PROCEEDINGS

of the

19th Annual Northwest Turfgrass Conference

September 22, 23, 24, 1965
Hayden Lake, Idaho

NORTHWEST TURFGRASS MEMBERSHIP DUES

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

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

It has been an honor and a privilege to have been your President for the past year, and I appreciate it more than I can adequately express. The wonderful cooperation all of you have given me is most gratifying.

You are to be congratulated upon having Harvey Junor take over and to him the best of luck and good wishes for the coming year.

Ken Putnam

NORTHWEST TURFGRASS ASSOCIATION

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The Place of The University In Future Urban Development

Mark T. Buchanan[1]

The news release that follows is datelined Puget. The year is 2015. Puget is that part of the city of Pacific that extends from what was once Vancouver, Washington to Vancouver, British Columbia. Pacific, the mother city, extends on south into Mexico.

Puget, North America, October 15, 2015. Samuel D. Smith, Minister of Education and Cultural Affairs for the world government made appropriate comments today on the role of education in the Superb Society. Speaking at a function in celebration of the 50th anniversary of the passing of the federal aid to education act of 1965, Dr. Smith congratulated the United States on its contribution toward world understanding of the importance of education. "Education," he said, "permits increased production without the added use of scarce resources. Thus it has added to real wealth. In increasing productivity it has permitted individuals to attain more leisure which they have used creatively. Improved citizenship and greater personal satisfaction have accrued to each person."

"Specialists and consultants in an ever-widening array of subject and service areas are available as a result of the increasing percentage of the population of college age who attend institutions of higher learning and who go on for advanced degrees. These specialists and consultants as well as citizens in general keep current and pursue general knowledge during a time each year set aside for each person to return to school.

"Not alone are the resources of the university available to train specialists and to enhance the citizenship of all, but additional service is rendered via the creation

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1. Director of Research, College of Agriculture, Washington State University, Pullman, Washington. Talk at 19th Northwest Turfgrass Conference, Hayden Lake, Idaho, September 22, 1965.

of new knowledge through research, via the training of technicians, and via the extension of information to the public in institutes, workshops, evening schools, in correspondence courses, and in other ways."

Dr. Smith pointed out that the United States was the first country to experiment with the idea that education might be useful to its total citizenry. He said that in 1862 Mr. Abraham Lincoln signed a bill that provided for the beginning of a system of higher education in the United States that ultimately resulted in the extension of educational opportunity to all citizens able to benefit by it. It opened up the curriculum to a large number of specialized areas far beyond the professions of that time. Prior to 1862, higher education in America, as in the rest of the world, was pretty much limited to the wealthy and elite; and it was also fairly well restricted to the learned professions of theology, medicine, and law. The resulting universities resulting from the 1862 Act were called land-grant institutions because then the United States had much land and little money, so that grants of land were made by the federal government to the states. It was expected that the income from the sale or use of these lands would finance the physical plants and operations of the resulting institutions. "The results from this beginning are such that Mr. Lincoln might well have been called the Great Emancipator for this effort as well as for his better known efforts in conjunction with the Civil War," Mr. Smith said.

"The development of the land-grant institution, and the later extension of their concept of service to other U.S. universities, was a fitting addition to the concepts of personal freedom as the basis for a new type of national structure that evolved in the United States in the late years of the 18th and the earliest years of the 19th centuries. In the establishment of the idea of free public schools the U.S. recognized the importance of education to the success of its revolutionary experiment in democracy. The establishment of the land-grant institutions thus gave powerful reinforcement to the concept of the political dependence of democracy upon broad educational opportunity. These colleges also provided an affirmation of an intimate relationship between education and the general welfare.

"By 1965 education through high school was almost universal. The proportion of people who attended college had greatly expanded, graduate schools had been developed, and many campuses had become centers for basic research. Expanding programs of continuing education had eveolved and U.S. universities were participating in similar programs abroad. The public had begun to look not only to education but to the educational institution, itself, for solutions to many of the social, economic and political problems of the day.

"Since before 1960, however, it had been obvious to the informed leadership of institutions of higher learning, private and church-supported as well as publicly supported, that resources from traditional sources were becoming increasingly inadequate to meet the twin expanding needs of vastly increasing enrollments and demands from the public in general for equally vast increases in services performed. They began the quest for really significant increases in support for institutions of higher education which ultimately culminated in the federal aid to education of 1965, the passage of which is now being memorialized.

"The federal aid to education act of 1965 was significant because it signified a reaffirmation in depth of the importance of education in a modern society. Also, and equally significant, it represented the first evidence of the nation's willingness to commit the level of resources needed to the job.

Prior to 1965, except for the initial commitment of funds to land-grant institutions via the Morrill Act and except for limited training and research programs designed to complement the missions of certain federal agencies and philanthropic foundations, funds for the support of universities had some from private donations, from church allotments, and especially from state taxes. Debate was lengthy and heated, in fact, on three major issues before the act of 1965 became reality. These were the federalism, control, and church vs. state issues.

"The issue of federalism involved the question of states' and federal rights and responsibilities. Education was considered to be the responsibility of the states. University presidents, while appreciative of the genuine efforts made within the states to meet the need, pointed out that the magnitude of the challenge and responsibility really surpassed the resources of the states. They said that a really major program of federal supplementation was essential. They also gave reasons why this approach was appropriate and proper at that time. First, there was the matter of the changing pattern of taxation in the U.S.A. Whereas in 1913, the year when the Federal income tax was initiated, 32 cents of each tax dollar went to Washington, in 1960, 70 cents of each tax dollar was sent to the nation's capitol. Realistically, the only possible source of funds of the magnitude needed was the federal government. Not only was this so, however, but there were other good, sound reasons for federal assistance. It had become quite evident that the scientific and general knowledge of the citizenry was a national resource justifying a national investment. More and more students were enrolling in schools of their choice, not necessarily in schools within their home states. After they had completed their schooling, they typically worked in another state. The middle-western states particularly provided educational opportunities for many, many scholars who moved elsewhere for their careers. In fact, the modern equivalent of the itinerant worker is the well-trained scientist who follows where his discipline leads. Most telling of all was the proof that the nation as a whole received tremendous returns on the investmant made in providing educational opportunities for its capable citizens. So large was this return, in fact, that the extra goods and services produced thereby would provide the added tax base necessary for the financing of this and other programs as well.

"The issue of control concerned the proposition that if the federal government provided a significant part of the funds used in the educational enterprise, it would also control a significant part of the program. Fortunately this was easy to counter as the land-grant universities had been receiving federal funds for more than 100 years with no evidence whatever of undesirable federal control. There was control and accountability of the funds supplied. Thus the states documented that the funds supplied were used in support of the educational program. Since the grants were for the purpose of supplementing programs proposed by the states, this accounting did not impair in any way state initiative and autonomy in the educational enterprise.

"The private vs. public and church-state issues took a bit longer to settle satisfactorily. Ultimately it was decided that all types of institutions then in existence, and perhaps more, were needed to assure an adequate variety and balance of educational opportunity. Assistance was badly needed by all types of educational enterprises. Private institutions which had been receiving support for some time already for research and special training programs following sputnik were quickly added to the list to receive federal supplementation. And those parts of church-related educational enterprises that were common with other educational institutions also became eligible for supplementation. To put it the other way around, the churches continued to support those parts of their activities that were designed to advance their own particular beliefs and doctrines; they continued to help as they were able but were also eligible for supplementation on the aspects of their programs that were similar to the programs offered in non-denominational schools--such programs as English, chemistry, physics, engineering, and the like.

"There were other debates concerning whether the services provided by university staff and graduates should be provided at a fee to be paid by the individual who immediately benefitted, by some form of insurance arrangement, or at a social cost on behalf of the general public. Such debates have continued. It was soon realized that in the context of the immediate need, however, these debates were academic. People to man such service activities had to receive education and training before such services could be rendered--no matter who paid or how payment was arranged.

"Also, for a time there was confusion over plans to provide assistance to the students and to their families via scholarship and tax credit plans. Such are helpful only if there is an educational opportunity available at a viable institution--thus, the need for help to the institutions as well--not to the students alone. During these times, most state institutions were forced to limit enrollment to match funds available. This was done usually by requiring higher grade-point averages out of high school. Such a procedure was especially deplored as being inimical to the philosophy of state universities. President Elvis Stahr of the University of Indiana put it as follows:

"Our forefathers' concept was that education should be free--free all the way through the university level. The Articles of Compact of the Northwest Ordinance first stated the high importance of education for the Territory's inhabitants. Then, the authors of the Indiana State Constitution of 1816 developed this statement of principle by incorporating provisions for the free pursuit of education. Article IX, Section 2, read: 'It shall be the duty of the general assembly, as soon as circumstances will permit, to provide by law, for a general system of education, ascending in a regular gradation from township schools to a state university, wherein tuition shall be gratis, and equally open to all.'

"This mandate was solemnly written by our pioneer forefathers a century and a half ago, yet some people today, ignorant of the State's and the Nation's historical traditions, appear to believe that free education is a great socialistic scheme, a pernicious product of some foreign ideology. In actuality, this great American principle, which led, in Indiana, to the establishment of Indiana and (later) Purdue Universities, and also to the founding of public colleges and universities in many of our states, is being diluted not by alien infiltration but, sadly, by native neglect. It was in the period from the end of the Civil War forward to World War II that the concept of the publicly supported institution, open to all with sufficient preparation and ambition to profit from it, really came into its own in America. And concurrently, large numbers of additional private colleges were founded while some of the older ones began to achieve worldwide prestige.

"The important thing, gentlemen, is that it was no coincidence that as America's institutions achieved an increasing degree of academic excellence and wider availability, the Nation as a whole was enabled to change from a primarily rural, isolated, underdeveloped Nation to the greatest Nation on earth--a Nation strong not only in her original political concepts, but economically strong, highly productive, with social mobility and with military power to back up and preserve her and her concepts of freedom from the threats of fascism and communism.

"In study after study, it has been shown that the greatest single factor in the growth of the Gross National Product in this century has been education, not capital, not the size of the labor force. The productivity of the work force, all the way through top management, has reflected the mounting economec effect of education. As I pointed out in a speech for the International Management Congress in 1963: 'One of the increasingly visible phenomena of the post-war world is the emergence of the modern university as a central factor in almost all advances in this society, and not least in the field of economic growth. This is because universities not only have become our primary sources of highly trained intelligence but also are contributing so greatly to the explosive pace of the discovery of new knowledge.' I mentioned there too, by the way, a fact that some of us are prone to forget--that the University is concerned above all with the high development of the human intellect, by far the most important resource on this planet.

"Curiously enough, the percent of GNP spent on higher education during this time grew scarcely at all, despite the fact that it was basically responsible for the GNP growth. In fact, we have failed to reinvest enough to keep opportunity as open as it had been.

"Concomitantly, an erosion of the principle of education-for-all began. Public institutions began to charge fees, increasingly, to make up the difference. Private institutions began to raise their tuition markedly. How ironic that even though far fewer real sacrifices are required of us today, the willingness to sacrifice at all has lessened so much!

"A curious theory, or rationalization, has arisen that it is the student alone who benefits from higher education and therefore he alone should pay for it. The theory in part grew out of the observation that over the lifetime of a student, he is likely to have much higher earnings than if he hadn't attended college. This is, of course, so, and applied to high school as well. But it is a strange warping of logic to reason that since the student will in time benefit, he must be charged for future benefits while he is still a student and no one else should be charged at all, even though everybody else benefits too! This pattern of thinking overlooks two basic considerations: 1) the principle, recognized by our forefathers, that society does indeed benefit from an educated citizenry, indeed cannot survive without it, and therefore in equity should bear at least part of the burden; and 2) the fact that graduates become members of society and quickly begin to repay the cost of their education in taxes and other ways during their many productive years. Their education is far from a free ride at society's expense; for they with their higher earnings, are keeping the investment in education constantly renewed. The basic principle, as our pioneer ancestors perceived, is the same as for, say, elementary schools; society, not the pupil, pays for them; but the principle has now been badly bent after the 12th grade!

"But really, you may ask, what of the citizen without a college education? Why should he pay for others to be educated? The answer, obviously, is that he too benefits from those who have had the advantage of college. What kind of society would it be for noncollege graduates if there were no lawyers, no doctors, no engineers, no well-educated people at all? I might draw an analogy from the Congo. The Congo obviously has abundant manpower and almost limitless natural resources, but there is a critical lack of education among the Congolese. As a result, they have little indeed in their way of life that we would want for ourselves or our children. The developing countries, striving to move forward, haven't a chance of succeeding without more and better education. The point is, neither have we. Yes, education requires an investment, as I've often told our Legislature, but it is an investment and not an expenditure, and it should always be regarded that way. The cost of not making it would soon be far too expensive to be supportable.

"When we escalate the cost to the student, on the other hand, we are escalating far more--the ultimate cost to society. For if we raise economic barriers that only the exceptional young man and very few young women indeed can hurdle, we are in effect decreeing that they shall be less productive than they could have been. May I remind you that the cost of an unemployable to society is far greater than the relatively small investment required of society for his education. No one proposes college education for everyone; but I submit that the vital thing is to include and exclude not on the basis of ability to pay, but of ability to learn.

"This is my public issue number one tonight--and it is a real one as well as a philosophical one, a practical one, a live one, and one that should be discussed when the legislature is not in session, rather than just biennially. For the people really decide, and you are leaders among the people."

"The culmination of these efforts and debates was the passage in the Congress of the United States on October 15, 1965 of the aforementioned federal aid to education act.

"For some time following the passage of this act, priority had to be reserved strictly to the teaching function in many subject matter areas. The supply of good professors was very small in relation to the need. Only that part of research which provided the apprenticeship by which a graduate student became a replacement professor or scientist could have priority equal to teaching. As in the cattle cycle, the number of professors available for other uses became for some time smaller still as they (the breeding stock) were held back to produce the expanded numbers of their kind needed for the ever-increasing teaching job plus the mission-oriented research jobs, the numerous extension and other service jobs. For a short while there were disturbing signs of continuing student unrest, such as were exhibited in the then recent Berkeley incident! Had the anti-university, anti-order attitude exhibited by some leadership of that day prevailed we would not now be having this ceremony. Fortunately, as with many other radical movements, calmer heads prevailed.

"Ultimately, with increased resources and good management, the universities provided the opportunities for education that resulted in expanded numbers of professors and scientists. These were sufficient to meet teaching needs and provide an overage who are today engaged in an ever-increasing variety of research, extension and consulting services. Our Super Society of 2015 might be said to be the result of the events that transpired 50 years ago in education; certainly it is much richer thereby. It is appropriate, therefore, that we pay our respects today to the leaders of institutions of higher education in the U.S.A. and to the Executive and Congress of the United States who approached this legislation in a truly bi-partisan way and who obtained its passage with a large majority, Dr. Smith concluded."

Of such is my own "message" of optimism on 22 September, 1965. The university, meaning all higher education, is in position to make tremendous contributions to urban and other development by providing educational opportunities, research, extension and community service. The extent and quality of the university's response to these and other public needs will be dependent, in turn, on the availability of funds of a new order of magnitude. In my opinion, society can afford no less. Meanwhile, the university will make the best use possible of whatever resources are put at its disposal. The priority will be teaching first, research second, and extension third.

Research Progress On Controlling Turfgrass Diseases

Charles J. Gould[1]

Fusarium Patch continues to exceed all other diseases in importance in both eastern and western Washington. However, Ophiobolus Patch has moved into second place in western Washington. Typhula Snow Mold ranks second in eastern Washington. Corticium Red Thread is the third worst turfgrass disease in western Washington in general. On fescues it is the most important disease.

Research has been underway for several years on Fusarium, Ophiobolus and Corticium. This is a preliminary summary of all our work on fungicides and fertilizers. It has been done in cooperation with Roy L. Goss and Vernon L. Miller. The financial assistance from the Northwest Turf Association during the past year is gratefully acknowledged.

Fusarium Patch

Fungicidal Research:

Phenylmercury acetate (PMA) formulations (at 3/4 oz/10 gal water/1000 sq ft) have continued to give good control. The new, more finely ground, Calo-Clor was found to be as effective as PMA, had a longer residual action, but is more expensive. Certain Washington State University experimental combinations of mercury and cadmium appeared very promising. Caddy and Panogen gave some control. A summary of the fungicidal research on this disease between 1961 and 1965 will be published in the November, 1965 issue of the PLant Disease Reporter.

Fertilizer Research:

Nitrogen- high levels have usually resulted in more loss from Fusarium Patch. Milorganite and ammonium sulfate produced less disease than other nitrogen sources.

Potash- high levels usually increased this disease.

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1. Plant Pathologist, Washington State University, Western Washington Research and Extension Center, Puyallup, Washington. Work conducted under Project 1394.

Phosphorus- helped reduce attack by this fungus.

Sulfur- markedly reduced the number of diseased areas in a small scale test in 1964. Research on this element will be expanded.

Corticium Red Thread

Fungicidal Research:

Cadmium fungicides were found to be best for control of this fungus, giv ing rapid control and having a long residual action. Such mercury compounds as PMA, Calo-Clor and Panogen also produced rapid control but they did not provide as long residual control as did the cadmiums. Panogen was somewhat better than PMA in this regard and both were slightly superior to Calo-Clor.

The WSU experimantal mixtures of mercury plus cadmium also gave excellent control. The control was almost perfect when these mixtures were applied 4 times a year but was very poor when applied only once. Two applications (once in spring and once in fall) of cadmium-containing fungicides would probably be adequate under average conditions. One application might be sufficient if mercurials are also applied at other times.

Fertilizer Research:

Nitrogen continued to be the most effective element in reducing losses from Red Thread. The higher the nitrogen level, the less Red Thread developed.

Potash- indefinite response.

Phosphorus- reduced disease attacks somewhat.

Milorganite- gave a good reduction of Red Thread in a small acale experiment.

Ophiobolus Patch

The Ophiobolus Patch disease is a very complex one. The disease appears and disappears often for no apparent reason. This erratic behavior has seriously complicated efforts at finding suitable control measures. The final solution will likely be a complicated one and it may vary from place to place. At the present time the best treatments appear to be continuous use of ammonium sulfate or chlordane until the disease disappears. Certain fungicides such as Calo-Clor and other mercurials seem to suppress the fungus but the latter often reappears after applications cease. In addition to ammonium sulfate and chlordane, the most promising treatment appears to be heavy applications of cadmium-containing fungicides. Certain zinc and iron compounds also appear promising.

The fertilizer-disease response is also confusing. Our high nitrogen experimental plots at first had the most disease but during the last two years the plots with lower levels of nitrogen were among the most heavily affected. In general, an unbalanced nutritional program appears to result in more Ophiobolus Patch. Phosphorus apparently helps reduce losses.

In view of some of our results, and research elsewhere, it appears that some of the effects of our treatments may be indirect ones, whereby certain beneficial (antagonistic) organisms in the soil are stimulated to develop and in the process either suppress or eradicate the Ophiobolus fungus. Consequently, although fungicides may help, we suspect that the best control of this pathogen will come from use of certain cultural procedures. We believe that more research is needed on organic materials which may be used to stimulate development of beneficial organisms and also to discover which materials may be promoting development of the Ophiobolus.

Does Your Turf Use Everything You Feed It?[1]

Roy L. Goss[2]

Fertilizer! What happens to it? When do we apply it? How much do we put on? Should it be organic or inorganic? What is organic, inorganic, and synthetic organic? How often should we put it on? When shouldn't we put it on? What is a complete fertilizer? What is a ratio? What effect do fertilizers have on diseases? And, there are many other

1. Paper presented at the 19th annual Northwest Turfgrass Conference, Hayden Lake, Idaho, September 22, 23, and 24, 1965.
2. Assistant Agronomist and Extension Turfgrass Specialist, Western Washington Research and Extension Center, Washington State University, Puyallup, Washington.

questions that could be added to this list.

In this paper I shall not attempt to answer all these questions, but will touch on a few in detail and some of them in general.

Fertilizer studies have been in progress at the Western Washington Research and Extension Center for over six years. Both lawn and putting green turf have been under investigation, however, only the putting green turf shall be considered at this time.

About the Experiment

Colonial bentgrass was established on Puyallup fine sandy loam soil in 1959 and, since that time, has been subjected to 18 different fertilizer treatments and one check plot. Nitrogen has been applied at 3 levels--20, 12, and 6 pounds per 1000 sq. ft. per season. Phosphorus has been applied at 0 and 4 pounds, and potassium at 0, 4, and 8 pounds per 1000 sq. ft. per season. Every combination of these 3 elements has been applied over this period of time. Every treatment except the check has received nitrogen, whereas certain plots have received no phosphorus, no potassium, or neither phosphorus nor potassium. All clippings have been removed from these plots from the beginning, hence, no fertilizer has returned to the soil from the plant itself. Every plot was tested for PH, organic matter, phosphorus, potassium, and calcium before any treatment was made. They have been tested periodically since. In order to have a clearer understanding of what has happened to the fertilizers we have applied, let's take a look at the following table to observe the initial and present soil nutrient levels.

Table I.

Initial and Present Soil Nutrient Levels

Treatment in Pounds Per 1000 Sq. Ft. Per Season				Initial (1959)			Present(1965)		
	N	P	K	P	K	Ca	P	K	Ca
1.	20	0	0	15	500	2650	12.6	215	1930
2.	20	4	0	16	491	2600	24+	145	1790
3.	20	4	4	15	481	2500	24+	200	1790
4.	20	4	8	15	488	2375	24+	350	1790
5.	Check			15	481	2430	15	255	2210
6.	20	0	4	16	500	2200	16	280	800
7.	20	0	8	14	498	2400	13	435	1265
8.	12	0	0	14	500	2450	16	200	2070
9.	12	0	4	15	482	2300	16	270	2070
10.	12	0	8	16	500	2410	16	475	1930
11.	12	4	0	16	500	2385	24+	170	2210
12.	12	4	4	17	500	2350	24	250	2210
13.	12	4	8	17	500	2280	24	385	2210
14.	6	0	0	17	500	2180	18.2	195	1930
15.	6	0	4	18	500	2195	19.5	330	1930
16.	6	0	8	18	500	2120	21.0	500	1790
17.	6	4	0	19	500	2130	24+	190	2070
18.	6	4	4	18	500	2180	24+	380	2070
19.	6	4	8	18	500	2100	24+	440	1930

What Has Happened To Phosphorus?

It is obvious from the table above that phosphorus soil levels have increased during the last 5 years. In only a few cases did phosphorus actually decrease, and this was with high nitrogen applications and no phosphorus. About 870 pounds of P_2O_5 have been applied to the highest phosphorus treated plots over the five-year period.

What Has Happened To Potassium?

This is probably the place where the greatest change has occurred. From the table above, it is seen that potassium levels have decreased in every case, regardless of the amount applied. The heaviest potassium treated plots (8 pounds per 1000 sq. ft. per season) have received about 1, 940 pounds of K_2O over the last 5 years.

Calcium?

Soil calcium levels have consistently lowered during the 5-year period, however, none are critical with the possible exception of treatments No. 6 and 7. It is interesting to note here that these are the only two plots not responding to 20 pounds per 1000 sq. ft. nitrogen treatment. All other plots, regardless of pH, are responding to N applications.

How Do We Interpret These Data?

About the only conclusions that can be drawn from the above data are that large amounts of plant nutrients have been applied but are not in the soil now. Such variables as how much leached, became fixed in the soil, was removed in the plant tissue, or was mineralized from the soil are not considered.

If we knew how much the plants removed, this would control one important variable. Therefore, studies were set up to investigate plant removal.

Tissue Studies

Since the analyses of plant parts for N, P, and K can become expensive, only 6 treatments out of 19 were selected for tissue studies. These were 20-4-8, 12-0-0, 12-4-0, 12-0-4, 12-4-4, and 12-4-8. Experience has shown that 12 pounds of N is more practical for putting turf, hence, the reason for more of the 12-pound N treatments.

Clipping samples were collected from these plots approximately once each week, dried, and weighed as a measure of yield. There were 29 weeks of sampling, however, the turf was cut about 85 times for the year. Out of the 29 weeks, 14 were selected for tissue analyses. The following table shows the results of these analyses.

Table II.

Dry Matter Yield and Nutrient Recovery as Estimated by Tissue Analyses

Treatment	Mean Dry Matter Yield Pounds Per Acre*	Nutrient Recovery Pounds Per Acre*		
		N	P	K
20-4-8	5,472	279	18.6	158
12-0-0	5,675	278	17.0	138
12-0-4	4,746	243	15.0	124
12-0-8	4,608	233	15.2	130
12-4-4	5,406	273	18.4	144
12-4-8	6,288	299	21.7	172

*Figures extrapolated from 14 weeks dry matter and nitrogen yields to 85 weeks. Each 14-week yield was multiplied by a factor of 6.1 as an estimate of annual totals.

It may be surprising to some to note that the 12-4-8 treatment resulted in a significantly higher yield of dry matter, N, P, and K than the 20-4-8 plots. There may be two significant explanations: (1) the grass cannot assimilate this much nitrogen, allowing it to be leached away (2) a combination of nitrogen and potassium at these levels definitely caused turf injury, especially during the hotter months of July and August.

It is felt by the writer that tissue analyses are the best measure of nutrient status, with the exception of tissue and lysimeter studies. Of course, we cannot ignore the standard chemical soil test as an excellent tool, also, since this gives us a measure of what is available in the soil.

Considering that the treatment 12-4-8 received 522 pounds N, 174 pounds P_2O_5, and 348 pounds K_2O in one year, we account for about 299 pounds N, 21.7 pounds P_2O_5, and 172 pounds K_2O. This leaves 223 pounds N, 152 pounds P_2O_5, and 176 pounds K_2O either left in the soil, tied up (fixed), or leached. It is reasonable to expect that a large amount leached away with excessive rainfall and irrigation water. These data do point out one important thing: OVER HALF OF WHAT IS APPLIED PROBABLY NEVER GETS INTO THE PLANT, especially at the higher rates.

It is also important to point out that 12 pounds of N and 4 pounds and 8 pounds of K_2O in combination resulted in the lowest recovery of N, P, and K. This is probably due to inadequate levels of available phosphorus and perhaps inadaquate levels of calcium.

What About Nutrient Ratios?

For sometime we have indicated that plants remove nutrients in about a 3-1-2 ratio of N, P, and K. If we consider that the 12-4-8 treatment above is the best one, then we find that potassium (K_2O) is about 58% as much as N in the tissue. This is an average for the entire year, but during peak growth, the K_2O level comes up to over 61% as much as N. Furthermore, soil test results indicate that this ratio and intensity are maintaining adequately high soil levels of K_2O.

These data also indicate that 4 pounds of P_2O_5 is ample for excellent quality turfgrass. Also, it is found that over 8 times as much potassium is removed from the soil in the 12-4-8 treatment as phosphorus. Therefore, when we put one part of phosphorus in a 3-1-2 ratio fertilizer, we are being extremely generous.

What About Fertilizer and Diseases?

Fusarium Patch--This disease continues to develop to the greatest extent with higher levels of N, especially urea. Interestingly enough, it has been found that applications of 2 and 3 pounds of wettable sulfur per 1000 sq. ft. in August caused a significant reduction in this disease, as well as stimulated a greener turf color. This is being reported in detail by Dr. C. J. Gould.

Ophiobolus Patch-- This disease has caused more concern in the research area than many due to its changing habit from year to year. In 1960 and 1961, the greatest infection occurred on plots receiving the highest levels of N. Little or no Ophiobolus Patch occurred in the lawn turf that was getting up to 8 pounds of N per 1000 sq. ft. per season. As time went on, the disease shifted its attack to the 12 pounds of N plots and, presently, the greatest infection is on the 6 pounds of N plots.

Oddly enough, the only consistent infection during the last 3 years in the fertility plots has been in those receiving only N and K, and especially at the 6 pounds of N level. This certainly points an accusing finger at phosphorus availability, but more studies need to be conducted.

The most serious infections of Ophiobolus Patch did not occur on the lawn turf until the last 2 years. The most significant observation is that it has developed significantly more on all plots not receiving phosphorus.

SUMMARY

1. Avoid excessive applications of nitrogen. Twelve pounds per 1000 sq. ft. per season appears to be ample.
2. Maintain a 3-1-2 ratio of N, P, and K.
3. Try to get most of your potassium on the turf during the cool months and avoid July and August if possible.
4. Use good laboratory chemical soil tests to help determine your soil levels.
5. Heavy N applications lower the pH, therefore, watch this as well as your calcium levels.
6. Fertility programs alone will not control turfgrass diseases. Be sure to follow good fungicidal programs.

Gratitude is hereby expressed to the Northwest Turfgrass Association and the Soil Improvement Committee of the Northwest Plant Food Association for financial assistance in making these investigations possible.

Agronomic Research Report For The Northwest Turfgrass Conference

September 22, 23, 24, 1965 Hayden Lake, Idaho

Roy L. Goss

NUTRITIONAL STUDIES REPORT

After six years of applying fertilizer elements, notably nitrogen, phosphorus, and potassium at various rates, it has been found that a ratio of three parts nitrogen, one part phosphorus, and two parts potassium are maintaining adequate soil levels of these elements. This is further backed up by findings in tissue analysis, which indicates this is the ratio at which the plants are removing these nutrients from the soil.

It was previously believed that phosphorus was one of the most heavily used elements in the soil, except for nitrogen, and probably accounts for many of the old fertilizer formulas being so high in phosphorus and low in potassium. It is known that turfgrasses utilize more nitrogen than any other single element, but it is closely followed by potassium. In other words, we are using about sixty per cent as much potassium as nitrogen if we wish to maintain adequate soil levels of potassium.

During the season when the grass is growing the fastest, particularly in May and June, grass leaves are lower in nitrogen than they are when the grass is growing more slowly. This is not so with potassium. During the period of most rapid growth, potassium levels are higher than they are during the periods of slower growth in the fall and winter.

Phosphorus seemed to be essentially unchanged by the season, and remained at very low levels in the tissue at all times.

EFFECT OF FERTILIZERS ON THE DEVELOPMENT OF OPHIOBOLUS PATCH DISEASE

Research results indicate that areas deficient in phosphorus are one of the first to be attacked by Ophiobolus

Patch disease. Even though phosphorus is used at relatively low levels by the plant, there must be an adequate supply at all times to keep the plant in a state of vigor, and perhaps to ward off certain diseases. Experimental plots where the disease has vigorously developed are not completely deficient in phosphorus, but they have had no applications of this element for a period of six years. Soil Testing Laboratory results of tests on these plots indicate that there is sufficient phosphorus for reasonably normal growth, meaning then, that a slightly higher level may be most optimum in reducing this disease.

There is also evidence that slightly higher levels of nitrogen, when adequately balanced with phosphorus and potassium, have some suppressing effect upon the disease. In lawn turf grasses, there is no evidence of disease outbreak where nitrogen levels are six to eight pounds per 1000 square feet per season, and particularly when the ratio of 3-1-2 is followed. There are many other complicating factors in what may be causing Ophiobolus Patch and other factors in its fungicidal control; however, there does seem to be a considerable correlation between fertilizer balance and intensity of this disease.

WEED CONTROL STUDIES

Speedwell, also botanically known as *Veronica filiformis*, has been one of the most difficult to control weeds in the Pacific Northwest in recent years. It furthermore appears that Veronica is becoming even more widespread than previously. It is difficult to say what is causing the increase in this weed unless that more seed is available and it is being transported more quickly. There is always the possibility that changing fertility levels, or changing management practices with the turfgrasses, is also causing this. However, since these are unknown factors, and many herbicides are available to us today, it would appear normal first of all to try to eliminate the weed, and then conduct basic investigations as to the cause of this development.

A series of fourteen different herbicides on the Capitol grounds at Olympia, Washington produced an extremely desirable results during the summer of 1965. Apparently almost any mixture of herbicides containing Zytron will do a good job in controlling Speedwell. Zytron was initially developed for pre-emergence control of crabgrass, annual bluegrass, and certain other annual weedy plants. The best controls were produced with Zytron alone at 15 pounds per acre, Banvel-D-Zytron combination at one pound Banvel and 15 pounds Zytron, and the other treatment was Torton-Zytron at 1/2 pound Torton and 15 pounds Zytron per acre. It is not known at this time whether or not the controls will be permanent; however, excellent control was observed from the time the herbicides first took effect in June through August. It will be desirable to see if controls continue on through the fall, winter and spring of this next year.

Turf Grass Varieties [1]

Kenneth J. Morrison[2]

Kentucky bluegrass is the most common grass used for turf in the northern United States. Bluegrass will grow in most sections of Washington if it has adequate moisture. Some parts of Washington, particularly western Washington, other grasses such as bentgrass or creeping red fescue are more desirable for a lawn than bluegrass.

Bluegrass Varieties

Cougar is a hardy low growing deep green turf grass for lawns, golf courses, parks, and playfields in the Pacific Northwest. The variety was developed at Washington State University from a Danish introduction. Cougar produces a weed-resistant tight turf. It starts growing early

1. Presented at 19th Northwest Turfgrass Conference, Hayden Lake, Idaho, September 23, 1965.
2. Extension Agronomist, Washington State University, Pullman, Washington.

in the spring and remains green well into the winter. It has faster germination and emergence than Merion and retains more desirable color in the off-season.

It is resistant to mildew and moderately resistant to leaf rust and leaf spot. Cougar, like Merion, requires high rates of nitrogen for the best turf and color.

Merion Kentucky bluegrass has received more publicity than other bluegrasses because it was one of the first improved bluegrasses available for turf purposes. It was selected at the Merion Golf Club near Philadelphia. Merion is superior to common Kentucky bluegrass when properly managed. It starts growth later in the spring but produces a tighter firmer turf that requires less mowing. Merion seed is slower germinating than other turfgrasses and it takes a longer time to become established. When Merion turf is established it will take more wear and spread faster into damaged areas than common Kentucky bluegrass.

Merion is susceptible to leaf and stem rust but Merion requires higher nitrogen fertilizers than common bluegrass and tends to develop a thatch problem if mowed too high.

Nebraska Dwarf is a selection of bluegrass from Nebraska. It is a finer-leafed variety than either Merion or Cougar.

Newport is a selection made in Oregon that is a high seed-producing Kentucky bluegrass. It produces a dense tight turf similar to Merion. It does not have as good a color as Merion and it does not have as good a color as Cougar. It does have better seedling vigor than Merion.

Delta is a selection of common bluegrass from Canada. The chief advantage of this variety is its high seed production. It does not produce as tight or dense turf as Newport, Merion, or Cougar in the Pacific Northwest. It does have good seedling vigor. Where common bluegrass is going to be used, Delta is the best common type Kentucky bluegrass.

A number of seed companies have developed or are working on Kentucky bluegrass varieties for the future. Washington state will test these new selections that are made available for tests in the future. Information on their performance will be made available to the turf growers in the Pacific Northwest.

Interest in blends of different varieties of Kentucky bluegrass has been expressed in the mid-west areas. At the present time we are not recommending blends of varieties because of the management problem in relation to fertilizer and mowing. Common type Kentucky bluegrass varieties included with Merion or Cougar or Newport would require more mowing than the last three. If adequate fertilizer was not applied there would be no advantage to having Cougar, Merion, or Newport in a seed mixture.

<u>Fine-Leaved Fescues</u>

The fine-leaved fescues are widely used for turf. They are particularly important in eastern Washington and other areas of the United States that enjoy relatively cool summers. They are a favorite of many home lawn owners because they start growth early in the spring. Most of the fescues have a bright green color and are tolerant to moderate to heavy shade.

<u>Varieties:</u>

<u>Pennlawn</u> red fescue was developed at Pennsylvania State University, and is well adapted as a lawn grass in eastern Washington. It is somewhat more disease resistant than other red fescue varieties.

<u>Illahee</u> and <u>Rainier</u> red fescue are varieties developed on Oregon. They produce good turf in western Washington as they are adapted to the cool, humid climate of that area.

<u>Olds</u> red fescue has been used in turf plantings for many years. It is superior in turf quality to Rainier and Illahee in eastern Washinton, but not better than Pennlawn.

<u>Chewings</u> fescue is a fine-leaved bunchgrass that does not spread to any extent. While it will not fill in bare spots or heal rapidly, it does not spread into flower beds or other lawn borders. For this reason it is a popular lawn grass. It is a tough grass and therefore the homeowner should have a sharp mower in good adjustment to keep the grass looking nice after mowing; otherwise, the grass

tips are bruised and turn to a light brown or straw color. This produces an unsightly lawn.

Sheep fescue and Hard fescue are the most drought resistant of the turf grasses. They are extremely difficult to mow. They are adapted to dry land turf in eastern Washington where close mowing is not essential. They are well suited for holding steep clay banks, roadsides and golf course roughs where it is not necessary to keep a fine turf.

Performance of Bluegrass Varieties Under Two Heights of Clipping

Alvin G. Law[1]

With the availability of several so called "dwarf" varieties of bluegrass has come an interest in the use of these dwarf bluegrasses for specialized turf. Can the newer varieties in fact be used on golf course tees where mowing heights are 1/2 inch or even less? Do the dwarf varieties perform in a superior fashion to the erect growing bluegrasses under these intensive management treatments? Bluegrass varieties generally are well adapted for use on many soil types in the Inland Empire area of the Pacific Northwest. These varieties are widely used in park, cemeteries, lawns and on golf course fairways. Moreover, Kentucky bluegrasses are used throughout the northern 1/3 of the United States. This widespread adaptation has prompted a more intensive study of the response of these grasses to intensive management practices.

Research Methods

Seven bluegrass varieties were seeded in turf trials in the spring of 1962. They were clipped at 1 inch in height during the extablishment year. They were fertilized at a

1. Agronomist, Washington State University, Pullman, Washington.

level of 4 pounds of actual nitrogen per thousand square feet. Phosphorus and potassium levels were maintained at a high level based on soil tests. The plots were irrigated as needed to keep the soil moisture above the wilting point. In 1963, 1964 and 1965 the plots were split, one half being mowed at 1 inch in height, the other half at 1/2 inch. They were nowed twice weekly during the growing season, extending from the middle of April to October 1 of each year. During the three treatment years the plots all received the equivalent of ten pounds of available N in the form of ammonium sulphate. In June and September of 1965 the plots were sampled with a core sampler which cut a plug 4 inches in diameter and 6 inches deep. These plugs were carefully washed out after the technique developed by Goss in 1960 and root production recorded. Additional data obtained included color rating and density ratings in both the fall and spring of each of the tears. We can consider the numbered entries 602, 402 and 205 as "Cougar", the recent release from the Washington Agricultural Experiment Station.

Experimental Results

Data on the average root production per core are shown in Table 1. It should be noted that the erect growing variety Delta shows the lowest production of roots at the 1 inch height compared to all other varieties cut at this height. It should be noted also that the production of Delta roots in June and in September are essentially similar for the 1 inch height. The dwarf types, 0217, 602, 402, 205 and Merion are higher than Delta in root production both in June and September at the 1 inch height of cut.

Considering the 1/2 inch cutting height it can be seen that Delta, the tall growing bluegrass, is much lower than any of the other varieties. This is a typical response to close mowing of the tall growing bluegrasses such as Delta, Park, Troy and most of the common bluegrass currently on today's market.

As with the one inch clippings the plots cut 1/2 inch high produced more roots by September than they had in June with the exception of 0217. With this latter variety, the production was essentially the same for both June and September. 0217, an experimental line developed by the Jacklin Seed Company shows one other characteristic different from the other dwarf bluegrasses in this test. It required almost twice as much time to wash the soil from the root plugs of 0217 as from the other dwarf bluegrasses. This washing time appears to be related to the greater density of fibrous roots and the resultant lower amount of rhizomes in the upper six inch profile of the 0217 plugs when compared to other dwarf varieties. Density readings at the surface of the turf indicate that there was approximately a 50% reduction in density of Delta compared to the low growing bluegrasses cut at the half inch height.

Table 2 shows the root yield, percent rhizomes, and surface density of bluegrass varieties grown in trials by Dr. Goss and reported in his doctorial thesis in 1960. These plots were also clipped at 1/2 and at 1 inch in height. They received both high and low nitrogen treatments and were irrigated to prevent any indication of wilting in the plots. Table 2 shows root data from these plots taken in the fall of the second clipping year. Here again it can be noted that Delta, a tall growing variety, produces much less root growth under both the 1 inch and 1/2 inch cut. Also the surface density of Delta is significantly less than that of the dwarf varieties indicating that this variety cannot tolerate close clipping for any extended period. In addition the percent rhizomes, as determined by Dr. Goss in this study, shows a highly significant difference between the three dwarf varieties, Newport, Cougar and Merion compared with the tall growing variety, Delta. Similar data have been reported by other workers with many plants. In every case the dwarf plants will consistantly withstand closer defoliation than the erect growing plants.

The data obtained from this present study, and those obtained by Dr. Goss are in agreement in that they indicate that many of the failures of bluegrass plantings on such specialized sites as golf course tees can be attributed to the use of tall growing varieties rather than the modern dwarf types that are currently available.

Returning to Table 1, the data reported for Cougar and Nebraska blend are from plots seeded in the fall of 1963. The inch and half inch cutting heights were applied to these plots in the spring of 1964 and during 1965. Note particularly the root production of these two varieties cut at the 1/2 inch height when they were not allowed to become well established before initiating the close clipping. This is an indication of the necessity of allowing bluegrasses to become well established before clipping back to 1/2 inch. At the 1 inch height Cougar root production was comparable to that of the varieties in the older trial.

Table 3 reports some seedling characteristics of four bluegrass varieties. Here we were attempting to identify some morphological characteristic that could be measured in the laboratory that would define the difference in growth habit of these various bluegrass varieties. The number of tillers and the length of leaf sheaths have been proposed by various investigators as possible distinguishing characteristics. In our trials we have not yet arrived at a satisfactory standard for measuring leaf sheaths as is indicated by the data in Table 3. Cougar and 0217 in seed production plots have the shortest mature plant stature and thus are considered the most nearly true dwarfs of the varieties in this study. Yet, Delta and Nebraska dwarf have the shortest leaf sheaths from these initial trials. On the other hand Cougar and 0217 show the greatest tillering ability which is one measure of the ability of a grass variety to heal after mechanical injury. It is planned to refine these tests in some greenhouse trials this winter.

Table 1. Average root production under bluegrass varieties cut at two heights and harvested at two dates.

Variety	One Inch		One Half Inch	
	June	Sept.	June	Sept.
0217	17.2	19.8	14.9	14.1
602	11.5	14.0	10.1	18.7
205	17.5	20.0	14.4	15.9
402	16.0	24.6	9.7	19.8
Merion	12.2	20.3	10.3	14.4
Newport	10.7	17.4	9.6	16.9
Delta	11.0	12.9	7.1	10.5
Cougar1/	14.9	20.6	5.8	9.2
Nebr. blend1/	4.2	19.7	7.4	9.6

1/ These varieties in the second cutting year; all others in third cutting year.

Table 2. Root yield, percent rhizomes, and surface density of bluegrass varieties grown in 1957 and 19581/

Variety	Yield Grams		%	Surface
	1" cut	1/2" cut	Rhizomes	Density
Newport	5.5	4.1	47	100
Cougar	4.8	3.8	48	100
Merion	3.4	3.1	40	92
Delta	2.4	2.2	12	65

1/ Data adapted from PhD. thesis by Cr. R.L. Goss, 1960.

Table 3. Seedling characteristics of some bluegrass varieties in 1965.

	Average Number 1/ Tillers	Average Leaf 1/ Sheath Length
Cougar	2.0	7.1
0217	2.3	8.0
Delta	0.9	7.0
Nebr. Dwarf	1.7	6.5

1/ 9 weeks after planting.

Low Temperature Injury of Turfgrass

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

Low temperature injury to turfgrass takes many forms. The nature and causes of injury vary widely from region to region on this continent.

In our area in British Columbia, we have chosen to study three types of winter damage to turfgrass:

1. needle ice injury of autumn seeded grass
2. winter water saturation of turfgrass
3. ice sheet injury of turf.

Our studies do not cover all facets of winter damage; these three facets happen to be those which, for a variety of reasons, we have chosen to study.

1. Needle ice injury of autumn seeded grass.

Substantial areas of turf are now seeded in autumn in

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the maritime areas of Southwestern B.C. Construction projects, roadside seedings, etc., often push seeding dates late into the autumn in our area into a time of year when times of wet weather and saturated soil are followed by clear nights, skyward radiation and temperatures dropping below the freezing point by a few degrees. Such conditions favor the development of needle ice at night which lifts soil particles, stones, and poorly established seedlings night after night 1/4", 1/2", or even 1" or 2". During the day the needle ice commonly melts. For several years now, we have kept careful records of the "needle ice nights" occurring at the University of British Columbia farm and find that in some years they are many and in some years, few. In one winter, 1960-61, we recorded over 50 needle ice nights - 50 nights on which grass seedlings at a time of year when growth is very slow - were tugged at and pulled out, or during which soil was removed from around their roots and crowns.

To make a fairly long story short, we found that to reduce needle ice damage, we could alter the microclimate at the soil surface sufficiently to prevent or reduce needle ice formation and damage by:

a) heavier rates of seeding - to produce a very solid mat of living seedlings, or by
b) creating a thin organic mulch of straw or other coarse material over the seedbed, or by
c) earlier seeding and better stand establishment.

We found also that some soils produced a good deal of needle ice and others tended to produce little. Certain organic and muck soils produced a great deal as did our light upland Alderwood soil. Heavy soils tended to surficial freezing and little needle ice. Severe damage to new grass seedings was associated with pronounced and frequent needle ice development.

2. Winter water saturation of turf

There are parts of the Pacific Northwest, advertised widely as the "Evergreen Playground", where, in winter, the turf is green but where it is saturated with water for such long periods of time as to be a mite misleading regarding play. Nonetheless, under these conditions there are legions who insist on playing on water saturated greens and playing fields.

Temperatures are commonly near to freezing and growth of turf is exceedingly slow. The injury to turf under conditions of use and non-use at this time of year is complex, and we feel we are just beginning to know our problem.

We have established that even on quite well drained turf, roots die and often we have found ourselves working with a superficial turf growing under a hydroponic culture not more than 1/4" deep. The turf under these conditions is very subject to wear and slow to recover, is very subject to sharp frost or snow cover, and is often quite susceptible to fungus attack.

Alternate greens, better draining profiles, aerification, are all measures which alleviate but don't prevent damage to turf or reduce susceptibility to damage. Currently we are following the lead of the Sportsturf Research Association at Bingley, Yorkshire, England, and we are laying out electric heating cable in a green with thermostatic controls to see if some of our winter saturation difficulties can be met.

3. Ice Sheet Injury to Turf by S. Freyman

a. Extent of Damage-- Damage to turfgrass and forage crops due to ice-sheet is sporadic, but often widespread and devastating.

For example, in British Columbia, widespread damage is attributed to ice sheets which lay over large areas for long periods of time in 1940-41, 1948-49, 1952-53, 1958-59, 1964-65. Of these, by far the most serious was the 1940-41 ice sheet which blanketed the soil surface in open areas from Terrace to Edmonton, Alberta - an east-west distance of over 400 miles, and also extended a considerable distance to the south.

Elsewhere in North America, particularly in the middle western states and adjacent to Canada, widespread ice sheets are well known.

b. Nature of the Ice Sheet--Ice sheet injury appears to be associated with the development of a continuous ice cover of variable thickness and of long duration, usually over unfrozen soil. Ice sheets are often associated with alternate freezing and thawing with intermittent snow; frequently the ice and snow crusts may be several inches in thickness; moreover these ice sheets may persist for many weeks or months.

c. Nature of the Damage--It has been widely assumed that damage is in some way directly associated with the ice cover, and not necessarily with sharp frosts and freezing of plants. However, injury associated with ice sheets *per se* is not always easily distinguished from winter injury associated with winter drying or desiccation, winter crown rots and other low temperature organisms. The most general reason given for ice sheet damage is suffocation or inability of the soil to exchange gases with the atmosphere because of ice impermeability. Experimentation has by no means proven that gas exchange is the responsible factor, and many workers question suffocation as a cause. New techniques such as gas chromatography and oxygen diffusion determinations make a new experimental approach to the problem of gas exchange desirable. This is the basis of our work.

d. Resume of earlier work-- Workers in Wisconsin have long displayed an interest in ice sheet injury. In the 1930's, Sprague and Graber (1) as a result of a series of experiments with alfalfa concluded that smothering resulting from an accumulation in the soil and plant of the by-products, chiefly gaseous, of respiration, was fundamental in ice sheet injury. Brierley and associates (2) in Minnesota were of the opinion that much of the injury in the field commonly attributed to "ice smothering" is due to lethal temperatures, excess water at the time the plants emerge from the dormant condition or a disease that may have had its inception in winter injury such as broken roots. Bergman (8), earlier found that water under ice in cranberry bogs was deficient in oxygen. Vasil'yev (5) states definitely that perennial grasses under Russian conditions do not die no matter how long they are under ice and commence their growth in spring like plants wintering under snow. Beard (3), (4), in several studies of ice sheet injury in turfgrasses found that bentgrass exhibited greater tolerance than bluegrass to injury associated with ice-cover, and is of the opinion that increased tissue moisture content which raised the killing temperature was an important factor. Sufficient of a fairly large amount of literature has been reviewed to indicate the fact that ice sheet damage to turf and herbaceous perennials is widespread, but that the reasons for and nature of injury or injuries under ice sheets has not clearly been established.

e. Our Statement of the Problem--The problem as it exists today may be described briefly as follows:

1. Vasil'yev (5) states unequivocally that ice under the conditions of his experiments has proven to be quite permeable to air and is representative of opinion opposing suffocation as a factor in ice sheet injury.

2. Hemmingsen (6) of the Institute of Zoophysiology in Oslo, Norway, found CO_2 permeation through ice to be about two million times less than in water and no permeation of oxygen through ice could be detected. In sea ice gas permeates through intercrystalline brine films rather than through ice crystals. In asking the question whether or not gas exchange can possibly take place through ice which entombs organisms, Scholander and associates (7) found that ice is extremely gas tight, indeed as tight as is glass to helium.

3. There seems every reason for believing on theoretical grounds that ice impermeability to the gases of soil and air is a factor in ice sheet injury of turfgrasses and other perennial herbs.

f. Experimentation in Field and Laboratory-- With recent developments in gas chromatography and oxygen diffusion measurement we believe that it is possible in laboratory and field to establish whether or not oxygen deficiency or carbon dioxide toxicity or both, developed under ice sheets of prolonged duration over turfgrass. The advantage present workers possess is that modern equipment permits measurements of oxygen and carbon dioxide in soil and plant simultaneously and precisely.

The equipment for field and laboratory determination is quite sophisticated and probably does not warrant description at this meeting. Climate did not cooperate very well for our field determinations last year and there is nothing to report from our field trials. Under laboratory conditions, however, success attended efforts. Greatest difficulties encountered were the establishment of gas tight systems to include living plants in environments closely simulating those of the field. Care was needed to produce small ice sheets artificially with gas tight margins; it was found, for example, that thick-walled plastic pots commonly employed by experimentalists were not gas tight. Progress was further complicated by the long periods of time, several weeks to months, required to produce responses in plants.

The stage was reached where with confidence we could say that overwintering alfalfa plants were killed in several weeks experimentally, on a number of occasions after being encased in an artificial ice sheet. Furthermore marked changes in the composition of the soil atmosphere were concurrent with the death of the plants. Carbon dioxide accumulation was marked, although residual oxygen was considerable.

Work, of course, is still in progress. The relationship of the lethal effect to initial soil atmosphere volume, soil water volume, soil temperature, activity of soil organisms, root respiration, and breaks in the ice sheet due to organic matter in the ice, to turf damage have yet to be completely assessed. Root volume variation and tolerance of different species to low temperature anaerobic systems have yet to be determined. This winter we will attempt to confirm with our equipment the differences found by Beard between bluegrass and bentgrass under ice sheets and probably extend them to include some other north temperate species such as ryegrass, fescue, and orchard grass.

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Winter Damage of Turfgrasses[1]

James B. Beard[2]

The results presented in this paper are based on findings obtained under Michigan conditions. It is hoped

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1. Contribution from the Department of Crop Science, Michigan Agricultural Experiment Station, East Lansing. A portion of this work was supported by a grant from the Michigan Turfgrass Foundation.
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that these results will assist the Pacific Northwest turfmen in better understanding winterkill which occurs under their particular regional conditions.

Discussion and research on the causal factors involved in winter injury of turfgrasses may appear at first to be academic. However, the causes of winter injury must be described and understood before the best cultural and management practices can be developed to minimize winter injury.

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

For the purpose of this discussion, the causal agents of winter injury of turfgrasses have been divided into eight categories. The order of presentation is not related to their relative importance. The degree of injury caused by any one causal agent may vary from year to year and from one location to another. However, under Michigan conditions, three main causes of winterkill are: direct low temperature injury, desiccation, and winter diseases.

I. Direct Low Temperature Injury to Hardened Plant Tissue

Injury caused by freezing temperatures involves mechanical destruction of the protoplasm in plant cells. Hardened plant tissue is more able to survive low temperatures as a result of changes which occur within the cell. The changes include an increase in soluble carbohydrates, a reduction in level of hydration or water content in the plant tissue, and an alteration in the proteins. Temperature conditions averaging between 30 and 40° F. for a period of three to four weeks will result in a plant which is low temperature hardy. Any management practice which stimulates growth, such as nitrogen fertilization, will reduce the hardiness level.

Considerable variation can be found in the low temperature hardiness of the more commonly used turfgrasses. The relative low temperature tolerance of 11 turfgrasses is presented in Table 1. The ranking is from most to least tolerant and is based on observations made under Michigan conditions.

Table 1: The relative low temperature tolerance of 11 field hardened turfgrasses ranked from most to least tolerant.

1. Bentgrass
2. Roughstalk bluegrass
3. Kentucky bluegrass

4. Annual bluegrass
5. Red fescue
6. Redtop
7. Tall fescue

8. Perennial ryegrass
9. Zoysia
10. Annual ryegrass
11. Bermudagrass

Creeping bentgrass and roughstalk bluegrass have proved to be by far the most low temperature tolerant turfgrasses. The colonial bentgrass, Astoria, is much less low temperature tolerant than the creeping bentgrasses.

Next in degree of tolerance are the Kantucky bluegrasses with Merion being more hardy than either common or Newport. Characteristically, Merion discolors and stops growth in early fall--thus permitting it to achieve maximum hardiness. On the other hand, Newport continues to grow throughout the fall period and, therefore, is the least low temperature tolerant of the three varieties.

Annual bluegrass, red fescue, redtop, and tall fescue are intermediate in low temperature tolerance. Although normally considered a weed, annual bluegrass is included because it constitutes a major portion of many close-cut, irrigated turfs in certain areas. Kentucky 31 tall fescue is more low temperature tolerant than Alta fall fescue.

A third group, including perennial ryegrass, zoysia, annual ryegrass, and Bermudagrass, show the least low temperature tolerance of the turfgrasses. The Norlea variety of perennial ryegrass is more winter hardy than common perennial. Although there are bermudagrass and zoysia selections that are quite low temperature tolerant, as a group the commonly used varieties rank low.

The degree of low temperature kill at any one temperature depends upon a number of factors. These include: (a) rate of freezing, (b) rate of thawing, (c) number of times frozen, (d) length of time frozen, (e) hydration level of the tissue, and (f) the post-thawing treatment.

Turfs killed by low temperatures during the MSU studies had a distinctive odor similar to that noted under field conditions.

II. Direct low temperature injury to plants in a reduced state of hardiness.

This type of injury is closely related to category I but is discussed separately for emphasis.

Turfgrasses usually reach peak hardiness in December followed by a gradual decrease. The decrease is relatively slow during the month of January but is then accelerated during February. The least low temperature tolerance of the entire winter period occurs in March and April.

The two critical periods of low temperature injury of turfgrasses are: (a) during late winter thaws, and (b) just after spring thaw.

The first critical period is during periods of alternate freezing and thawing in late winter when plants are in a reduced hardiness state. Certain combinations of freezing and then thawing for a period of four hours or more, followed by refreezing to below 25° F. can cause serious injury to turfgrasses. Annual bluegrass is particularly susceptible to this type of kill since it initiates growth processes quite rapidly resulting in reduced hardiness and greater susceptibility to low temperature kill. The more hardy, perennial grasses, such as Toronto creeping bentgrass and Kentucky bluegrass, do not exhibit any great degree of susceptibility to injury of this type.

The second cretical period occurs when the grass appears to have survived the winter in excellent condition. Subsequently, the weather may turn warm for several days which accelerates the loss of low temperature hardiness. This loss of hardiness results from the premature initiation of plant growth processes causing an increased hydration level within the plant. Should temperatures drop below 25° F. at this time, serious direct low temperature injury to turfgrasses may occur. The grasses most susceptible to kill under these conditions are annual bluegrass, red fescue, tall fescue, and ryegrass.

Low temperature injury to turfgrasses which are in a reduced state of hardiness seems most prominent in the region from Chicago east through Michigan, Ohio, Pennsylvania, New York, and the New England states.

III. Desiccation

Kill from desiccation occurs when water loss from the above-ground plant tissue exceeds uptake and transport from the roots. The inability of roots to take up water may be due to a lack of soil moisture or to the water being in an unavailable, frozen state. Kill of this type commonly occurs on elevated locations which are exposed to drying winds and is more prevalent in open, dry winters. This is a major cause of winter injury in the northern plains states and Canadian provinces.

Desiccation can also be the secondary cause of winter injury where extensive damage to the plant root system renders the plant incapable of providing water for the above-ground plant parts. In this case, the primary causal factor would be direct low temperature injury to the root meristematic tissue or lower crown with subsequent total kill of the plant caused by the secondary factor, desiccation.

IV. Toxic accumulation of respiratory products under ice sheets

Carbon dioxide is a by-product of plant respiration processes. Even at below freezing temperatures a minimum respiration rate exists. Thus, it is possible in time for killing concentrations of carbon dioxide or similar toxic breakdown products to accumulate.

Sprague and Graber (8) of Wisconsin have reported injury of this type in alfalfa. However, investigations at Michigan State (2) have not shown toxic accumulations of plant respiratory products after 90 days of ice coverage to be a serious problem in winterkill of perennial grasses. The degree of kill from four different types of ice cover was evaluated. Table 2 shows the percent survival of hardened Toronto creeping bentgrass, common Kentucky bluegrass and annual bluegrass which were flooded, frozen, and held at 25° F. for intervals up to 90 days. Note that the bentgrass survived 100 percent after 90 days coverage. Kentucky bluegrass and annual bluegrass showed no significant injury after 75 days, but 30 and 50 percent kill, respectively, after 90 days.

Table 2: The percent survival of field hardened Toronto creeping bentgrass, common Kentucky bluegrass, and annual bluegrass after having been flooded, frozen, and held at 25° F. for intervals of up to 90 days.

	Percent Survival		
Treatment Interval (Days)	Toronto Creeping Bentgrass	Common Kentucky Bluegrass	Annual Bluegrass
0	100	100	100
15	100	100	100
30	100	100	100
45	100	100	100
60	100	100	100
75	100	100	80
90	100	70	50

The effects of ice sheets under field conditions was also investigated (3). The ice covers remained in place for 51 days, which is the longest period that has been achieved in the last five winters. The survival of common Kentucky bluegrass and Toronto creeping bentgrass was evaluated under these two treatments and is presented in Table 3.

Table 3: Percent survival of common Kentucky bluegrass and Toronto creeping bentgrass leaves, crowns, rhizomes, and stolons resulting from a two inch ice coverage for a period of 51 days.

Treatment	Species	%survival after 51 days Leaves	Crowns	Rhizomes or stolons
Direct ice coverage	Ky. bluegr.	100	100	100
Direct ice coverage	Tor. bentgr.	30	100	100
Ice layer over snow	Ky. bluegr.	100	100	100
Ice layer over snow	Tor. bentgr.	100	100	100

Results showed no injury to common Kentucky bluegrass and Toronto creeping bentgrass crowns, stolons, or rhizomes after 51 days of coverage inder a two-inch ice layer. Kill to bentgrass leaves occurred after 51 days, but new growth from buds in the spring readily replaced the injured leaves. Generally, bentgrass was less susceptible than bluegrass to injury associated with ice sheets. Also, a snow layer under the ice reduced injury.

Although toxic accumulations of plant respiratory products may cause kill from ice coverages in excess of 50 to 60 days, it still must be proven that it is a major cause of winterkill of turfgrasses. These studies were conducted on relatively thatch-free material and do not rule out kill caused by toxic accumulations produced by fungi or fungicides which have not been evident in these studies.

V. Oxygen suffocation under an ice sheet

The respiring plant requires oxygen for maintenance of plant tissue even at extremely low temperatures. It has been suggested that the ice sheet could impair oxygen diffusion to the extent that, in time, it might become limiting. The MSU results presented in the previous paragraph cast doubt on this.

VI. Leaching of vital cellular constituents when plants are submerged in water

During thawing periods, the grass leaves and crowns may be submerged in water for a period of time due to poor internal or surface drainage. Injury due to severe leaching during submergence has been observed in small grains. Turfgrass injury caused by leaching was investigated at Michigan State (2). Shown in Table 4 is the percent survival of field hardened Toronto creeping bentgrass, common Kentucky bluegrass and annual bluegrass after being submerged in water at 35° F. for periods of up to 90 days.

Table 4: The percent survival of field hardened Toronto creeping bentgrass, common Kentucky bluegrass and annual bluegrass after having been submerged in water at 35° F. and held for intervals up to 90 days.

Treatment Interval (Days)	Percent Survival		
	Toronto Creeping Bentgrass	Common Kentucky Bluegrass	Annual Bluegrass
0	100	100	100
15	100	100	100
30	100	100	100
45	100	90	100
60	100	90	100
75	100	85	95
90	100	80	90

No significant kill of the three species was observed during the 90-day period when held at near-freezing temperatures and provided with a 12-hour low intensity light period. This suggests that leaching of vital cellular constituents is not a primary cause of winter injury at near-freezing temperatures.

VII. Heaving

Kill due to soil frost heaving is not a problem in established sod. However, on late fall or early spring planted grasses, heaving and kill of young seedlings can be a serious problem.

VIII. Winter diseases of turfgrasses

Low temperature parasitic fungi of concern include: snow mold (Fusarium spp., Typhula spp., etc.) and spring dead spot. These diseases can cause serious injury if steps are not taken for their control. If the soil does not freeze before a lasting snow cover is established, then microclimatic conditions under the snow are especially favorable for low temperature fungal activity. The potential seriousness of winter diseases is widely recognized and fungicides are available for protection and control.

Factors Contributing to Winter Injury

The following six factors are not basic causes of winter injury but can result in increased kill. For the most part, these factors are under the control of the professional turfman. He should be cognizant of these factors and attempt whenever possible to follow management practices that will insure the best possible winter survival.

A. Increased Water Content in the Plant Tissue

Any increase in tissue moisture content will reduce the hardiness level of the plant and increase its susceptibility to low temperature kill. Investigations by Olien(7) show that as the tissue moisture content of hardened barley plants is increased, the killing temperature is also raised (Table 5). Also, root meristems or the lower crown, showed greater injury at higher temperatures than shoot meristems or upper crown tissue.

Table 5: Freezing processes in two regions of barley plants adjusted to three moisture contents. Olien, East Lansing, Michigan. 1964.

Moisture content (gm. H_2O/ gm. of dry tissue)	Temperature of Severe Injury: Young leaves and leaf meristem	Young roots and root meristem	Killing temperature
3.5	25°F.	25°F.	25°F.
2.5	0°	25°	5°
1.5	0°	0°	0°

This differential susceptibility to injury of shoot and root meristems was observed in annual bluegrass by Beard and Olien(4). Microscopic examinations of longitudinal cross-sections of injured annual bluegrass crowns, collected from Michigan fairways in early April, showed the lower crown and root tissues to be completely degenerated while the young leaf and meristematic areas were uninjured. Kill to the lower crown and root system resulted from low temperatures which probably occurred sometime during the late winter or early spring period.

Kill caused by low temperature injury to the roots and lower crown is characterized by the following symptoms. The turf exhibits healthy foliage at the time of spring thaw but subsequently dies after several warm, sunny days. Warm temperatures promote growth and transpiration of aboveground tissue as well as degeneration of injured root and crown tissue. Plants with severely injured crowns may not be capable of providing a new root system rapidly enough to meet the water uptake requirements of transpiration. Under these conditions, the upper plant tissue becomes desiccated and dies. The ultimate cause of death, is desiccation. However, the primary cause was low temperature injury to the annual bluegrass roots and lower crown.

Physical and environmental factors which can cause increased tissue hydration levels (water content) include the following: (a) Poor surface drainage. Low spots accumulate water causing the grass crowns to be submerged; (b) Inadequate internal drainage of the soil. Compacted soils impair drainage causing the submergence of grass crowns. It is commonly observed that greater injury occurs on heavier soils, areas of concentrated traffic, and older, more compacted turf areas; (c) Ice or snow accumulations which impair surface drainage and cause ponding of water and resulting submergence of the grass crowns; (d) Melting from beneath the ice or snow layer with no means of draining the water away from the grass crowns. In this condition, the grass crown may be submerged for an extended period of time. The removal of ice or snow layers from a turf may simply be a means of mechanically draining or removing the water from the area.

All four conditions cause submergence of grass crowns. As indicated earlier, this submergence will not cause serious injury due to leaching. However, submergence does result in increased water levels within the tissue. If these tissues are subsequently exposed to temperatures below 25° F. serious kill may result.

B. Excessive or Late Fall Nitrogen Fertilization

Any factor which stimulates growth, tends to increase the tissue hydration level and to reduce low temperature hardiness. The effect of high nitrogen fertilization in increasing low temperature kill of 16 turfgrasses was reported by Carrol (5) of Ohio in 1943. Table 6 shows the effect of high nitrogen fertilization on five of the grasses included in this study. In every instance, the grass survived better at the lower nitrogen level. Other studies, Carrol and Welton (6) showed that late fall nitrogen fertilization of common Kentucky bluegrass caused increased low temperature kill.

Table 6: Percent survival of five field hardened turfgrasses following a single cooling to different soil temperatures, Carrol, Wooster, Ohio. 1943.

Grass	23°F.		14°F.		5°F.		-4°F.	
	LoN	HiN	LoN	HiN	LoN	HiN	LoN	HiN
Common Kentucky bluegrass	100	90	80	60	25	5	20	5
Annual bluegrass	80	50	40	10	3	1	5	0
Astoria bentgrass	90	80	60	50	0	0	0	0
Red fescue	80	65	60	25	0	0	0	0
Perennial ryegrass	70	20	0	0	0	0	0	0

C. Potassium Deficiencies

Adams and Twersky (1) in Georgia have shown that increased potassium levels reduce low temperature injury of coastal Bermudagrass. Using potash rates of 0, 50, 100, and 200 pounds per acre, the degree of stand survival was increased with each increased increment of potash. The effect of potassium in reducing kill was greater at higher rates of nitrogen.

Similar responses from potassium have been reported in legumes, but no detailed work has been done on the cool season grasses. However, the findings from legumes and warm season grasses suggest that a similar response to potassium might be expected on the cool season grasses.

D. Height of Cut

General field observations indicate that grass cut at one inch or more survives low temperature injury better than when cut shorter. The higher cutting height could function in two ways: a) as an insulating factor, or b) by providing increased photosynthetic area for carbohydrate production and ultimate storage for increased low temperature hardiness. It might prove beneficial to permit fairways, particularly annual bluegrass fairways, to go into the winter at a one-inch height or higher.

E. Excessive Thatch Accumulation

Thatch tends to elevate the grass crowns, rhizomes, and stolens above the soil where there is a greater chance of low temperature injury. This is due to a reduction in the protective influence of the soil, since soil temperature minimums are generally not as low as air temperature. Also, turfs with excessive thatch are more susceptible to injury by low temperature fungi and desiccation.

F. Traffic Control

Areas subjected to human and mechanical traffic during the winter will have a greater chance of being injured. The effect of a 160-pound man stepping on a 5 by 5 foot plot of hardened common Kentucky bluegrass when covered with slush was evaluated at Michigan State University. Results of this traffic showed complete kill of Kentucky bluegrass leaves, crowns, and rhizomes, with no recovery throughout the remainder of the subsequent growing season. This illustrates the importance of judicious traffic control, particularly during periods of freezing and thawing when high soil moisture conditions exist.

SUMMARY

Direct low temperature kill, desiccation, and low temperature fungi are three major causes of winterkill which concern turfmen. Injury from these three causes can be minimized by:

1. Employing management and construction practices which insure adequate surface and internal drainage for the removal of excess water, plus mechanical removal of ice or snow layers when warranted.
2. Avoidance of excessive thatch accumulation.
3. Judicious, early fall nitrogen fertilization.
4. Insuring adequate soil potassium levels.
5. Avoidance of any cultural practice which stimulates late fall growth.
6. Raising the height of cut in late fall, especially fairways and tees.

7. Proper use of fungicides.
8. Use of covers, snow traps and similar devices in areas prone to desiccations, plus mid-winter applications of water when needed.
9. Eliminating traffic on dormant turfs, especially during periods of freezing and thawing and when soil moisture levels are at or near saturation.
10. Avoiding any practice which will prematurely initiate early spring grass growth.
11. Use of management practices to reduce or eliminate annual bluegrass.

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Planting Ornamentals — What, When, and Where

Harold T. Abbott[1]

What

Early in the summer, Dr. Roy Goss invited me to share with you some thoughts regarding landscaping, ornamental plants, or management of outdoor areas. And although this organization is the Northwest Turfgrass Association, I recall that many of you are not golf superintendents, but park superintendents and cemetery superintendents. You all work with turf and you all must also be familiar with the other classes of plant materials.

So it seems fitting that we take a few minutes to review some of the basic facts regarding these materials as they apply to our areas of authority and responsibility. We speak of these plant materials generally as "ornamentals" a term often misconstrued along with "beauty" and "beautification". It is most fortunate that all of a sudden, these terms have been given national status and are now being highly respected by even those who at one time ridiculed anyone who spoke of a beautiful America or highway beautification. Ornamentals in the sense in which we use it is a term applied to plant materials grown for the enhancement of our environment, and to create architectural forms significant in defining outdoor space. The growing of maple trees in a nursery may be for ornamental purposes or for reforestation, which in itself would not be considered as other than a commercial crop, like wheat or strawberries. Ornamentals are regarded not as a crop to be harvested but as a relatively permanent planting, subject to all the skill and attention possible for an indefinite period of time.

If we were to spend the time to analyze the purposes of ornamentals, we would be required to look at the entire field of planting design. We would see that the sense of enclosure, the defining of distance, the determination of space, and the description of extrinsic and intrinsic values constitute

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some of the functions of ornamentals when used in the planned landscape development.

Plantings consist of turf, shrubs (including woody groundcovers), trees, and herbaceous plants such as perennials and annuals. Turf, because it is our major plant material, I mention separately, even though it is made up of herbaceous plants, both perennial and annual.

Turf is the basic material in all landscape work. It is the most practical and economical to maintain. It is essential for a wide scope of outdoor uses in recreation, for erosion control, and as the background for architecture. In combination with other plant materials its texture and col color contrasts with and enhances these materials. It serves as a background or a ground cover upon which the cast shadows from taller plants may be of advantage in defining distance.

Shrubs are multistem woody plants. In structure, they generally branch from a crown at ground level, but they may develop their branching from a single stem just above the surface. The range of forms is variable, from exceedingly dwarf structure to tall treelike clumps. There are types that are horizontal or procumbent; others of compact vertical habit, suitable as conspicuous accents or for combining into excellent hedge masses. Our selection of appropriate materials will require fundamental knowledge of the chief characteristics, whether evergreen or deciduous, broadleaf, s scalelike, or needlelike. We must determine whether we desire shrubs for flower, fruit, colored foliage, or colored and textured bark. The seasons of outstanding attraction, and the length of time when such attractions can be counted on, are factors to be figured in the planning of ornamentals for display.

The maintenance of deciduous shrubs as compared with evergreens should be a matter for consideration. In those regions where broadleaf evergreen shrubs are not generally reliable, needletype evergreens must many times be substituted. Where deciduous shrubs are used, a much more regular program of pruning than where slower evergreens serve the purpose.

Trees are woody plants having single main trunks or axes. Often they are so trained in their early days that a shrublike form is encouraged. When several are planted together, the popular clump, as used often today, will develop. Trees are the basis for the principal structure in the landscape plan. Trees are generally regarded as the permanent plant material, presenting height or great width in the design. There is a tremendously wide range of forms within the classifications listed for the planting designer. Within recent years, the common forest type trees have given way to improved forms, many of them ideally suited for restricted areas or where special effects are desired.

In the selection of trees, as with shrubs, their value will be dependent upon characteristics of quality and refinement. They should be durable, reliably hardy, free from insects and diseases, and be free from litter. They should be distinctive for their foliage color and texture. Flowers and fruits should not be of an objectionable odor. They should have fruits of color and persistence. Root growth should not be unduly aggressive.

Herbaceous plants are those referred to as annuals and perennials. Some are biennial in habit and the bulbs are usually referred to as perennials. They are transient in the garden, require skillful and regular maintenance. For dramatic color effects, these plants are popular attractions in parks, cemeteries and in other public and private areas where adequate personnel is available. With shrub plantings, annuals and perennials may be used for effective color after the flowering season of the shrubbery.

When

Louis Sullivan's apt phrase "Form follows function" could be applied rather appropriately to our discussion here with the paraphrase "Planting follows Planning". Far too often planting design is left to the end of the program of landscape development. Even among people who claim to recognize the importance of planning in their own professional work, there are some who will treat with casual indifference the coordinated planning of outdoor space, and in particular, the development of the land and its plantings.

The extent of the work is immaterial. A single tree improperly placed may be in conflict with the efficient use of the entire area. Once planted, sometimes at considerable expense, it is difficult to move or destroy the tree to carry out the original plan.

Time for planting depends upon two main issues, first, the determination that the design is satisfactory, and second, the suitable season for guaranteeing successful plant growth. When to plant is determined by the normal local conditions, the experience of qualified plantsmen in the area, and the availability of the materials themselves. Fall planting versus spring planting is often a matter of discussion in eastern Washington. I am one of those advocates of late winter and spring planting, because of the opportunity then offered to follow through with proper attention to the protection of newly planted materials particularly in the maintaining of adequate moisture in the plant during its critical period of change of environment. Where the extremes of winter temperature, moisture loss, and excessive drying winds must be watched, it is recommended that fall planting be done only in very favorable locations.

Planting seasons have been extended in recent years by the increase in container grown materials. Even through the summer months, trees and shrubs in full leaf may be moved with real success, with the aid of plastic sprays applied to the foliage before and after planting. Plastic sprays have proven highly desirable when used in the fall to reduce winter foliage burn on plants being established during their first growing season. The spiral wrapping of the trunks of newly planted trees reduces the incidence of sunscald and drying also during the first couple of growing seasons, especially on trees such as horse chestnuts, beeches, maples, birches, lindens, and other smooth barked trees. In western Washington, where winters are comparatively mild and the periods of severe frost conditions are of short duration, planting may be carried on throughout the year. As we cross the Cascades and enter the middle hardiness zones of 5 and 6, we find it difficult to decide when to plant.

For large scale work involving the moving of sizable specimens of both evergreen and deciduous trees, it may be good planning to root prune for at least two years in advance, and then to proceed with the work of moving when the balls of earth are frozen. Modern equipment is available whereby large trees may be cut free from their established location and within a few minutes be transported to their new locations without any serious loss of roots and soil moisture. With proper care, trees and shrubs may be kept, balled and burlapped, out of the ground for long periods awaiting a convenient time for planting, but such delays should be accompanied only by well organized programs of protection against winds, maintenance of soil content in the balls, and application of adequate mulches and screens.

Where

Again, plan before planting to be assured of the correct location for plant materials or ornamentals. Whether it is a golf course, highway right-of-way, a cemetery, a school, park or residence, the work may be impaired by not studying the planting requirements along with the architectural plans, the grading plans, and all related details. Far too often the outdoor spaces are planned after the buildings have been conceived, in fact, often times, constructed.

Many lists are available giving the names of trees and shrubs best suited to specific growing co-ditions. Recognition of the types of habitats in which introduced ornamentals have been growing mean far greater success to the plantsman as he prepares new growing conditions for these exotics. He will review his inquiry concerning hardiness, the need for protection against driving winds, dependence upon other compatible plants, the depth of soil for adequate root growth, and the relative demands for moisture, heat, and light.

The selection of plants for landscape use cannot be covered within the scope of this discussion. We can merely cite a few examples as we examine some of the illustrations of plant materials in representative works of landscape design. There is an increasing need in our design offices, for men and women well trained in planting design, people who have a good background in the appreciation of outdoor use areas and what plant materials will enhance these spaces and encourage their efficiency for many years. They must know what sort of maintenance equipment will be used, in order to assure adequate spacing to allow convenient access for such equipment. Appropriateness of materials, such as moisture loving plants for bogs, swamps, stream banks and other wet locations, means more suitable growing conditions will be in areas of this character. For parking area islands, it is reasonable to assume that upright, narrow trees would be more satisfactory than forest type trees with extensive spread that would annoy car owners. It is surely reasonable for the golf course designer to understand why the silver poplar or the silver pendent linden could prove to be nuisances to players during the fall season, when hundreds of white leaves camouflage a well placed golf ball.

Where adequate maintenance is available, mixed plantings of shrubs, ground covers, and flowers are desirable; however, it is more economical to maintain larger plantings of a single species where possible. Trees whose beauty lies in the preservation of the lower limbs, will lose much of their attractiveness if the use area requires the removal of all limbs to a height of a tractor mower and its operator. The browsing line may be acceptable in an English pasture, but not on a well landscaped golf course.

Planted areas are properly placed if they can be enjoyed as background for recreation. They must be so located that they do not handicap the public in their use of the adjacent open space. It has often been stated that a tree on a golf course that poses an unfair handicap to the player should be removed. Encroaching or invading roots of trees near by often become the reason for the removal of excellent specimens.

An eastern nurseryman has in recent years built up quite a business selling what he calls "Tailored Trees". He maintains that there is a tree for every special need. The demand is greater than the supply, and the number of new species in the trade is growing year by year. In the slides that we shall now examine, some of the potential values of representative ornamentals will be more graphically described.

Slides of Ornamentals

Trees for Shade

Acer platanoides Cleveland	Cleveland Norway Maple
Acer rubrum Gerling	Gerling Red Maple
Acer rubrum Armstrong	Armstrong Red Maple
Acer rubrum Scanlon	Scanlon Red Maple
Acer rubrum columnare	Columnar Red Maple
Acer sccharum Newton Sentry	Sentry Sugar Maple
Tilia petiolaris	Silver Pendent Linden
Phellodendron amurense	Amur Cork Tree
Gleditsia triacanthos inermis	Thornless Honeylocust
Sorbus aucuparia	European Mountain Ash
Liquidambar styraciflua	Sweetgum
Gymnocladus dioicus	Kentucky Coffeetree
Sophora japonica	Japanese Scholartree
Acer palmatum	Japanese Red Maple

Flowering Trees

Amelanchier canadensis	Eastern Serviceberry
Prunus sargenti	Sargent Cherry
Prunus sargenti Rancho Columnar	Rancho Columnar Cherry
Prunus avium Scanlon	Scanlon Cherry
Prunus yedoensis	Yoshino Cherry
Cornus florida rubra	Pink Flowering Dogwood
Aesculus carnea	Pink Horsechestnut
Koelreuteria paniculata	Golden-rain Tree
Robinia pseudacacia Idaho	Idaho Pink Locust
Magnolia stellata	Star Magnolia
Magnolia soulangeana	Saucer Magnolia
Malus Van Eseltine	Van Eseltine Crabapple

Conifers

Pinus strobus nana	Dwarf Eastern White Pine
Picea abies conica	Arrowhead Norway Spruce
Picea abies nidiformis	Nest Spruce

Shrubs

Viburnum rhytidophyllum	Leatherleaf Viburnum
Viburnum tomentosum sterile	Japanese Snowball
Syrings vulgaris hyb.	French Hybrid Lilac
Syrings chinensis	Chinese Lilac
Euonymus alatus	Winged Spindletree-Burning Bush
Euonymus alatus compactus	Dwarf Winged Euonymus
Prunus tomentosa	Nanking Cherry
Daphne cneorum	Rose Daphne
Teucrium chamaedrys	Germander

Control of Insects and Diseases In Ornamentals and Shade Trees [1]

Jack Daniels

PHYTOTOXICITY & COMPATIBILITY OF PESTICIDES

Phytotoxicity is the tendency of chemicals to injure plants. It can be determined only by actual trial under various conditions and the damage is determined by many factors such as the nature of the chemical, the nature of the additives, the species and variety of the plant treated, the condition of the plant, the vigor of the plant, the season of the year, the concentration of the material used, the temperature and atmospheric humidity. Some chemicals are called active if they react with the plant tissue causing death of the plant. Others are called inert if there is no detrimental reaction. For instance, lime sulphur or dormant oil applied to foliage can damage while safened coppers, highly refined oils and DDT are relatively safe on foliage. Solvents used in pesticides can be toxic to plants and usually are the offenders in the emulsifiable products, particularly where there are combinations of materials used. Wetting and spreading agents can cause penetration of the pesticide into susceptible plant

1. Presented at 19th Northwest Turfgrass Conference, Hayden Lake, Idaho, September 23, 1965.

parts with ensuing damage. A combination of chemicals in the same family can sometimes cause injury to plants, such as a mixture of several chlorinated hydrocarbons. An example would be the combination of Kelthane, Lindane and DDT. A whole botanical family may show tolerance for a certain chemical but this is the exception to the rule. On the other hand a single horticultural variety can be highly susceptible to injury whereas some other species or variety which are related can be very tolerant of the same material. Ethion is an example, most rhododendrons will tolerate it but the Loderi will be damaged severely. The young growth of trees and shrubs can be much more susceptible to toxic materials than the old growth. During fall and winter, concentrations can be increased but only on the deciduous types of plants. Concentration of material is very important. You must adjust the concentrations to meet with the variations of plant species, varieties, temperatures, season, etc. Any chemical regardless of how toxic it may be to plant life can be diluted to a point of plant safety. However, it should not be diluted to the point where it is too weak to do the job. The amount of finished spray material applied is not too important. AS a rule of thumb, get complete coverage of the plant, usually to a run-off point without wasting too much material. Temperatures and atmospheric humidity are to be considered when applying pesticides. Dormant oil sprays should not be applied when there is danger of freezing within 48 hours after application. At high temperatures no pesticide should be applied and low humidity can cause absorbtion of materials into the plant system. Dew or heavy dampness and rainfall of course would tend to dilute and reduce the effectiveness of materials.

Plant diseases as well as insects are predators of plants. These partners in crime can be controlled in many instances simultaneously. It may well be convenient and economical to put the materials on in combination if they are compatible. The ability of an insecticide to be combined with a fungicide without impairing the inherent efficiency of either material, or causing injury to the plant that is treated is referred to as compatibility.

There are many compatibility charts available which indicate which materials may be safely combined. Generally, alkaline fungicides should not be combined with organic insecticides. Sometimes the emulsifiers used in products will create a physical imcompatibility when used together. This would result in excessive precipitation or buttery masses in the spray tank. The use of nonionic surfactants will eliminate this problem. Chemical incompatibility can cause phytotoxicity, decomposition of either material or reduce the residual action of the materials.

I would like to mention a few plants used in the Northwest which do react unfavorably to the application of various pesticides. Bechtel crabapples will not tolerate any spray materials, sometimes plain water will cause leaf drop and spotting, regrettably the crabapple trees are hosts to many insects and diseases and require repeated sprayings. We like to refer to the Bechtels as being the sprayer's dilemma. Cut leafs and some of the other red maple trees and shrubs respond poorly to plain water on the foliage. On the other hand the crabapples and maples will tolerate a dormant oil spray. DDT will defoliate the horse chestnut tree. Defoliation will occur from the usage of Cygon on prunus varieties and as I said before Ethion will burn rhododendrons of the Loderi hybrids. Thiodan, a very effective and broad spectrum insecticide will cause erratic phytotoxic effects on birches. From what we have observed, birches lacking vigor or those which have been in a dry environment will be affected by the material whereas vigorous trees setting in moist areas will be unaffected. Koster spruces and other conifers can be burned severely with spray oils if soaked too heavily or if they are exposed to slow drying conditions after the application of the oil. Oils used in combination with copper compounds or sulphurs should not be used on foliage and coppers used alone can be disastrous to holly. If in doubt about the results of pesticide applications call your county agent first. Most manufacturers of pesticides carry specific compatibility information on their labels. If everything else fails go back and read the label.

Controlling Diseases of Ornamental Trees and Shrubs [1]

Otis C. Maloy[2]

Ornamental trees and shrubs contribute greatly to the appearance and design of golf courses. The fact that trees and shrubs require many years to develop their full potential in golf courses makes their loss a serious problem. Disease may be one cause of this loss. Two broad categories of disease problems may affect trees and shrubs. The first are the non -parasitic or physiologic diseases that are caused, not by living agents, but by some chemical or environmental factor such as drought, winter injury, herbicide damage, fertilizer burn, or mechanical injury. Control of these diseases is not usually difficult providing the plant is adapted to the site and the problem and its cause are accurately determined before permanent damage is done.

Accurate diagnosis is equally important in attempting control of the diseases belonging to the second main category, namely the parasitic ones. These are diseases caused by living agents, such as bacteria, fungi, nematodes, viruses, or even other green plants such as mistletoes. The parasitic diseases may be categorized further on the basis of the part of the plant affected. There are diseases that affect only the foliage, such as mildews, leaf spots, and needle casts. Some diseases affect only the shoots and branches, such as stem rusts and various canker diseases. Diseases such as willow scab and sycamore anthracnose affect both leaves and twigs. Some diseases such as Phytophthora collar rot and Armillaria root rot affect only the lower stem and roots.

Although specific disease problems require specific control measures, there are certain basic approaches to disease control.

The initial selection of species and varieties to be planted is a primary consideration where diseases may be a problem. Many plants vary considerably in their susceptibility

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1.Presented at 19th Northwest Turfgrass Conference, Hayden Lake, Idaho.

2. Extension Plant Pathologist, Washington State University, Pullman, Washington.

to certain plant diseases. And many disease agents have a very wide host range: the root rot fungus, Armillaria mellea, has been reported to attack 562 species and varieties of plants. Knowing the disease history of an area is a great help in selecting varieties for planting.

Cultural practices also play a major role in the control of many plant diseases. These practices may either control a disease or actually contribute to its severity. Heavy irrigation and fertilization which favor lush vigorous growth also favor the development of diseases such as mildews and rusts. Pruning can be en effective method of disease control in removing sources of infection from the plant. Pruning also improves air movement through trees and shrubs reducing the amount of moisture in and around the foliage and making conditions less favorable for disease organisms to develop. Raking and burning fallen diseased foliage is another measure that helps to eliminate sources of infection. Some diseases such as dwarfmistletoe on conifers, and western gall rust on lodgepole and ponderosa pines can be effectively controlled by merely pruning out affected branches.

Chemical sprays are a valuable aid in reducing losses from many foliar diseases. Powdery mildews are effectively controlled by timely applications of sulfur or Karathane. Maneb, zineb, captan, ferbam, and bordeaux mixture are some of the sprays that are successfully used to control many leaf and twig diseases. Often, timing of a spray, is a more important consideration than which chemical is used.

There is no single solution for disease problems on ornamental trees and shrubs and an accurate identification of each problem is necessary for effective disease control. But proper selection of planting material, well balanced cultural practices and a well planned spray program will go a long way toward keeping disease problems to a minimum.

Are You A Good Boss? [1]

Wm. H. Bengeyfield[2]

Since this is the age of "do it yourself", I am going to attempt, in the next fifteen or twenty minutes, to put you to work both physically and mentally--and thereby avoid having to work too hard myself. You can see that this is going to be an unorthodox presentation and you are in for a treatment rather than a treat. When it is all over however, I hope that the experience will be a memorable one and perhaps, because of it, you will have a greater insight to the emotions and feelings of the new worker on a rather important day in his life--starting a new job.

We are going to attempt some very simple projects and I will need your full interest, cooperation and participation if this undertaking is to prove to be worthwhile. For this reason, I should like to ask you to relax and to consider this an informal affair.

Each of you have received three of the 5 x 8 cards normally used for office indexing. Now the first project that I ask is for everyone to take one of your index cards and make one of these simple paper boxes exactly like the one I hold in my hand. It is a very simple box made from a flat piece of paper similar to the one you will use. With this audience of above average intelligence, we will surely have no difficulty in solving this fourth grade problem. Incidentally, this is a leakproof box as there are no cracks in the bottom or on any of the box sides. All of the edges of the paper are at or above the top level of the sides of these boxes. Your cooperation is desperately needed as the rest of my presentation depends upon you making such a box right now

(At this point, you might point out and name three or

1. Presented at 19th Northwest Turfgrass Conference, Hayden Lake, Idaho, September 23, 1965.
2. Western Director, United States Golf Association, Green Section, Garden Grove, California.

four individuals in the audience and encourage them to get started on this first project. After a short delay--perhaps one or two minutes--continue with below)

Well, I can see that things are not going to rapidly on this first project so let's have a brief word of explanation. Now if you will all stop your present work, I will show you very briefly how to make this box so that we can proceed.

First, let's take a new sheet of paper. This should be folded into three equal parts. This is done in width as well as in depth of the paper. (Demonstrate with a fresh card. Then, before the audience has completed their work, proceed to the next explanation).

Now, in the upper left hand square that has been formed by these folds, all you need do is fold from the center of the left hand margin to the lower right hand corner of this upper left hand square. Repeat this on all four corners. Very simple--it's simply a fourth grade problem.

(Carry out your work without showing exactly what you are doing to the audience. Complete the box and hold it up to show the audience).

Now, if you will complete your box as rapidly as possible we can go on to the next project. I am surprised that in this room of men who have been very successful in a number of fields of endeavor, including turfgrass management are having so much difficulty with this very simple problem. Let's apply ourselves and move forward to the next project. Here is the box, it was made from the same type of paper that I asked you to make yours. It was done right here before you. It is a leakproof box with all of the paper edges at or above the top level of the box. There is no need to tear the paper as this is a simple folding operation.

(Step up comments and urge the audience ever onward with no repeat explanation as to how the box was made. After several moments delay, continue).

Well, let's all stop our work again and see if we can't get together on this very simple undertaking. There is not a great deal of mental or physical skill required and yet something has obviously gone wrong. Why didn't this work out? (attempt to get answers and reactions from the audience).

1. You have never been exposed to this type of work before.
2. Speed of explanation.
3. Terminology used.
4. Mirror effect.
5. No motivation.
6. Poor physical relation in this room.
7. There was not a "successful environment".

Alright, let us correct as many of these reasons as we possibly can and put together one of these simple boxes. Before taking the third piece of paper, let me try to develop your interest or motivation in this undertaking. After all, you should know what these boxes are good for, if anything. Well, the terminology and correct name for this type of box is a "painter's box". Painters use them quite frequently I am told, when they are doing field work such as painting signs along the road, on store fronts, etc. This simple box holds paint indefinitely, it is leakproof, the paint cannot run out and it gives the painter an opportunity to mix paints for a particular tone or shade that he may desire without having to use a lot of extra equipment. After it has been used, it may be easily destroyed and no cleaning or great expense has been involved. Now if you are not a painter, this box may still come in handy as it could be used in a meeting such as this one for an ash tray if one is not provided. It could also be used on camping trips as a cup or small container. If nothing else, you can amaze your friends, the wife and the children tonight by your ability to make a cup from a flat piece of paper that is absolutely leakproof--at least until the paper disintegrates. I'll make a bet that there will be some "painter's boxes" made by some members of this audience at home or in their office in the next few days.

Now, let's all take the third sheet of paper and we will slowly go through a complete explanation that, in the end, you will find very simple.

As we did in the beginning, fold the piece into three equal parts in width as well as in depth. Then, starting with the upper left hand square, fold the paper from the center of the left paper margin to the lower corner of the top left square. In this manner. (slowly demonstrate and perhaps draw a line showing where the fold should be made). Repeat this on the other four corners. After completion, fold the ends into place--and finally, fold the flap down to lock the cup together.

In the last several minutes, I have tried to reverse tables on you. You have been put in the subordinate's place. Exactly the same position that a new worker faces in a totally unfamiliar job. You have experienced some of his emotions and feelings. When we first started the project, there seemed to be a sense of frustration in the audience and I believe you resented me a bit when I expected you to know how to build one of these boxes without an explanation.

They say that "the first step in solving any problem is in recognizing that a problem does exist". When any of us are exposed to a totally new experience or requirement, regardless of our intelligence, we are in a difficult position and not always 'ourselves'. If, in the past twenty minutes, this message has been brought home to you in a forceable manner, then our "do it yourself" visit together has been a successful one.

How many times have you heard people say, "I've told that fellow a dozen times how to do that job, and still he doesn't know how." This shows that someone has done a poor job of training. "Telling" is not instructing.

Instructing is telling, plus showing, plus try-out performance and follow-up. Let the worker do the job. You ask him questions. Let him ask you questions, and before putting him on his own, make sure that you know that he knows.

It is difficult to be a good instructor. It does require patience, tolerance, tact and an honest desire to "know your people". Re-check yourself on these points every so often. Most people want to do a good job and it is up to you to motivate them and to show them exactly what is expected of them. If you will do this, you will surely succeed along with your new crew.

My thanks to this audience for your patience, tolerance, tact and your honest desire to follow this presentation.

Maintenance of Athletic Grounds [1]

Norman Goetze[2]

The purpose of an athletic field is to provide the facilities for the proper support of athletic events which are conducted for enjoyment of the spectators or for the physical development of the participants. The requirements of certain sports have dictated that the fields should be covered with a protective mantle of turfgrass vegetation. Such vegetation may provide better footing for the athletes, a cushion to avoid serious injury and a pleasing atmosphere for the spectators. If turfgrasses are properly used during the athletic activities, they most undoubtedly will be damaged by heavy use and frequent repair operations are required. A perfect stand of turfgrass would probably not support much athletic wear. Hard, coninual use of the athletic areas will damage the stands. Thus, the overall management procedures to be used on the field are a compromise between requirements of the particular sport and best principles of turfgrass management. The purpose of this paper is to relate peculiar management practices that differ from classical turfgrass management as they relate to management of athletic areas.

Management of existing facilities

There is no greater controversy in athletic ground maintenance than mowing heights. The coaches want large amounts of cushion obtained by high mowing heights. They also want little interference to the foot traffic, which is lessened by shorter mowing heights. Obviously, both requests cannot be met. Grasses vary in their reaction to mowing heights. The bentgrasses should be mowed at 1-1/2 to 2 inches in height when used for athletic purposes. Ryegrasses and tall fescue should be mowed no closer than

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1. Presented at Northwest Turfgrass Association Annual Meeting, September 24, 1965.
2. Farm Crops Extension Specialist, Oregon State University, Corvallis, Oregon.

2-1/2 to 3 inches in height. The fine leafed fescues are not very precise in their mowing height requirements and they can be mowed at heights most suitable to other grasses in the mixture. Frequency of mowing should be determined by the rate of grass growth and the accumulation of clippings. Clippings need not be removed if they dry up and fall into the turf within two days after mowing. Grass should be mowed more frequently during the rapid spring growing periods and need not be mowed very frequently during the midsummer period. Frequent mowing during the fall periods will create a more uniform turf with less clipping disposal problem.

The changing of the height of mowing during different seasons of the year is a very popular practice. Reasons for this changing of heights are not too clear. The vigor of the grass is lessened each time the mowing height is changed. The grass will be less affected by altering the frequency of mowing instead of the height of cut. If grasses are being maintained during the playing season at heights lower than those recommended above, some recovery of the root system can be obtained by raising the height of cut to the desirable height during the seasons of the year when the turf is not being used. If adjustments in cutting heights must be made, they should be made drastically so that the grass will have sufficient time to adjust to the new mowing heights rather than over a wider period of time.

The irrigation problems on athletic fields are the same as for other turf uses and are often compounded by surface compaction which reduces the water infiltration rate. Also, many athletic field installations have poor internal drainage resulting from improper soil mixtures. These factors create needs for better designed irrigation systems which apply water at lower rates and over longer periods of time. Since surface compaction results from traffic when the soil is more nearly saturated with water, the irrigation schedules should be adjusted to fit the periods of activity on the field. The best time to irrigate a football field would be immediately after a game and far enough ahead of the next game so that the field is nearly dry when it is being subjected to the heaviest play.

The fertility requirements of athletic turf are the same as for other turf uses, but certain adjustments in seasonal schedules must be made. Grass roots tend to be weakened by heavy application of nitrogen fertilizer. Therefore, nitrogen applications should not be made during the periods of heaviest use. Nitrogen applications should be made immediately following the cessation of activity and the seasonal requirements of the nitrogen should be met from that time up through three or four weeks prior to the first activity of the next season. If the period of use extends throughout the year, or if additional amounts of nitrogen are needed during the season of use, then single application should never consist of more than 40 pounds of nitrogen per acre. Because the resistance of the grass plant to heavy athletic use depends so much on good root growth, extra amounts of phosphorus and potassium should be used in comparison to other turf useages. The greatest response from phosphorus applications can be obtained by fall and early spring applications. There are no problems involved with the use of phosphorus fertilizers during the playing season. Since phosphorus moves so slowly in turf soils, we can get the best response from it by making applications during the rainy season. Potassium can cause serious burning like nitrogen; therefore, it is advisable to use it during the seasons when possible damage from burning are slight. An ideal yearly fertilizer application for athletic turf would consist of 240 pounds of nitrogen, 80 pounds K_2O, and 160 pounds of P_2O_5 per acre. The nitrogen should be applied during the late fall and early spring periods, and the potassium can be applied at the same time as nitrogen or any time during the season when the turf is not being used. Potassium should be handled with as much care as nitrogen, insofar as turfgrass burning is concerned.

On athletic sites where excessive irrigation has been used or where natural leaching has occurred, responses from lime can be expected. Lime can be applied anytime during the season but most rapid responses would be expected from fall or early spring applications. The amounts to apply should be based on soil tests and local recommendations.

The elimination of compaction problems is a continual problem on athletic areas. Alterations in the watering schedule to prevent the heaviest traffic on saturated soil surfaces will prevent compaction. Control of traffic concentrations on specific areas of the field will also eliminate the most severely compacted areas. Aerification schedules should be adjusted so that the greatest benefit can be obtained during periods when grass is making its maximum growth and when traffic will not close up the aerification holes so quickly. On a football field, aerification could best be done during the mid-spring periods so that good air penetration can occur throughout the summer period when the turf is not being used. Aerification during the football season will not have such a long lasting effect. Spiking has not been shown to be permanently beneficial for heavily trafficked areas.

Regardless of how well athletic turfgrass is maintained, it still sustains some injury which must be repaired on an emergency basis. Divots which are removed by heavy foot traffic should be replaced immediately following an athletic event. If such replacement is delayed and the divot thoroughly dries out, healing will not occur.

Grasses like the fescues and ryegrasses do not have vegetative means of reproduction and if a small area of the stand is lost through mechanical damage, overseeding of the damaged area must be done. With these grasses a seasonal overseeding operation should be part of the management schedule. Overseeding can be done in the early fall, late fall, or early spring period with a fair degree of success. Late spring overseeding operations are generally not successful. Overseeding can be carried on in conjunction with an aerification program. Greater success will be obtained if the cores from the aerification operation are broken up and used as a mulch for the new seedlings.

Some of the more heavily damaged areas could be most efficiently repaired by sodding. Production of the sod can be done on the areas of the athletic fields which do not receive intensive use, such as the sideline and end zone areas on football fields, or the outfield areas of baseball diamonds. If sod were produced on the existing facility, the total cost of resodding the damaged areas would not be great. A common mistake being made in sodding is that the sod is being cut too thick. All of the research data indicate that the fastest healing time occurs with thinly cut sod. Sodding should be done immediately after the end of the season, to allow for maximum time of healing prior to the next season of heavy use.

Establishment of New Athletic Areas

Many of the management problems on athletic areas could be prevented by proper construction techniques. More attention needs to be given the soil composition used in the field. An ideal athletic area soil should have excellent internal drainage. This can best be accomplished by using coarse sands which have had most of the fine clay and sand particles removed. Fields which have high clay content do not drain properly after surface compaction. Such a soil mixture should be to a depth of at least 12 inches. If it is impractical to use an ideal soil mixture composed of coarse sand and a minimum amount of silt and organic matter, many of the drainage problems can be solved by having a slope of at least one percent. This gives excellent surface drainage which will cut down the time that the field remains in a saturated soil moisture condition. For surface drainage to be effective, however, there must be ample disposal of the surface water. Slopes of less than one percent will not provide much surface drainage after uneven traffic or settling has occurred. When using high percentages of sand, additional amounts of organic matter may be desirable to increase the nutrient and water holding capacity of the soil. This is not too important where good irrigation facilities are used.

All of the soil requirements for lime, phosphorus, and potassium should be met by soil incorporation of these nutrients prior to planting. They can be mixed into the top 6 inches of the seedbed by rototilling or other conventional tillage treatments. By incorporation, these nutrients will provide a much more effective response than from surface applications after seeding. Rates of application should be based on soil tests and local interpratations but generally we don't expect to get a response from liming on soils having pH's above 6. We can use relatively large amounts of phosphorus which will be available for several years following treatment. Potassium is readily leached from new seedbeds and there is no advantage in providing more than one season's supply during the soil incorporation procedures. Approximately 80 pounds of nitrogen per acre can be incorporated into the seedbed just before seeding. Subsequent applications of 40 pounds of nitrogen per acre should be made to the seedlings as required, based on the general appearance of the grass.

There often is a desire to shorten the establishment time of athletic fields by the excessive use of nitrogen. This is a very unwise procedure, because such treatments cause a shallow root system which is quite susceptible to damage from heavy play during the first year.

There is no one best grass for all conditions of athletic fields. A choice of the grass or mixture depends upon the soils, the use being made of the field and the level of management being planned for the area. Tall fescue is one of the toughest grass species available in this area. It has a very deep root system which is extremely resistant to mechanical wear. The grass also is very drought tolerant and has the longest season of growth and is adapted to a very wide range of soil pH. It must be cut at 2-1/2 to 3 inches in height and is extremely slow in establishment. No plans should be made to use it for at least one year after establishment. It does not have a rhizome system and any permanent mechanical injury must be repaired by sodding or overseeding. Once firmly established, it produces the toughest athletic turf known. The ryegrasses are nearly as tough as tall fescue, but are not so long lasting and are more difficult to mow. They are especially valuable in that they require the shortest period of time for establishment. They are not very well adapted to areas having severe cold winter temperatures. Like the tall fescues, they do not have rhizomes and any damage must be repaired by overseeding.

As a group, the bluegrasses are extremely valuable for use in athletic fields in the interior of the Northwest, east of the Cascade Mountains. They are not well adapted to extremely acid soils. On soils having pH's above 6.0, they provide good athletic turf. They have a vigorous rhizome system which forms a very tight sod which will repair itself readily. For maximum sod strength, they should not be mowed closer than 1-1/2 inches.

The fine fescues are often used in mixtures with other grasses. They have a wide range of adaptation and will tolerate almost any practical mowing height. As a solid planting, however, they do not offer much resistance to heavy mechanical wear. They are quite well adapted to outfields of baseball and softball diamonds and intramural areas of primary and secondary schools. The bentgrasses are often included in athletic turf mixtures quite by accident. They must be mowed very short for maximum turf quality, and even then are very unsatisfactory for athletic turf because of the exremely shallow root system and poor resistance to mechanical wear. When included in mixtures with other grasses, they tend to dominate the mixture under good management procedures, and eventually most fields become solid bentgrass.

The early management of seedling grasses on athletic areas is often very critical. The mowing schedule should be started as soon as there is enough grass and the soil if firm enough to support the machinery. Mowing to the planned height during the seedling stages will tend to develop a stronger turf much earlier and will avoid any future shock to the turf by changing of mowing heights. If proper soil incorporation of phosphorus and potassium has been done, only light infrequent applications of nitrogen fertilizer will be required during the first year. This is especially important in cutting down the number of mowing operations that are required before the turf is firmly established, and will also develop a stronger root system.

<u>Summary</u>

High quality athletic turfgrass requires a year-around management schedule for most efficient use of resources. If an annual maintenance schedule is properly designed, there need be little reason for emergency changes in the procedures. Usually such emergency changes are a reflection of poor long range planning and are usually rather detrimental to the quality of the playing field.

Will Water Run Uphill? [1]

Dr. D. L. Guettinger[2]

This summary could be entitled "Water Does Not Run Downhill" as well as the present title, "Will Water Run Uphill?". We all know, of course, that water does not run uphill--at least not in the usual sense. But it can move "uphill" against the force of gravity. This means that gravity is not always the most important force acting on water.

Before we consider how water moves in soils, we must first be familiar with some of the properties of water and its surroundings and the term used to describe these properties. The first of these terms is adhesion. It is used to describe the attraction of particle surfaces for water molecules. The action of this property can best be likened to that of adhesive tape; that is, the adherence of one object to an unlike object.

The next term needed to describe water is cohesion. Cohesive forces are the forces that hold water molecules together. This force of attraction between water molecules allows water to rise to great heights as, for example, in a tree. Capilarity is used to describe the rise of water on a wettable surface. We are all familiar with the action of a wick. Different size capilary tubes can be used to

L. Presented at 19th Annual Northwest Turfgrass Conference, Hayden Lake, Idaho, September 22, 23, 24, 1965.
2. Extension Soils Specialist, Washington State University, Pullman, Washington.

illustrate the point that the smaller the tube the higher the water will rise in the tube.

The capilary tube concept can be used to visualize what may happen in the soil. Water will rise much higher in a soil consisting of fine particles such as clay which has small pores than it will in a soil consisting of large particles such as sand where the pores are large. Another term commonly used to describe the properties of water and its surroundings is tension. Tension is a measure of the tenacity or strength that water is held in the soil.

We have just discussed some of the mechanics of how water is held and how it will move in the soil. We have shown how it can move much higher in a "fine-textured soil" than in a "course-textured soil". Besides the upward movement of water, movement by attraction or capilarity is very important in the lateral movement of water.

Under saturated conditions the dominant force controlling water movement is gravity. The speed that water moves through soils under these conditions is governed by the size of the pores. In general, large pores exist where the particles are large and small pores are present in fine-textured soils.

Although water intake rates are a problem in fine-textured soils, water management problems are not usually too complex when soils are uniform. Management problems are intensified when soils are layered; that is, when either a fine-textured soil is layered within courser material or conversely, when course-textured soil is layered within fine material. Whenever layering is present, the forces affecting the downward movement of water must be considered from the capilary as well as the gravity standpoint.

When water is added to a course-textured material it will flow quite readily through the large pores. When it meets a layer of finer-textured material it will adhere more firmly to the finer particles and will move into the fine material. However, flow will be restricted because the pores are small.

When water is applied to a fine-textured material that contains a layer of course-textured material, similar problems result. Before the water can move from the fine layer into the course, the fine material must be saturated. Although the factors causing the surface to be saturated are different, the effect is the same. Water will move from the course material into the finer material, but flow is restricted because of pore size.

By these two examples it is obvious that any layering of soils causes definite water management problems. Water management problems may be a problem on a uniform soil but they are very small compared to the problem of soils with various layers.

In the past, many people have held that a fine-textured material overlaying a courser-textured material would be an ideal situation for plant growth. It was felt that water would move readily into the courser-textured material and drain away. I hope that the previous examples have shown that this would not be the case. The water in the fine-textured material must be saturated before it will move into the courser-textured materials.

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Elks G & C Club	Box 187	Selah, Wn.
Eastside Spraying & Fogging Service	10021 126th NE	Kirkland, Wn.
Enumclaw G & C Club	Te 3, Box 599	Enumclaw, Wn.
Eugene C Club	255 CC Road	Eugene, Ore.
Everett G & C Club	Box 146	Everett, Wn.
Evergreen Memorial Park	11111 Aurora Ave N.	Seattle 98133
Fircrest Golf Course	6520 Regents Blvd	Tacoma, Wn.
Fisher J. R.	Rt.3 Box 65434	Issaquah, Wn.
Faulkner Spray Service	2820 S. 150th	Seattle 98188
Fischer, Bernie (Buckner Ind, Inc.)	6508 Ustick Road,	Boise, Idaho

Forest Lawn Cemetery	5409 Kitsap Way, Box 1279, Bremerton	
Forest Lawn, Inc.	6701 30th Ave. S.W.	Seattle, 98106
Ft. Lewis Golf Course	Rt. 3	Ft. Lewis, Wn.
Floral Hills, Inc.	409 Filbert Rd.	Alderwood Manor, Wn.
Fowler H. D. Inc.	13440 30th SE St.	Bellevue, 98004
General Spray Service of Magnolia	1031 NE 114th	Seattle, Wn.
Glendale C Club	Box 797	Bellevue, Wn.
Glendoveer Golf Course	14015 NE Glisan St.	Portland, Ore.
Greenup Spray Service	12437 1st Ave SW	Seattle, Wn.
Greenwood Memorial Terrace Co.	Rt. 4, Government Way,	Spokane, Wn.
Grays Harbor C Club	Rt. 1	Aberdeen, Wn.
Haines, John S.	4700 E. Oregan St. Rt. 4	Bellingham
Hemphill Bros, Inc.	201 Boren Ave N.	Seattle, 98109
Hayden Lake C Club	Rt. 2, Box 14	Hayden Lake, Ida. 83835
Hillcrest C Club	Box 1083	Boise, Ida.
Hogan Don	9060 37th Ave. S.	Seattle 98108
Holms John	Box 1196	Fairbanks, Alaska
Inglewood C Club	Rt. 6	Kenmore, Wn.
Jacklin Seed Co.	8803 E. Sprange	Dishman, Wn.
Jackson Park G Course	1000 NE 135th St.	Seattle, 98125
Jefferson Park G C	4101 Beacon Ave S.	Seattle, 98144
Kelso Elks G Course	Box 247	Kelso, Wn.
Kitsap G & C Club	Box 397	Bremerton, Wn.
Lewiston G & C Club	Lewiston, Ida.	
Liberty Lake G Course	Box 235	Liberty Lake, Wn.
Lilly Co	1900 Alaskan Way	Seattle, Wn. 98101
Longview G & C Club	Box 1075	Longview, Wn.
NcChord Air Force GC		McChord, Wn.
Manito G & C Club	Box 8025 Manito Sta.	Spokane
Morton Chemical Co.	1620 SW Custer	Portland, Ore. 97219
Michel Lumber Co.	Box 55, 338 An. State St.	Lake Oswego Ore.
Miller Products Co.	7737 NE Killingsworth,	Portland 98201
Mountain View Memorial Park	4100 Steilacoom Blvd,	Tacoma 98409
Mount View Cemetery	Box 632	Walla Walla, Wn.
Mt. Si G Course	Box 68	North Bend, Wn.
Moses Lake G Course	T.K. Nanto Box 1694,	Moses Lake, Wn.

Northwest Mower	7710 24th NW	Seattle 98107
New Meadow Lark C Club	Inc.	Great Falls, Mont.
NuLife Fertilizer Co.	2030 Lincoln Ave.	Tacoma Wn.
Olympia G & C Club	Box 1063	Olympia, Wn.
Overlake G Course	Box 97	Medina, Wn.
Oswego Lake C Club	20 Iron Mt. Blvd.	Oswego, Ore.
Pacific Agro Co.	3308 Harbor Ave. SW,	Seattle 98106
Pacific Equipment Co.	1001 S. Jackson ST.	Seattle,Wn.98104
Peace Portal G Course	190 King George Hwy,	White Rock, B.C.
Portland G Course	5900 SW Scholls Ferry Rd.	Portland
Prineville G Course	133 E. 3rd St.	Prineville, Ore.
Puget Sound Seed Co.	1530 Westlake Ave. N.	Seattle Wn.
Pullman G Course	1235 College St.	Pullman, Wn.
Rainier G & C Club	1856 S. 112th St.	Seattle 98188
Ramsey Waite Co.	Box 5173	Eugene, Ore.
Riverside G & C Club	8105 NE Sunderland Ave.	Portland
Rogue Valley G & C Club	Box 427	Medford, Ore.
Roseburg G Course	Rt. 2	Roseburg, Ore.
Royal Oaks C Club	8917 NE 4th Plain Rd.	Vancouver, Wn.
Salisham Beach G Course		Gleneden, Ore.
Sand Point C Club	8333 55th Ave NE	Seattle 98105
Scott O.M. & Sons	Box 327	Salem, Ore.
Seattle G Course	145th N and N Greenwood,	Seattle
Seattle Park Dept.	100 Dexter Ave.N.	Seattle 98109
Shoreline School Dist.412,	NE 158th & 20th	Seattle 98125
Shelton-Bayshore G C	Box 89	Shelton, Wn.
Sirmais, Peter A. Asst. Supt. Great Falls C Club	140-1/2 3d Ave S.	Great Falls, Mont.
Short, Ed, Co.	2400 6th Ave S.	Seattle 98104
Spokane C Club	Rt. 5	Spokane 53
Spokane Park Dept.	504 City Hall	Spokane, Wn
Sumner Cemetery	Box 55	Sumner, Wn.
Sunset Hills Memorial Park	Box 561	Bellevue, Wn.
Stitt Loyd	321 W. Prairie	Wheaton, Illinois
Tacoma G & C Club	Gravelley Lake Dr. SW	Tacoma 98499
Taylor, Pearson & Carlson (B.C.) Ltd.	1100 Venables St.	Vancouver, B.C.
Three Lakes Public G C	Box 234	Wenatchee, Wn.

Tri-City G Course	Box 456	Kennewick, Wn.
Turfco Industries Inc.	1340 N. Northlake Way, Seattle 98103	
Turf and Toro Supply Co.	1200 Stewart ST. Seattle 98101	
Twin Falls, City of	Box 867	Twin Falls, Ida.
United Supply Co.	Box 1236	Tacoma, Wn. 98401
Van Waters & Rogers, Inc.	4000 1st Ave. S. Seattle 98104	
Veterans Memorial GC		Walla Walla, Wn.
Velsicol Chemical Corp.	341 E. Ohio St	Chicago, 60611
Wagner, Croydon	Box 3417	Tacoma, Wn. 98499
Wandermere G Course	Rt. 5	Spokane, Wn.
Walters C.R. Co.		Bothell, Wn.
Walla Walla C Club	Box 523	Walla Walla, Wn.
Washington Tree Service	17868 28th Ave, NE, Seattle 98155	
Waverly C Club	1100 SE Waverley Dr. Portland 98222	
Wellington Hills G C		Woodinville, Wn.
Wenatchee G & C C	Box 1479	Wenatchee, Wn.
Western Farmers Association,	201 Eliot W. Seattle 98119	
Western GC Supply	1240 SE. 12th Ave. Portland, Ore.	
Wing Point G & CC	Box 727	Bainbridge Island, Wn. 98110
Western Plastics Corp.	3110 Ruston Way	Tacoma Wn. 98402
West Seattle G Course	4470 35th Ave SW, Seattle Wn. 98106	
Woods, Norman H.	Box 204, Sta A	Vancouver 1, B.C.
Yakima Metropolitan Park Dist.	Box 171	Yakima, Wn.

Conference Attendance

19TH NORTHWEST TURFGRASS CONFERENCE
HAYDEN LAKE, IDAHO, SEPTEMBER 22, 23, 24, 1965.

H. T. Abbott, WSU	Pullman, Wn.
Chet Allbee	Seattle, Wn.
Bud Ashworth	Spokane, Wn.
Harvey Banks	Bremerton, Wn.
Clayton Bauman	Bellevue, Wn.
Milt Bauman	Medina, Wn.
Lee Bean	Seattle, Wn.
James B. Beard	East Lansing, Michigan
Norris Beardsley	Spokane, Wn.
John E. Beheyt	Kirkland, Wn.
Bill Bengeyfield, USGA	Garden Grove, Calif.
George Bevan	Seattle, Wn.
Al Blain	Seattle, Wn.
Wilbur L. Bluhm	Salem, Ore.
Robert G. Bowers	Tacoma, Wn.
Vernon C. Brink, UBC	Vancouver, B.C.
Babe Brinkworth	Minneapolis, Minn.
Dave Brown	LaGrande, Ore.
Dr. M.T. Buchanan, WSU	Pullman, Wn.
Reg. Caddy	New Westminster, B.C.
Jack Chase	Seattle, Wn.
Virgil Clark	Everett, Wn.
Ray Collier	Portland, Ore.
Jack W. Daniels	Seattle, Wn.
Wayne Dean	Yakima, Wn.
Chas. Deming	Idaho Falls, Idaho
R.E. Donaldson	Vancouver B.C.
A.D. Elliott	Seattle, Wn.
Cliff Everhart	Spokane, Wn.
Fred Federspiel	Lake Oswego, Ore.
Francis Fischer	Spokane, Wn.
Ed Fluter	Portland, Ore.
Russ Fouts	Albany, Ore.

Stan Freymanm UBC	Vancouver, B.C.
Bill Gabel	Walla Walla, Wn.
Gray Galbreath	Ritzville, Wn.
Al Gleeson	Richmond, B.C.
Murl Goddard	Selah, Wn.
Norm Goetze OSU	Corvallis, Ore.
Roy Goss WSU	Puyallup, Wn.
Chuck Gould	Puyallup, Wn.
Wm. Griffing	Bainbridge Island, Wn.
Manny Gueho	New Westminister, B.C.
Dr. D. Guettinger, WSU	Pullman, Wn.
George Harrison	Tacoma, Wn.
Larry W. Harriman	Walla Walla, Wn.
John Harrison	Hayden Lake, Ida.
William R. Harshaw	Great Falls, Mont.
Allen Hart	Oakland, Calif.
Dick Martmann	Portland, Ore.
Dick Haskell	Seattle, Wn.
Leonard Hays	Gleneden Beach, Ore.
John H. Heinrichs	Missoula, Mont.
Don Hogan	Seattle, Wn.
John Jaslowski	Seattle, Wn.
Walt Jefferson	Wenatchee, Wn.
Jack Jung	Oakland, Calif.
Harvey Junor	Portland, Ore.
Roger Junot	Seattle, Wn.
George Kide	Oakland, Calif.
Dale Knott	Spokane, Wn.
Don Kolassa	Spokane, Wn.
Herman D. Kruiswyk	Spokane, Wn.
Keith Kuechmann	Yakima, Wn.
Carl M. Kuhn	Seattle, Wn.
Henry W. Land, Sr.	Tacoma, Wn.
Bob Larson	Bellingham, Wn.
Howard R. Larson	Olympia, Wn.
Dean W. Latiner	Ft. Lewis, Wn.
Al Law WSU	Pullman, Wn.
Wes Ledford	Spokane, Wn.
Willard Lighty	Gresham, Ore.

Daryl J. McClelland	Spokane, Wn.
Duane McCracken	Boise, Ida.
Lester McCracken	Boise, Ida.
Ken McKenzie	Seattle, Wn.
Jim Magers	Spokane, Wn.
Dick Malpass	Eugene, Ore.
Donald D. Metzler	Vernon, B.C.
Don Miller	Tacoma, Wn.
Charlie Mitchell	Clarkston, Wn.
Virgil J. Martenson	Spokane, Wn.
Ken Morrison, WSU	Pullman, Wn.
Peter Nason	Riverside, Calif.
T.K. Nanto	Moses Lake, Wn.
Tom Neidlinger	Diamond Alkali Co.
Richard Oliphant	Portland, Ore.
Ray Perry	Spokane, Wn.
Don Postlewaite	Beaverton, Ore.
Glen Proctor	Seattle, Wn.
Larry Proctor	Tacoma, Wn.
Joe Pottenger	Yakima, Wn.
Ken Putnam	Seattle, Wn.
Stan G. Raplee, Jr.	Seattle, Wn.
Byron Reed	Portland, Ore.
Earl L. Ripley	Ontario, Ore.
Albert Rock	Walla Walla, Wn.
Ed Rogers	Seattle, Wn.
Cecil Rose	Spokane, Wn.
Chen Rowe	Tacoma, Wn.
Bill Russell	Salem, Ore.
C.A. Schmidt	Coeur D'Alene, Ida.
Richard A. Schwabauer	Bend, Ore.
Elmer Sears	Seattle, Wn.
Chas. E. Seibold	Portland, Ore.
Bill Senske	Spokane, Wn.
Dewey Shepherd	Los Altos, Calif.
Bob Staib	San Francisco, Calif.

Phil Stecker	Tacoma, Wn.
LeRoy Sutphin	Kennewick, Wn.
Al Tomiuk	Christina Lake, Ida.
Charles Thurman	Spokane, Wn.
Vern Turgeon	Seattle, Wn.
R.H. Turley	Saanichton, B.C.
Marc Venable	Seattle, Wn.
Douglas Weddle	Olympia, Wn.
Rudy Werth	Seattle, Wn.
Lester Winslon	Ontario, Ore.
Vernon W. Wright	Spokane, Wn.
Sam Zook	Portland, Ore.
Frank Zook	Vancouver, Wn.
Frank Yoshitake	Redmond, Wn.