTS

Spray adjuvants such as spreaders may be added to endothall without ill effects during optimum weather conditions. The addition of an adjuvant during cold weather or when frost is likely will increase injury to desirable grasses. When used properly spray adjuvants enhance *Poa annua* control at moderate endothall rates. Normal dilutions for adjuvants run around 1 to 800 (e.g. 1 pt/100 gal spray solution).

SPRAY VOLUMES

Most of my work was done using spray volumes in excess of 1000 l/ha or 100 gal/acre. I feel that uniform and thorough coverage enhances control and high spray volumes help in this regard. On the other hand success in the field has been achieved with spray volumes as low as 40 gal/acre. As a result it is difficult to say that high volumes of spray are necessary for control.

TIMING

Current label directions indicate early spring is the most desirable time for endothall applications. My work does not support this recommendation. On the contrary, I found that <u>at appropriate rates for the grass being treated, endothall is most effective if applied when turf is growing vigorously without heat, cold, or drought stress.</u> In the Pacific Northwest these general guidelines can be interpreted as follows:

Kentucky Bluegrass

Applications most effective when applied between early-June and mid-September provided general guidelies are met. During summer avoid applications if day time temperatures exceed 85^{o}.

Perennial Ryegrass

Same as for Kentucky bluegrass. I suspect ryegrass can be treated earlier than bluegrass but I have no data to back it up.

Creeping and Colonial Bentgrass

Applications are most effective between late April and mid-June and again during early-to mid-September provided general guidelines are met. Summer applications are acceptable during mild periods when temperatures are below 80^{o} and moisture stress is not a factor.

Cautions-

Spring or fall applications when frost is likely will result in excess discoloration and injury to desirable grasses. Applications when grass is growing slowly such as mid-spring for Kentucky bluegrass may also result in excessive discoloration.

REPEAT APPLICATIONS

Endothall appears to be most effective on mature leaf and sheath tissue. Single applications often leave the apex and any developing young leaves uninjured. Follow up applications within 2 or 3 weeks often have little effect on this young tissue since it is enclosed in dead foliage. On the other hand the desirable grasses that withstood the first application are further weakened by the repeat treatment and may begin to thin. I chose to delay repeat applications until all grasses had completely recovered. This seems to allow maximum control of *Poa annua* with only minimum injury to desirable grasses. Empirical observations indicated that eight weeks was sufficient for this purpose. Therefore, I try not to make consecutive applications closer than about eight weeks apart.

PRE-EMERGENCE HERBICIDES

My tests and general field trials indicate that long term *Poa annua* control cannot be achieved with endothall alone. Endothall has virtually no soil activity and only a very short foliar residual activity period. Therefore reestablishment of *Poa annua* from seed is possible shortly after death of the original plants. In the course of my work I concluded that ultimate control would depend on either use of a pre-emergence herbicide to prevent reestablishment or overseeding with a vigorous grass in hopes of outcompeting the germinating *Poa annua*. All of my work depended on pre-emergence herbicides to add the final measure of control. I have no data on the real possibilities of over-seeding.

The question of what to do after treating an area with endothall is important because there is no use in killing the *Poa annua* present unless something better can take its place. For this reason a short discussion of the potential of both pre-emergence herbicides and overseeding is included below.

If people had a choice I'm sure most would choose to overseed after they killed the original *Poa annua*. The idea is a good one but it does have limitations. For example, given that *Poa annua* seed is also present, successful overseeding requires a vigorous germinating grass that can outcompete *Poa annua* from the start. Perennial ryegrass is probably the best answer to this problem but it may not be suitable for such areas as putting greens or bentgrass lawns where its color and growth habit do not blend in well with the other grasses. Bentgrasses also germinate very quickly but are very weak during the juvenile phase. As a result areas overseeded with bentgrass would have to be held out of play during establishment. Perhaps the greatest disadvantage of overseeding is that it means a gradual transition at best from *Poa annua* to the desirable grasses and will probably require several years of endothall treatments plus continuous overseeding to achieve desired results.

Pre-emergence herbicides evoke controversy among many people. A continuing fear is that there is no way overseeding can be done if, for example, vandals strike or an accident occurs and turf is killed. Also there is a nagging fear that prolonged use of pre-emergence herbicides will cause decreased rooting and poor turf quality. To avoid such problems I feel pre-emergence herbicides need to be used intelligently. For example, as soon as the turf is thinned by killing the *Poa annua*, conditions are prime for germination. A pre-emergence herbicide is needed only from then until the desirable turf fills in vegetatively. Often the lowest effective rate of a pre-emergence herbicide can be used. My research indicates that bensulide, for example, is effective at rates as low as 8 kg ai/ha and is safe at least up to rates as high as 18 kg ai/ha. Therefore, when using bensulide for pre-emergence control it is safe and effective to use moderate rates such as 10 kg ai/ha (8-10 lb ai/A). An additional advantage of lower rates is a shorter activity period and less chance of any longterm negative effects on desirable turf. My data indicate that pre-emergence herbicides work very well with spreading types of grasses such as Kentucky bluegrass and bentgrasses. There is still a question in my mind as to whether or not they would be satisfactory for bunch-type grasses such as perennial ryegrass.

In developing a long range program it may be desirable to adopt the best features of both overseeding and pre-emergence herbicides. For example, if a perennial ryegrass turf is heavily infested with *Poa annua* it might work best to overseed with ryegrass after initial endothall treatments in order to increase the percentage of perennial ryegrass. Once the ryegrass component is more uniform a pre-emergence herbicide could be applied prior to the next endothall treatment to speed up control efforts.

FERTILIZATION

Even though I can't offer strong evidence to support it I feel a strong nitrogen fertilization program is essential to effective *Poa annua* control with endothall. Normally this involves at least one application of a soluble nitrogen source (4-5 g N/m^2 or 3/4-1 lb N/1000 ft^2) before endothall to stimulate grass growth and a second application after endothall to stimulate fill in of treated areas. This approach is essential when using pre-emergence herbicides. It also appears to stimulate rapid recovery of color in the desirable grasses.

CONCLUSIONS

The above discussion can be summarized by outlining what I feel are effective programs for controlling *Poa annua* in different types of turf.

I. Kentucky bluegrass and perennial ryegrass

(Example for two treatments in one year)

1. MID MAY - Nitrogen - 40-50 kg/ha (3/4-1 lb/1000)
   LATE MAY - Bensulide - 10 kg ai/ha (8-10 lb/A)
   EARLY JUNE - Endothall - 2.5 kg ai/ha + X-77 (2.25 lb ai/A + X-77)
   1-2 wks later - Nitrogen - 40-50 kg/ha (3/4-1 lb/1000)

2. EARLY AUGUST - Nitrogen - 40-50 kg/ha (3/4-1 lb/1000)
   MID AUGUST - Bensulide - 8 kg ai/ha (6-8 lb/A)
   EARLY SEPTEMBER - Endothall - 2.5 kg ai/ha + X-77 (2.25 lb/A + X-77)
   1-2 wks later - Nitrogen - 40-50 kg/ha (3/4-1 lb/1000)

The above program would allow maximum time for recovery and fill in during summer and again during fall. If necessary, however, treatments could be started at any time during the summer when weather is conducive. To achieve acceptable levels of *Poa annua* control, endothall will have to be applied more than once since single treatments rarely kill more than 60-80% of the *Poa annua* present. After two treatments in one year any treatments the following year could probably be held off until late summer or early fall. Once *Poa annua* is reduced to about 10%, pre-emergence herbicide applications are optional.

II. Colonial bentgrass lawn turf (2-3 cm mowing ht)

(Example for two treatments in one year)

1. MID APRIL - Nitrogen - 40-50 kg/ha (3/4-1 lb N/1000)
   LATE APRIL - Bensulide - 10 kg ai/ha (8-10 lb ai/A)
   EARLY MAY - Endothall - 2.0 kg ai/ha + X-77 (1.75 lb ai/A + X-77)
   1-2 wks later - Nitrogen - 40-50 kg/ha (3/4-1 lb N/1000)

2. (Optional depending on success of first treatment)

   MID AUGUST - Nitrogen - 40-50 kg/ha (3/4-1 lb N/1000)
   LATE AUGUST - Bensulide (opt) 8 kg ai/ha (6-8 lb ai/A)
   MID SEPTEMBER - Endothall - 2.0 kg ai/ha + X-77 (1.75 lb ai/A + X-77)
   1-2 wks later - Nitrogen - 40-50 kg/ha (3/4-1 lb N/1000)

The approach after the first year of treatment would be similar to that for Kentucky bluegrass or perennial ryegrass. Eventually applications could be made on an as needed basis.

III. Colonial or Creeping Bentgrass putting turf (4-6 mm mowing ht)

1. MID APRIL - NITROGEN - 40-50 kg/ha (3/4-1 lb N/1000)
   LATE APRIL - Bensulide - 10 kg ai/ha (8-10 lb ai/A)

EARLY MAY - Endothall - 1.25 kg ai/ha + X-77 (1 lb ai/A + X-77)
1-2 wks later - Nitrogen - 40-60 kg/ha (3/4-1 lb N/1000)

If necessary the above treatment sequence could be applied in the fall so that the endothall treatment would be applied before mid-September.

On putting turf I hesitate to make more than one application per year to avoid excess stress. Because the lower endothall rates used result in poorer *Poa annua* control, annual applications would probably be required for 2 to 3 years to achieve desirable control. This, of course, depends on the individual site involved.

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TURFGRASS RESEARCH REPORT[1]

Alvin G. Law[2]

The turfgrass variety trials at Stateline, Idaho, established in 1975 in cooperation with Jacklin Seed Company, were observed for color, disease resistance, and winter survival. We are growing 25 ryegrass varieties, including all of the available fine-leaved 'turf' types as well as the older coarse-leaved varieties. Of considerable interest is the fact that all varieties have survived two relatively normal winters with no evidence of any winter damage. Some of the same varieties in seed production fields in the same general area have winter-killed consistently. I have no explanation of the evident winter hardiness of close clipped turf compared to the lack of winter survival when the same varieties are allowed to produce seed. The fine-leaved 'turf' types consistently had a dark green color compared to the light green color characteristic of the wide-leaved coarse types and thus would blend better with Kentucky bluegrass, the dominant general purpose turfgrass in the Inland Empire. Moreover, density readings were higher for the 'turf' type ryegrasses.

The 31 Kentucky bluegrass varieties in this trial showed expected differences in density readings with the tall growing types such as Delta and Park having much less dense turf than the low growing varieties typified by Nugget, Glade, Bonnieblue or Victa. There were some differences in *Helminthosporium* tolerance with Delta, Park, Plush, and

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Prato having more damage from this disease. In contrast, Warren turf selections A-20 and A-34, and Nugget, Majestic, and Aquilla were only slightly damaged. Mixtures of bluegrass varieties with creeping red fescue greatly reduced the amount of *Helminthosporium* damage. There was no discernable difference in turf quality or density in these mixtures clipped at one inch in height.

A second research effort has been with annual bluegrass. We used endothall and bensulide in various combinations on Kentucky bluegrass turf that had a 25 to 50 percent annual bluegrass contamination on the A.S.S.C.W. golf course fairway No. 6. The treatments were applied in late June 1978. Bensulide was applied at 8, 12, and 16 lb a.i. per acre across plots that were later treated with endothall at 2, 2.5, and 3 lb per acre. Both treatments were applied as water solutions and a sticker-spreader was included as a treatment with the endothall applications. Plots were rated for control of established annual bluegrass or for control of reinvasion by annual bluegrass seedlings using a 1 to 9 system.

First year data are shown in Table 1, Reinvasion of the treated areas by *Poa annua*. Here the effect of bensulide on controlling re-establishment of the weed becomes clear. There was essentially no re-establishment of annual bluegrass on any of the bensulide treatments, average readings of 1.8 on a scale where 1 = no seedlings at all. Compare this with the average readings of 5.05 on all the 0 bensulide plots. As was expected, endothall had no effect on the reinvasion by annual bluegrass seedlings.

Table 2 shows the first year effect of endothall on established annual bluegrass. We would emphasize that first year data must be considered as preliminary and the plots must be read again next year. There was a highly significant reduction in annual bluegrass for the 2.5 and 3.0 lb of endothall compared to the check. There were no differences in the amount of established annual bluegrass left in the plots on the bensulide treatments. We think there is sufficient perennial bluegrass (Merion variety) present in the plots so that by next spring the recovery will give us a good cover of grass. Reseeding obviously cannot be a help because of the bensulide treatments, so it is important to start this control program before the perennial bluegrass is damaged beyond recovery.

TABLE 1. Annual bluegrass seedling reinvasion 71 days after treatment.[a]

Endothall lb/acre	Bensulide (lb/acre) 8	12	16	0	Average
2	2.3	2.0	2.0	5.8	3.03
2 + X77	1.5	2.3	2.0	6.8	3.15
2.5	1.8	2.5	1.5	6.5	3.07
2.5 + X77	1.3	1.5	1.8	5.8	2.72
3	1.5	2.3	1.5	4.3	2.40
none	1.2	1.2	1.3	5.3	2.25
average	1.78	1.96	1.68	5.75	

[a] 1 = 0 seedlings, 9 = many seedlings

TABLE 2. Control of annual bluegrass 71 days after treatment.[a]

Endothall (lb/acre)	Bensulide (lb/acre) 8	12	16	0	Average
2	4.8	4.3	4.0	4.5	4.40
2 + X77	5.3	3.8	3.5	4.8	4.35
2.5	3.8	4.0	4.8	3.0	3.90
2.5 + X77	4.5	4.3	4.8	6.8	5.10
3	3.3	4.8	3.3	3.5	3.75
none	8.3	8.5	8.3	8.5	8.35
Average	5.0	4.95	4.78	5.18	

[a] 1 = good control, 9 = no control

TURFGRASS DISEASE RESEARCH REPORT[1]

Gary A. Chastagner, Roy L. Goss, Worth Vassey
and John M. Roberts[2]

RESIDUAL ACTIVITY OF FUNGICIDES AGAINST RED THREAD

A fungicide test plot was established on putting green turf containing a mixture of 'Highland' bentgrass and *Poa annua* at the Western Washington Research and Extension Center's Farm 5, Puyallup, WA. Applications were started on September 26, 1977 and repeated at 2 or 3-week intervals until May 10, 1978. Fungicides were applied in 10 gal of water per 1000 ft^2 to six replications of 25 ft^2 each. Rates and formulations of fungicides used are shown in Table 1. The wettable powder formulation of CGA 64251 was used initially with the first application using the emulsifiable concentrate formulation being applied on March 10, 1978.

This test was initiated to test the effectiveness of these fungicides in controlling *Fusarium* patch. Although no *Fusarium* patch developed within the test plots through May, we did obtain information about the residual activity of these fungicides against red thread.

1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

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Red thread developed throughout the test plot in June. Table 1 shows that Rhodia's RP 26019 and Ciba-Geigy's CGA 64251 effectively prevented the development of red thread 40 days after the last application of these fungicides. The highest rate of CGA 64251 applied every 2 weeks caused a reduction in turf density and resulted in a dark blue-green colored turf.

Current tests are evaluating the extent of residual activity of selected fungicides against *Fusarium* patch and red thread. We have also initiated a test to determine if these fungicides have any effect on the rate of nitrification following applications of urea.

Dark Green Depressed Circular Spots: A disease of unknown cause appeared on the bentgrass varieties under advanced management at Western Washington Research and Extension Center's Farm 5 during June. The symptoms of the disease are:

1. Dark green circular spots up to 10 inches in diameter. These spots often coalesce.

2. Thatch is decomposed under the spots which results in the center of the spot being depressed.

3. The turf is easily lifted from the surface beneath the spot.

This is the fifth year that the bentgrass varieties have been under advanced management. Each variety is replicated three times and consist of 100 ft^2 replication. Each variety receives nitrogen at 5 and 10 lb per 1000 ft^2. Turf receiving both levels of N also receives alternating applications of Fore and PMAS throughout the year.

Table 2 shows that the percentage of turf covered by these spots varies between bentgrass varieties, but is generally less prevalent on turf which received applications of fungicides and/or high levels of nitrogen.

The percentage of turf area with this disease has increased throughout the summer months. Because of the depressed nature of the spots, the turf texture within the spots is rough.

Isolation of Causal Agent: Results from initial attempts to isolate the causal agent were inconsistent. By placing sections of turf removed from the margin of the spots into moist chambers, white spherical masses of hyphal tissues developed in 2-5 days. The hyphal tissues from these structures were isolated on a variety of media which contained antibiotics to surpress bacterial development. The fungus consistently isolated in this manner is a basidiomycete as evident by the presence of clamp connections.

The isolated fungus grows optimally at temperatures between 68-86^{o}F on potato-dextrose agar. However, even at these temperatures it has only grown .3-.4 inch after 8 days.

Inoculum is being increased on wheat seeds so that pathogenicity studies and other tests can be performed.

TABLE 1. Evaluation of fungicides for control of red thread (Corticium fuciforme) on putting turf.

Treatment	Rate/1000 ft^2	Interval (wks) between applications	Percent area diseased[a] 6/15/78	Percent area diseased[a] 6/19/78	Color[b]	Density[b]
RP 26019 50W	8 oz	3	0.0 a	0.0 a	7.8	8.8
CGA 64251 WP or EC	20 g a.i.	2	0.0 a	0.0 a	8.2	5.2
CGA 64251 WP or EC	20 g a.i.	3	1.8 a	1.0 ab	8.6	8.0
CGA 64251 WP or EC	10 g a.i.	2	0.8 a	1.2 ab	7.6	8.0
CGA 64251 WP or EC	5 g a.i.	2	2.6 a	7.8 ab	7.4	8.6
PMAS	0.75 oz	3	11.0 ab	9.6 ab	6.8	8.8
CGA 64251 WP or EC	10 g a.i.	3	9.6 a	17.8 abc	7.4	8.2
Benlate 50W	2 oz	3	16.6 abc	20.8 bc	7.2	8.8
Fore 80W/Benlate 50W (alt.)	8/2 oz	3	33.0 cd	30.0 c	7.4	8.8
CGA 64251 WP or EC	5 g a.i.	3	27.4 bcd	33.0 c	7.2	8.4
Fore 80W	8 oz	3	44.0 d	37.0 c	7.2	7.8
Check	-	-	33.0 cd	31.0 c	6.6	8.0

[a] Numbers in vertical columns followed by the same letter are not significantly different, P = 0.01, Duncan's multiple range test.

[b] Ratings taken on 4/24/78. Ratings based on 1 = yellow-brown/bare plot to 9 = dark green/full stand for color and density respectively.

TABLE 2. Effect of bentgrass variety, fungicide application and nitrogen levels on the percentage of turf area with dark green depressed circular spots.[a]

Variety	Percent area showing symptoms			
	Without fungicide		With fungicide	
	High N	Low N	High N	Low N
SEEDED:				
Bardot	3.0	4.8	2.8	4.0
Boral	2.0	4.8	0.0	2.3
Highland	0.0	15.5	0.3	4.5
Kingstown	1.8	4.5	8.0	10.3
Novobent	0.5	4.8	1.3	5.8
Penncross	5.3	12.5	0.3	6.0
Prominent	5.3	11.5	2.5	3.8
Emerald	3.5	7.5	3.8	3.8
Tracenta	2.0	8.3	5.5	6.0
A-75	4.3	12.3	3.0	5.3
Rusta	0.0	0.5	0.0	2.5
Aggrettina	0.0	0.3	0.0	0.3
Tendenz	0.0	0.5	0.0	5.0
PSU-PBCB	0.0	0.5	0.5	3.0
STOLONIZED:				
Arlington	3.0	11.8	0.3	4.8
Nimisila	22.5	31.3	6.8	5.5
Northland	17.3	36.3	9.3	14.5
Waukanda	16.0	12.8	4.3	18.3
Yale	0.8	13.0	0.8	19.3
Keen's 36	1.5	4.3	0.0	2.0
Arrowwood	3.5	10.5	1.5	7.3
MCC-3	0.5	3.0	0.3	2.3
UCR-30	3.8	5.5	4.3	5.0
Penn #5	5.0	5.3	0.8	4.0
Smith 721	1.3	8.0	0.0	2.8
Smith 732	1.3	4.5	0.3	1.3
Smith 736	0.8	10.0	1.0	3.5
Hayden Lake	2.0	6.3	0.0	2.0

a Data taken on September 11, 1978

GROWTH REGULATORS ON ESTABLISHED TURF[1]

John M. Roberts and Roy L. Goss[2]

The desirability of maintaining a healthy low growing turfgrass cover without frequent mowing is something that most turf managers would appreciate. There are basically two areas of research attempting to accomplish this low growth either by (1) breeding of low growing turfgrasses, or (2) using growth regulators.

PROCEDURE

Three growth regulators, Maag RO 7-6145/001 (6,9,12 lb/A), Embark (0.25,0.50,0.75 lb/A) and Sustar (1 gal/A) were applied on July 24, 1978 on an established 'Highland' bentgrass turf at the Puyallup Research Station. The plots were mowed at 2.0 cm four days prior to the application of the growth regulator and received irrigations thereafter to maintain healthy plant cover. Color and plant height readings were recorded 10 and 30 days following application (Table 1).

RESULTS AND DISCUSSION

All the growth regulators reduced the growth of the bentgrass (up to 45 percent) as compared to the control. In general as the reduction in plant growth increased, the color ratings decreased. For example, the product, Embark, at all three rates resulted in the greatest reduction in bentgrass growth as compared to Sustar or the Maag RO 7-6145/001 products; however, Embark also obtained the poorest color ratings.

1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

2/ Turfgrass Research Associate and Agronomist/Extension Agronomist, Western Washington Research and Extension Center, WSU, Puyallup, WA.

TABLE 1. The effects of three growth regulators on color and plant height on established bentgrass turf.

		Days after treatment			
		14		30	
Product	Rate lb/A	Color	Plant ht(cm)	Color	Plant ht(cm)
Maag RO 7-6145/001	6.0	8.7	3.3	8.7	7.8
	9.0	7.7	3.4	8.7	7.7
	12.0	7.7	2.8	8.0	5.8
Embark	0.25	6.0	2.2	7.0	7.0
	0.50	6.3	2.1	6.0	6.2
	0.75	6.7	2.2	6.0	5.8
Sustar	1 gal	8.8	3.3	9.0	7.7
Control		9.0	3.8	9.0	9.7

Color rating: 1 = yellow; 9 = green

A NEW PLANT GROWTH REGULATOR WITH POTENTIAL POST EMERGENCE *POA ANNUA* CONTROL?[1]

John M. Roberts and Roy L. Goss[2]

A new plant growth regulator, MBR 18337, at rates of 0.375 to 0.75 lb ai/A has been reported to show plant growth retardation and seedhead suppression on Kentucky bluegrass, tall fescue and common bermudagrass. *Poa annua* retardation has also been reported in established bluegrass sod in Northern California. Certainly any product having the capacity to suppress or eliminate *Poa annua* in established turf is of interest for future research testing.

MBR 18337 was applied at rates of 0.10, 0.40 and 0.70 lb ai/A on various established bluegrass varieties on July 12, 1978, at the Puyallup Research Station. The test area received no additional irrigation and the bluegrass sod was under a moisture stress throughout the majority of the testing period. The *Poa annua* (Table 1) was also showing moisture stress symptoms and in general had a weak, off-color appearance. The MBR 18337, especially at 0.70 lb ai/A caused a further weakening of the *Poa annua* without severely impairing the bluegrass color and appearance. However, at no time in the testing period did the MBR 18337 "kill" or severely retard the already weakened *Poa annua*.

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After 40 days following application bluegrass height reductions of 1 to 2 inches were recorded as compared to the control and only minor reductions in color ratings were observed at all the application rates.

MBR 18337 was applied at rates of 0.10, 0.40 and 0.70 lb ai/A to a healthy established 'Highland' bentgrass sod mowed at 0.75 inch on July 12, 1978 (Table 2). This area received irrigation as needed to maintain a vigorous turf.

Two days after application one-half of the plots were mowed (Table 2), as reports indicated that this practice enhanced the MBR 18337 activity on retarding plant growth. In this test there was little to no advantage of mowing following the herbicide application as indicated by the color and plant height data in Table 2.

In general only minor reductions in the color ratings were noticed and the bentgrass growth was reduced 1 to 2 inches as compared to the control 40 days following the herbicide application. The MBR 18337 had no effect on the healthy *Poa annua* within the plots.

TABLE 1. The effects of MBR 18337 on a mature bluegrass turf.

		Days following application					
		14 days			40 days		
Treatment	Rate lb/A	Color	Plant height	Poa annua suppression	Color	Plant height	Poa annua suppression
MBR 18337	0.1	9.0	5.2	2.2	8.7	12.7	3.5
MBR 18337	0.4	9.0	4.9	3.0	8.8	10.2	3.8
MBR 18337	0.7	9.0	4.5	4.5	8.5	10.8	5.0
Control		9.0	5.3	2.0	9.0	15.0	3.0

Color ratings: 1 = yellow, 9 = green.

Poa annua suppression: 1 = none, 9 = complete kill

TABLE 2. The effects of MBR 18337 on a mature bentgrass turf.

		Days after application							
		14 days				40 days			
	Rate	Color		Plant height		Color		Plant height	
Treatment	lb/A	Mow	No mow	Mow	No mow	Mow	No mow	Mow	No mow
MBR 18337	0.1	7.3	8.0	1.3	1.9	9.0	9.0	7.0	7.5
MBR 18337	0.4	7.0	7.0	1.1	1.5	8.3	8.3	6.2	5.3
MBR 18337	0.7	6.3	7.0	1.5	1.6	7.5	7.4	6.5	7.0
Control		9.0	9.0	2.5	3.0	9.0	9.0	10.0	10.0

Color ratings: 1 = yellow, 9 = green

OVERSEEDING METHODS FOLLOWING ENDOTHALL/ BENSULIDE TREATMENTS ON BENTGRASS TURF[1]

John M. Roberts and Roy L. Goss[2]

The promising effects of post-emergence applications of endothall on the destruction of *Poa annua* in established turf in western Washington prompted the idea of researching various re-establishment methods in order to convert the endothall treated areas back into an excellent playing surface.

PROCEDURE

On June 16, 1978 one-half of the plots were treated with endothall at 1 lb/A on an established 'Highland' bentgrass putting green. The other half of the plots received the same endothall treatment yet bensulide was applied at 15 lb/A one week prior to the endothall application. On June 26, 1978 (10 days after the endothall treatments) various overseeding techniques including a) spike-airing, b) aerifying, c) drop seeding, and d) Rogers seeder were used to prepare and deposit 'Highland' bentgrass seed which was applied at 2 lb/1000 ft^2. Two mowing heights, 3/16 and 5/16, were then maintained. One week following the endothall application 1 lb/ 1000 ft^2 of urea was applied to all treatments. A light sand topdressing immediately followed the overseeding and light, frequent surface irrigations were applied to maintain a moist seedbed for germination and establishment.

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RESULTS AND DISCUSSION

All of the endothall alone or in combination with the bensulide treatments were effective in destruction of *Poa annua* without any severe damage occurring to the bentgrass. The initial color ratings on the bentgrass were reduced about 2 points on a 1 to 9 scale. However, notice that 25 days following the endothall applications the color ratings were excellent. On the average the percent of *Poa annua* was reduced from approximately 50 percent to less than 10 percent in all treatments.

In general when bensulide accompanied the endothall treatments the rate of bentgrass germination and hence recovery was reduced compared to the endothall alone plots. It should be mentioned, however, that new bentgrass seedlings were observed following the bensulide treatments in both the aerifier holes and in the grooves created by the Rogers seeder.

The best method of overseeding following the endothall and/or bensulide treatments was obtained by the use of the Rogers seeder. Increasing the cutting height from 3/16 to 5/16 inch also resulted in improved bentgrass recovery.

It was promising to see that within 20 to 30 days after an endothall treatment that a putting green having 50 percent *Poa annua* could be converted into a beautiful playing putting green with 90-95 percent bentgrass.

TABLE 1. Overseeding methods following endothall/bensulide on an established bentgrass putting green.

Treatment	3 days			25 days			
	% Poa annua	% Bent	Bent Color	% Poa annua	% Bent	Color	Density
Endo., Aerify, Drop, 5/16"	45	55	6.0	5	95	9.0	8.4
Endo. + Ben., Aerify, Drop, 5/16"	55	45	6.0	5	95	9.0	7.5
Endo., Aerify, Rogers, 5/16"	55	45	6.0	7	95	9.0	9.0
Endo. + Ben., Aerify, Rogers, 5/16"	50	50	6.0	5	95	9.0	8.1
Control	55	45	8.0	55	45	9.0	9.0

Color rating: 1 = yellow; 9 = green

Density rating: 1 = least; 9 = most

NUTRIENT LEACHING IN SAND PUTTING GREENS[1]

John M. Roberts and Roy L. Goss[2]

Getting the maximum efficiency from the fertilizers applied is something every turf manager would desire. However leaching of soluble nutrients such as nitrates and sulfates in sand rootzones under wet climates will certainly reduce this efficiency. Beside the agronomic benefits, both the economical and environmental pressure make efficient fertilization practices of turf areas necessary.

The objective of this study was to monitor the degree of leaching in a putting green constructed of a medium textured sand. Twenty-four field lysimeters (1 m x 3 m) were constructed in April 1978 in Puyallup, WA in order to record the degree of leachate from the sand rootzones. An established sodded 'Highland' bentgrass has been maintained at 0.25 in. On September 1, 1978 the following treatments and rates of application were applied:

Treatment	Rate/Days
Ammonium sulfate	2#/60
Ammonium sulfate	0.5#/15
SCU (fine)	2#/60
SCU (fine)	0.5#/15
Urea + Elemental S	2#/60
Urea + Elemental S	0.5#/15

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Two of the questions we hope to answer are: 1) is it (how much) more efficient to fertilize on a light/frequent or heavier and less frequent schedule, and 2) what is the relationship between applying sulfur in the sulfate or the elemental form on plant uptake and leaching patterns.

In addition to the nitrogen (12#/1000 ft^2) and sulfur applications, phosphorus (3#/1000 ft^2) and potassium (6#/1000 ft^2) utilization will also be determined.

BENTGRASS ADVANCED MANAGEMENT TRIALS - APRIL 1978[1]

Roy L. Goss and John M. Roberts[2]

From an original test of 156 varieties, selections and cultivars of *tenuis*, *palustris* and *canina* bentgrass types, 29 have been under intensive observations and tests for a period of 5 years ending September 1978. Nitrogen levels have been maintained at 5 and 10 lb per 1000 ft^2 representing high and low N and fungicides have been applied to one-half of each plot whereas the other half has received no fungicides, and phosphorus and potassium have been applied as needed to maintain adequate fertility levels. The plots have been mowed regularly at 1/4 inch and have been aerified, topdressed and otherwise managed as usually is required for good putting green maintenance.

The objectives of this study for the past five years has been to determine the response of these better selections which showed promising resistance to *Fusarium* patch disease to normal maintenance and management programs over an extended period of time. Many of us have learned to our sorrow that short-termed tests are frequently disastrous from the standpoint of making longterm recommendations; therefore, we feel that longer tests are needed, particularly when dealing with varieties in case there is a genetic breakdown or a loss of resistance. Data are recorded at regular intervals; however, only data

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from one month are shown for the purpose of this report as a basis for comparing the various varieties. The table shown below summarizes the response of these varieties to high and low nitrogen and the effect of nitrogen on *Poa annua* development.

HIGH NITROGEN

All vegetative varieties in general responded better to high nitrogen than the seeded types. Since the vegetative varieties are generally more vigorous and produce a great deal more organic material, they can probably utilize a little higher nitrogen level than the seeded varieties. Among the seeded varieties showing the best response to high nitrogen level would be Penncross and A-75 while all other varieties ranked about equal from nitrogen response. Nimasila, Northland, Waukanda, Yale, Penn #5, Smith 721, all ranked ahead of the others with response to color from the vegetative varieties.

It is interesting to note that certain varieties whether seeded or vegetatively propagated have the ability to exercise good quality even at reduced nitrogen levels. Kingstown velvet bentgrass showed the same response to low nitrogen as high nitrogen and there was little difference between the two nitrogen levels with Penncross. Rusta, Dudeck Selection and PBCB showed equal response to low as well as high at this particular rating date. Among the vegetative varieties, only Northland, Waukanda, Yale and UCR 30 showed equal response to both high and low nitrogen.

Some very significant differences appear among these varieties with regard to nitrogen level and *Poa annua*. It is very difficult to evaluate *Poa annua* without looking at the evaluations for an entire year. But looking at the levels at this particular data, there is almost a straight line consistency of greater amounts of *Poa annua* at the low nitrogen levels when compared to the high nitrogen. Exceptions to this of any significance was Dudeck's Selection where there was a reversal - less *Poa* *annua* at the lower nitrogen level. It was interesting to note that Penncross showed significantly more *Poa annua* at the low N level than at the high N level and is a reflection on the ability of the grass to utilize more nitrogen for greater density and possibly compete better with *Poa annua*. Only a few varieties were outstanding from the standpoint of *Poa annua* resistance at both nitrogen levels, and these include: Aggretina, PBCB, Nimisilla, Waukanda and Yale.

It still appears that vigor and density play an important role in resistance to *Poa annua*.

Evaluations for *Poa annua* at a later date in the summer reveal significantly lower amounts of *Poa annua* than reported at this particular month. All 29 of these bentgrasses received an application of endothall in the summer of 1977 and received two applications of endothall in the summer of 1978. The reason for two applications in 1978 was to determine the ability of these grasses to withstand repeated applications of a *Poa annua* post-emergent treatment. *Poa annua* percentages sharply decreased following two applications during the summer of 1978 and with minimal loss of color. The color depression on most varieties was approximately 2 points out of a possible 10 and this color depression persisted for less than 2 weeks. In other words, the loss of color was not a significant factor and the turfgrasses recovered very rapidly while high amounts of *Poa annua* were killed.

These tests lead us to believe that nitrogen levels of approximately 8 to 10 lb are very satisfactory for vigorous varieties of turfgrasses whereas smaller amounts can probably be effective on certain other bentgrasses. We can also conclude at this point from these studies that all of the varieties under test will withstand applications of endothall for *Poa annua* post-emergent control with the possible exception of Kingstown velvet bentgrass.

TABLE 1. Bentgrass advanced management trials - April, 1978

	Color		Poa annua %	
Variety	High N	Low N	High N	Low N
Bardot (S)	8.0	7.0	21	34
Boral (S)	8.0	7.0	40	53
Highland (S)	7.0	6.0	31	41
Kingstown (S)	8.0	8.0	24	20
Novobent (S)	7.0	7.0	30	30
Penncross (S)	9.0	8.0	4	24
Prominent (S)	8.0	7.0	13	34
Emerald (S)	8.0	7.0	13	29
Tracenta (S)	8.0	7.0	28	39
A-75 (S)	9.0	8.0	11	26
Rusta (S)	8.0	8.0	19	18
Agrettina (S)	8.0	6.0	4	3
Tendenz (S)	8.0	7.0	25	24
Dudeck (S)	8.0	8.0	19	9
PBCB (S)	8.0	8.0	2	2
Arlington (V)	8.0	8.0	30	34
Nimisila (V)	9.0	8.0	10	10
Northland (V)	9.0	9.0	6	10
Waukanda (V)	9.0	9.0	4	8
Yale (V)	9.0	9.0	3	8
Keen's 36 (V)	8.0	7.0	5	10
Arrowood (V)	8.0	7.0	27	33
MCC-3 (V)	8.0	7.0	19	23
UCR-30 (V)	8.0	8.0	35	40
Penn 5 (V)	9.0	8.0	14	24
Smith 721 (V)	9.0	8.0	19	36
Smith 732 (V)	8.0	7.0	35	43
Smith 736 (V)	8.0	7.0	40	43
Hayden Lake (V)	9.0	8.0	30	40

OTHER RESEARCH CURRENTLY UNDERWAY[1]

Roy L. Goss[2]

POA ANNUA POPULATION REVERSAL STUDIES

Plots that were treated for several years with ammonium sulfate, urea, and Milorganite were observed to have differential levels of *Poa annua* some three years ago. Plots continuously treated with ammonium sulfate had an average of 15 to 20% *Poa annua* whereas those treated with urea and Milorganite had populations up to 80% or higher. Milorganite plots were selected and subdivided into 4 equal 5' x 5' plots and received sulfur applications at the rate of 0, 50, 100 and 150 lb per acre. After three years of continuous sulfur applications differences are exhibiting themselves in the percentage of *Poa annua*. Plots without sulfur still show approximately 85% *Poa annua*, plots with 50 lb sulfur show approximately 60% *Poa annua*, plots with 100 lb S show approximately 50% *Poa annua*, and plots with 150 lb S show approximately 35% *Poa annua*. This represents a significant reduction in *Poa annua* populations on soils of fine sandy loam or heavier.

1978 appears to be an excellent year for *Ophiobolus* patch disease and ammonium sulfate plots and the Milorganite plots receiving sulfur are the only plots with an absence of *Ophiobolus* patch disease.

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ADVANCED BENTGRASS TRIALS AT LIBERTY LAKE GOLF COURSE, SPOKANE, WA

A very large screening trial of bentgrass varieties was conducted at Hangman Valley Golf Course for several years to determine the agronomic characteristics of these various bentgrasses to climatic conditions in the eastern Washington area. They were observed not only for color, texture, density and general quality, but also for resistance to *Typhula* snow mold. Out of all the varieties under test, only Yale, MCC-3, Northland, Ligrette, Norfel, Tracenta, Boral and Penncross showed any significant resistance to *Typhula* snow mold or showed significant recovery following snowmold attack. Although the fungus disease attacking these grasses may be present, the ability of the grass to recover following a disease attack relates significantly to its survival. In general, none of the varieties were resistant to snow mold although these under test presently were those that recovered more rapidly or had the least amount of disease affecting them over the years they were under test.

Bud Ashworth, Superintendent at Liberty Lake Golf Course, agreed to establish a green using all of these varieties. Yale, MCC-3 and Northland were all vegetatively propagated at Puyallup and stolons were transported to the site. Ligrette, Norfel, Tracenta, Boral and Penncross are seeded varieties. Carmen, a new bentgrass variety to most of us, was also included in the test on part of the green. These grasses were planted in strips completely across the green and will be observed for their agronomic characteristics in addition to their resistance to snow mold under regular golf course playing and management conditions. The grasses were established in August, 1978 and will probably have some limited play in the fall of 1978 and should be in excellent condition by 1979. More information will be reported on the response of these grasses in 1979.

WESTERN REGIONAL VARIETY TEST

A very large turfgrass variety trial has been established at the Western Washington Research and Extension Center at Puyallup as part of the Western Regional Trial. This will be a uniform trial and other participants include Colorado State University, University of California at Riverside, University of Idaho, Moscow, and possibly University of Nebraska. It is anticipated that another set of plots will be established in the Spokane area to compliment the Western Regional Trial to include a northern site for the project test.

At the present time we have included 55 bluegrass varieties, approximately 55 fine leaved fescues and 33 turftype perennial ryegrasses. Many of these varieties are already on the market and a number of them are in the process of being developed for market.

The objectives of this study are to uniformly evaluate the varieties for the Western United States to determine the ones best suited over wide areas of adaptation. They will be evaluated for color, texture, disease resistance, general quality, and in some instances tolerance to heat and salinity. The plots will receive uniform fertility and mowing practices and will be evaluated periodically for their characteristics.

TOLERANCE OF BLUEGRASSES, RYEGRASSES, AND FESCUES TO SULFUR APPLICATIONS[1]

Roy L. Goss[2]

Plots of bluegrass, turftype perennial ryegrass and fine leaved fescues were established in the summer of 1977 to determine their response to applications of sulfur. Considerable information is available regarding the response of bentgrasses to sulfur applications but little is known how the other turfgrass genera respond to sulfur applications over an extended period. This project is partially supported by the U.S. Golf Association Green Section to obtain this information.

The fertility treatments were initiated in the early spring of 1978. Evaluations of *Poa annua* were made at the time the treatments were initiated and it was found that the bluegrasses were almost completely overshadowed by *Poa annua* establishment at the same time the bluegrass established. The turf-type ryegrasses showed the smallest percentage of *Poa annua* establishment, followed by the fescues. The fine leaved fescues and ryegrasses were not dominated by *Poa annua* whereas the bluegrass was. The bluegrass plots were subdivided and one-half of each plot was treated with endothall for a post-emergent control of *Poa annua* as the treatments were being applied.

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Sulfur levels up to 150 lb per acre will be conducted on these three turfgrass genera for a period of at least three years to determine their response. It is too early in the program treatment period to adequately assess any effects of nutritional treatment at this time. More on this will be reported at the 1979 turfgrass conference.

SLOW RELEASE NITROGEN TESTS[1]

Roy L. Goss and John M. Roberts[2]

Tests were initiated in May of 1978 to determine the effect of several slow release nitrogen materials on bentgrass and bluegrass quality. Bentgrasses are maintained as putting green turf and bluegrasses or mixed stands are maintained as lawn or fairway-type turf.

Nitrogen rates for lawn-type turf are 4 and 6 lb per 1000 ft^2 applied in November, February, June and September. The sources of nitrogen are IBDU (fine and coarse), sulfur-coated urea from Canadian Industries, Ltd. in regular size and fine, Nitroform, Tennessee Valley Authority sulfur-coated urea, and ammonium sulfate. Also included in this test is IBDU and ammonium sulfate 50:50.

The putting green tests include IBDU (fine), Nitroform (powder blue), ammonium sulfate, Lilly's putting green mix, and Scott's putting green fertilizer. All slow release materials are applied in six applications (November, March, May, June, August and September, and all of the soluble materials are applied in November, March, April, May, June, July, August and September.)

A putting green and lawn test is being conducted at the Western Washington Research and Extension Center at Puyallup and a duplicate set of plots are being conducted at the Hangman Valley

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Golf Course in Spokane. The objectives of this test are to determine any differences that may exist in response between eastern Washington and western Washington in comparing these slow release and soluble nitrogen materials.

Data evaluations for all of these tests will include color, density, quality, disease and clipping rates to determine nitrogen recovery.

1978 SUMMARY

Although the tests have been conducted for only a short period of time in relation to the total time planned, all materials are performing very satisfactorily. IBDU, a relative newcomer to the Pacific Northwest, is performing very satisfactorily at this point and appears to be a very acceptable source of nitrogen for any use. Sulfur-coated urea was purposely left out of the putting green trial since particle size does not lend itself to treatments where the grass is being cut as short as putting greens. The ratio of N, P, K from all of these treatments is being maintained at 3-0.5-2, three parts nitrogen, 1/2 part phosphorus, and two parts potassium, based upon earlier nutritional findings.

SAND GREEN FERTILIZER TESTS - PUYALLUP[1]

Roy L. Goss[2]

Fertilizer tests have been conducted on a green constructed from sand with 75% sand, 25% sawdust since May 1975. The objectives of this test were to determine the effects of various levels of sulfur when nitrogen sources were derived from urea, ammonium sulfate and Milorganite. The question has frequently arisen - how much sulfur can I apply on a sand green when I am using other sources of sulfur such as ammonium sulfate. This question could not be answered until tests were conducted. We feel confident at this time that we have significant information to offer with regard to this management program.

The following table presents data from only one month of evaluation through the entire year. Data for June 20, 1978 are included as a comparison on color from the April 24, 1978 evaluations. Footnotes at the bottom of the table will indicate the abbreviations shown in the table. The reasons for splitting sulfur applications between spring only and sulfur uniformly applied throughout the year relates to previous tests where sulfur was applied only in the spring. Since it is common knowledge that sands are more heavily leached than normal soils such as fine sandy loam, it was imperative to have this information available.

1/ To be presented at the 32nd Annual Northwest Turfgrass Conference, Holiday Inn, Richland, WA, September 25-28, 1978.

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

SUMMARY AND EXPLANATIONS

This project is designed to run for a minimum of 5 years, therefore positive conclusions cannot be drawn at this time; hence we are indicating a summary of what has been observed at this time and some explanations for the data.

By April of each year plots have recovered from partial winter dormancy and are generally in high quality condition. It can be observed in the table that nearly all treatments had the maximum rating of 9.0 which is our maximum color rating except for all Milorganite plots which showed essentially no response to nitrogen where all nitrogen was derived from Milorganite. A rating of 5.0 would generally be unacceptable quality as far as color and density are concerned. Density ratings are not shown here; however, all Milorganite plots were thin as well as off-color.

When the color is compared between April 24 and June 20, 1978, you will note a very significant color change with the Milorganite treatments. We were baffled for about one year as to why Emerald creeping bentgrass would not respond to 10 lb of nitrogen derived from Milorganite while all other plots showed normal response to nitrogen applications. In May of 1978 a complete application of micronutrients was made to all plots including Milorganite and it can be observed that by June 20, 1978, the Milorganite plots showed a complete reversal trend in color and were as good as the best and better than a number of the treatments. Although it is normally expected that Milorganite will supply a broad spectrum of micronutrients, there may be other factors concerned with the use of solid waste materials that may affect the release of certain micronutrients, particularly manganese. Tissue was collected from the Milorganite plots for analysis and data have not yet been obtained. We are only assuming that this was possibly a manganese response, but until tissue testing has been completed, this is purely conjecture at this point. Nonetheless, the Milorganite plots have returned to normal color and density which we assume was due to the micronutrient application. In most normal turfgrass maintenance programs, it is rare that anyone will apply as much as 10 lb of nitrogen from Milorganite in a single season. Therefore, it would appear that this response of poor color would not be observed under normal programs where many of you are applying Milorganite 2 to 4 times annually.

In comparing the various treatments for percentage of *Poa annua*, very significant differences can be observed with regard to treatment. Two lb of elemental phosphorus (approximately 4.5 lb P_2O_5 phosphorus per 1000 ft^2 per year) significantly increased *Poa annua* as compared to the 0.5 lb elemental P (1.1 lb P_2O_5). This trend is holding true from previous investigations on heavier normal soils and is following earlier predictions. The lowest mean *Poa annua* population is observed in the urea applications with 0.5 lb P where all sulfur is applied in spring only. This may be related to a high level of sulfur in the immediate surface and a low level of P influencing the development of *Poa annua* during the major part of the season.

Unfortunately, Milorganite shows a mean of approximately 50% *Poa annua* regardless of sulfur treatment. We had hoped that the higher levels of S would suppress *Poa annua* development under sand conditions, but at this time it is not happening. This may be related in part to poor density of the bentgrass due to micronutrient deficiency and allowing *Poa annua* to become established although *Poa annua* was in poor vigor. Had the bentgrass been in a high state of vigor, it is very possible that the competition would have been too great for the *Poa annua* under the higher sulfur levels. Another year's data may tend to show reversals in this area.

At this time we would feel quite comfortable with applying up to 3 lb elemental sulfur in addition to any program utilizing all nitrogen from the source of ammonium sulfate; however our final conclusions and recommendations will not be forthcoming for at least two more years.

TABLE 1. Sand green - fertility tests

lbs/1000 ft^2/yr					Mean color 4-24-78	Mean Poa annua 4-24-78	Mean color 6-20-78
	N	P	K	S*			
U	10	2	3	0	8	16	8
U	10	2	3	1	9	12	8
U	10	2	3	2.5	9	15	8
U	10	2	3	3.5	9	8	8
U	10	2	3	4.5	9	14	8
U	10	.5	3	1	9	8	9
U	10	.5	3	2.5	9	6	9
U	10	.5	3	3.5	9	6	9
U	10	.5	3	4.5	9	9	8
U	10	.5	3	2.5(S)	9	6	9
U	10	.5	3	3.5(S)	9	5	9
U	10	.5	3	4.5 (S)	9	6	8
AS	8	.5	3	0	9	9	7
AS	12	.5	3	0	9	4	8
AS	10	.5	3	0	9	8	7
AS	10	.5	3	1	9	8	8
AS	10	.5	3	2.5	9	7	7
AS	10	.5	3	3.5	9	8	8
AS	10	.5	3	4.5	9	8	8
M	10	0	3	0	5	50	9
M	10	0	3	1	5	53	9
M	10	0	3	2.5	5	50	9
M	10	0	3	3.5	5	48	9
M	10	0	3	4.5	5	48	9

U = urea

AS = ammonium sulfate

M = Milorganite

P and K = Elemental

* = All S applied throughout the year except (S) - applied in Feb., Mar., and April.