PROCEEDINGS

of the

14th ANNUAL NORTHWEST TURF CONFERENCE

Sept. 28-29-30, 1960

WASHINGTON STATE UNIVERSITY PULLMAN, WASHINGTON

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LAWN RENOVATION - NEED FOR - PREVENTION - RENOVATION METHODS

Roy L. Goss[1]

Lawn renovation is certainly not a new concept in lawn management. It is something that has been practiced for many years, and there will always be a continuing need for this type of practice on older established lawns. Renovation as the term implies constitutes a changing over of an existing problem. Renovation can imply anything from merely removing thatch to complete removal of all sod, releveling the ground, and completely reseeding.

Renovation as I shall discuss it today will be concerned only with the removal of certain undesirable factors and with the bringing about of necessary conditions for the proper growth and management of turf grasses. In this discussion the first assumption that I wish to make is that there are no major limiting soil problems existing. The only problem is where grass has gotten out of hand due to lax management, the loss of this grass by disease or other causes, to where weeds or undesirable grasses have invaded to the point that renovation becomes necessary.

Need for Renovation

1. Thatch. The formation of dense mats of dead but not decomposed stolons, grass stems, and perhaps leaves is one of the major causes for the thatch formation. Thatch or mat accumulation to depths of 8 to 10 inches is not uncommon. More often, thatch is encountered in depths of 2 to 4 inches deep, which imposes some serious limitations upon the growth and proper management of our lawn grasses.

Thatch not only serves as a wonderful retreat for insects and diseases but it also interferes with the movement of water, air, and nutrients into the soil. When this mat of dead grass builds up deep enough on the soil surface, water tends to run off as it would from a hay stack. Tension builds up on the surface of the grass when it is dry and does not allow water to enter readily. On lawns that have slopes, this water will more often run off than run in. Deep thatches will soak up a considerable portion of the applied sprinkler water to the point where surface rooting is induced. When frequent light applications of sprinkler water are applied it is quite often only enough to wet this thatch layer. A good portion of this applied water is available for immediate evaporation due to action of sun and wind, hence you may say the effectiveness of the applied irrigation is very low. The more that the lawn grass tends to grow and develop roots on the surface the more susceptible this grass is to periods of drought or extremely hot weather. If this thatch condition continues unchecked then it is only a matter of time until renovation becomes necessary.

2. Summer Loss. For the sake of no better term for this phenomenon I am listing it as summer loss. Some grasses just cannot withstand extreme heat conditions, and of course the one that is most familiar to all of us is *Poa*

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annua. Lawns that run high to Poa annua suffer the greatest loss from extremely hot conditions in the summer. This loss generally does not occur in any one specific area in the lawn, but it is generally scattered throughout the entire lawn. In this case it leaves the lawn looking very ragged and uneven.

Loss of desirable turf grasses also occurs in the summer due to inadequate or improper irrigation methods. In some areas water is rationed during critical periods in the summer, and not enough water can be applied to the lawn to keep it in a green and growing condition. If this period is extended enough some of these grasses not only go dormant but some die out completely leaving large dead areas in the lawn. If left to nature these large dead areas will eventually fill in, but the type of grass to which they fill is almost always undesirable. To say the least these areas will not fill in until the fall cool season arrives and in most cases it is Poa annua and weeds. Loss of turf can also occur in the summer where adequate amounts of irrigation water are being applied if the water does not penetrate the soil. Thatch formation, compacted soils, or just plain steep grades will cause this.

3. Diseases. Certain turf grass diseases will kill out enough of existing lawns to necessitate renovation in the fall. This is not so much a problem in the Pacific Northwest as it is in other areas of the United States. However, diseases such as red thread and Fusarium patch can weaken the turf to such a degree that it can be invaded by undesirable species, eventually causing the need for renovation.

4. Weeds. Weed populations large enough to cause renovation can occur. Lawns that have been seriously neglected for fertilization and other management practices can develop very large weed populations. If these weeds are chemically removed, then quite often so much bare ground is exposed that some modifications are needed to bring the area back into a desirable lawn.

Crabgrass, even though not severe in western Washington, could assume significant proportions in eastern Washington, eastern Oregon, and Idaho. This grassy weed can build up its population very rapidly to the point where it can take over desirable turf species. With the advent of fall and frost this grass is killed immediately leaving the lawn brown and dead. This would be adequate cause for a renovation program. Velvet grass and other weedy grasses in the Northwest in some cases are building up to the point where renovation will eventually become necessary. These are only a few examples of weeds that will cause or bring about the need for renovation in the future. Many others are presenting similiar problems if remedial measures are not made quickly.

Preventing the Need for Renovation

1. Species. The selection of the proper species of turf grass for your lawn is very important in eliminating any future need for lawn renovation. The long-lived perennials are the ones which we should select for our permanent plantings. In eastern Washington, Oregon, and Idaho any of the bluegrasses and fescues do a wonderful job for permanent lawns. However, in western Washington, Oregon, and British Columbia it is a somewhat different story. In this wetter, miler climate the bluegrasses do not thrive so well, and are eventually overridden by native bentgrasses and other encroaching native grasses.

It is well known that the bentgrasses, both the creeping and noncreeping types, will eventually cause serious trouble with thatching if they are not properly managed at all times. It would look to one at this point that it is difficult to find a grass which would perform satisfactorily on the west coast. This is only partially true, since the bentgrasses in conjunction with red fescue or chewings fescue make excellent quality lawns in western Washington provided they are given proper management. The reason why bentgrasses have not been specifically recommended in western Washington is that they actually respond as short-lived perennials. In most cases they do not persist for any longer than 3 to 4 years as solid stands. They become invaded by annual bluegrasses and bentgrasses as well as by other weeds and other grasses. When the bluegrasses are replaced by native vegetative or creeping types of bentgrasses then thatching is almost inevitable. When this occurs the renovation will generally follow within a short period. It is therefore imperative that we select the proper species for the proper geographic location.

2. Mowing. Mowing is perhaps the most important point in the management of our turf grasses in preventing any need for lawn renovation. High mowing does not remove enough of the old stems and vegetative portions to prevent them from lying on the surface where they accumulate and eventually cause these thatching conditions. As the stems and stolons accumulate they retain more water and more of the plant nutrients, thereby encouraging surface rooting. Surface rooting will continue to add more to the thatch with time. In eastern Washington, Oregon, Idaho, and British Columbia, the bluegrass and fescue turfs should be mowed to heights of 3/4 to 1 inch without any ill effects. These grasses can even be mowed to 1/2 inch, however, this is rarely necessary. Mowing to about 3/4 of an inch will promote leafing out closer to the ground and discourage stemminess of the grasses. If the bluegrasses and fescues were mowed to 2 inches or so in height, serious thatch accumulation would occur in a period of time. The bluegrasses, due to new shoots being put up from the rhizomes, increase their population very rapidly. Eventually a dense, tough mat of dead stems will occupy most of the soil surface.

In western Washington, where the bentgrasses and fescues are the predominant types, mowing should never be practiced higher than 1 inch. Since the bentgrasses continue their growth throughout the winter, it can be said that they grow effectively all year long. Hence stolon and stem accumulation is very rapid with the bentgrasses. If these grasses are cut down to 3/4 of an inch in height there is a minimum accumulation of this organic debris.

One of the failures of industry today is the production of mowing equipment without proper consultation to determine the use of this equipment. Many of our rotary mowers today will not cut closely enough to prevent this thatching formation, and even some of the reel type mowers will not get down this low either. Another serious limitation is that even though the mowers will adjust to suitable heights, the increments between the settings are so large that to set down to a lower height results in serious injury to the grasses. These are problems that an agronomist can bring out, but cannot prevent due to the industrial tie-up.

3. Fertilization. This is a most controversial subject, since high rates of nitrogen tend to discourage thatch formation, whereas low rates of nitrogen will increase thatch formation. Perhaps the most important factor operating here is that enough nitrogen is available for decomposition of accumulating organic debris as compared to little nitrogen available for this decomposition under low nitrogen levels. This is the carbon/nitrogen ratio in action. If the carbon/nitrogen ratio becomes too wide, then we can certainly expect thatch formation because bacterial decay will not keep abreast of the accumulation of

the organic material. Perhaps another important factor operating here is that grass with high levels of nitrogen contains a lower amount of lignified tissue which will break down more readily than the highly lignified tissue of grasses with low nitrogen levels. This discussion of nitrogen is not to discredit phosphorous and potash, but only emphasizes that these two should be in adequate amounts and in balance with all of the nutrients. However, it is known that nitrogen is one of the controlling factors in thatch accumulation.

I believe that it would be safe to say that turf grasses, whether in the eastern part of the northwestern states or on the west coast proper, should receive a minimum of 4 lbs. of available nitrogen annually, that is, during the growing season. The maximum rate of nitrogen fertilization should be around 8 lbs. of nitrogen per 1000 sq. ft. This nitrogen, or any of the fertilizers for that matter, should be applied to the area in a minimum of three equal applications throughout the season, or as many as four or five if you go to the higher rates of fertilization.

4. Other. Under this section a multitude of things could be mentioned that would possibly prevent any need for lawn renovation. However, two or three of the more important ones will be considered. Irrigation, which was mentioned only briefly previously, is important in preventing a need for renovation. Instead of the commonly recommended frequent and light applications of irrigation water, we would rather recommend deep and thorough less frequent, irrigation. On many occasions I have found that where irrigations are frequent and light water has never penetrated the soil, but has only been able to wet the thatch layer. A deep irrigation will wet the soil down to at least 8 to 10 inches deep and perhaps even a foot, if this much good soil exists.

Vertical mowing, power raking, or any combination of thatch removal and aeration, or other mechanical treatments will tend to prevent thatch formation or loss of turf grasses and prevent the need for lawn renovation.

5. The Cure or Lawn Renovation. The following steps are recommended for renovating an old lawn that has either been lost by thatch accumulation, disease, summer loss, or other causes, or when one merely wants to reestablish a better-quality lawn. As pointed out before, this does not consider completely rebuilding with new soils.

A. Mow the lawn to a height of 1/2 inch and remove all the old clippings. This will certainly be a harsh treatment to the existing grass, particularly if it has been cut at heights of 1-1/2 to 2 inches or higher. The grass will appear dead and much of it will be, however, a good portion of the more desirable grasses will come back.

B. Power rake, Aero-thatch, verti-cut, or aeration.

a. Power rake is a rotary instrument with small spring tines designed to scratch out or rake out all of the old organic debris on the soil surface. This machine should run over the grass enough times so that the old debris is raked out, down to new soil. This does not mean to strip the ground completely bare, but to rake so that some soil is exposed, and some of the grass is still rooted to the soil.

b. An aero-thatch is a machine that has been introduced on the market in recent years. It will both rake out and cut grooves into the soil. The thatch is removed, and the soil is lightly tilled in one operation. This machine then will leave a suitable seed bed for subsequent reseeding.

c. Verti-cut. The verti-cut machine is designed almost specifically for thatch removal. This machine will cut out all of the old thatch, removing most of the surface stolons and cutting back the existing growth to the ground line.

With all of these machines, the prime objective is to remove the thatch and expose some of the mineral soil so that reseeding can be practiced.

After all of the organic debris has been removed from the soil surface, inspect the lawn and see if there are high spots that should be removed or if there are low spots that should be filled. After this has been taken care of, proceed with the over-seeding of the lawn. Broadcast enough seed over the surface of the lawn to insure a good replacement stand of young seedlings. In the cases of bentgrasses and fescue combination, 2 to 3 lbs. of seed per 1000 sq. ft. should be broadcast. In the cases of bluegrasses, about 2 lbs. of seed per 1000 sq. ft. should be sufficient.

There are two approaches for getting seed into the soil. The first would be to rake the seed in lightly after broadcasting and then roll the surface down. The second would be to rake the seed in, lightly top dress with a suitable soil mixture, and roll after that.

By approaching the renovation problem in this manner you can take advantage of some good grasses still remaining in the lawn area. These will quickly recover and soon give an adequate surface cover while the seedlings are establishing. They will be fast in establishing, and the method will perhaps be less expensive in the long run.

Poor space structure, texture, water-holding capacity, aeration, compaction, nutrients, etc., are all inseparable factors in turf soils. Many of these are related to the temperature factor which is so important to root growth.

SNOWMOLD CONTROL AND OTHER DISEASE STUDIES IN EASTERN WASHINGTON

Ted Filer[1]

Thank you, Dr. Patterson, I must say it is a pleasure to be here today. The work I have been doing on the control of snowmold has been in conjunction with the Agronomy Department at Washington State University. Our objective in doing research on control of turf diseases in the eastern part of the state is not to test new material; we have generally used the materials which Dr. Gould has tested in his work.

In the first tests we put out in 1958, we notice that the rates of chemicals which do such a good job on the west side of the Cascades will not do the job in the eastern part of the state. We also noticed that where it is necessary on the coast to use ten gallons of water as the carrier in the application of the chemicals, this does not appear to be true in the eastern part of the state. I believe that the big difference is the time of year the chemicals are applied. Our work is with snowmold and not Fusarium patch, although we do have a disease complex in which both Fusarium nivale and Typhula sp. are present.

I want to point out at this time that the results I am about to show you are mostly from one year's work. I believe that the test should be continued for another year, and if the results are similar they could be used. If any one wants to use these chemicals and rates he should do so with caution to test the rates. The biggest problem would be getting discoloration of the grass.

The ideal time to put the chemicals out would be before the first snowfall or better yet before the permanent snow cover. In this way you could get by with one or two spray treatments in the fall.

Slide 1. Field plot on Putting green in 1958

PMAS 2 oz. gave 91.2 per cent control.

Panagon 2 oz. gave 60.2 per cent control.

Slide 2. Will show the amount of snowmold we had at Pullman that year. The greens were sprayed in early September (2 oz. PMAS). This gave only 20 per cent control.

Slide 3. This shows the summary of the results of last year's work. The first thing I want to point out is the difference found in control when different amounts of water were used with chemicals at the same rate. For example, PMAS with 5 gallons of water gave twice the control as with 10 gallons of water. The differences obtained in control were similar with most of the chemicals used, but the greatest differences appeared when the amount of the chemical used was of a "marginal dosage" (a dosage which may give good control under ideal conditions).

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[1]Department of Plant Pathology, Washington State University, Pullman, Washington.

	Pullman	Spokane
PMAS - 1 oz. 5 gallons of water gave	73%	97%
PMAS - 1 oz. 10 gallons of water gave	51%	30.3%
PMAS - 2 oz. 5 gallons of water gave	95%	95%
PMAS - 2 oz. 10 gallons of water gave	92%	90%
Caloclor - 3 oz. 5 gallons of water gave	93%	93%
Caloclor - 4 oz. 5 gallons of water gave	95%	95%
Cadminate - 2 oz. 5 gallons of water gave	93%	88.1%
Cadminate - 4 oz. 5 gallons of water gave	98%	85%
Panagon - 4 oz. 5 gallons of water gave	91%	100%
Panagon - 6 oz. 5 gallons of water gave	95%	100%

Slide 4. This is a picture of #8 green at Pullman on the 1959 study. This shows the amount of snowmold we had on the bunkers and the edge of the test plots. Pictures taken in March, 1960.

Slide 5. Plot on green #8 at Pullman. Shows the check plots. On the right is Panagen 4 oz., below the Panagen is Caloclor 3 oz., on the left is Panogen 6 oz., then the check and this plot are PMAS 2 oz.

Slide 6. This is #2 green at Pullman. This also shows the amount of snowmold we had on the edge of the plots. You can see that in the treated area there was very little snowmold on any of the plots except the check plots.

Slide 7. This is #2 green at Pullman. This is to show the comparative control of some of the chemicals used. Panogen 4 oz. on the right of the control. Cadminate 4 oz., Caloclor 3 oz. 5 gal. Below is Caloclor 4 oz. 10 gal. and to the left is Panogen 6 oz., the check and above are PMAS 1 oz.

Slide 8. A close-up of plots treated with Panogen 4 oz., Caloclor 4 oz. and Panogen 6 oz.

Slide 9. The next two slides show the amount of phytotoxicity we had from the application of the fungicides. Panogen and Cadminate gave very little phytotoxicity PMAS, Caloclor caused the turf to be discolored, and mercury chloride caused extensive discoloration.

Slide 10. This shows also the amount of phytotoxicity we got when applying the chemicals at the different rates.

Summary

PMAS - 2 oz. per 1000 sq. ft. (5 gal. of water)

Caloclor - 3 oz. in 5 gal. of water

Cadminate - 2 oz. in 5 gal. of water

Panogen - 4 oz. in 5 gal. of water

Any of the above chemicals will give control of snowmold if applied after first snowfall or before permanent snow cover.

I am at present working on fairy ring disease. I am not working on control as such, but I anticipate that in my research I will bring out enough information through which some type of control can be worked out. I have been working with this problem since I came to Washington. I have no positive facts to present at this time, but I do have indications that the fungus will reduce growth of grass and that it is pathogenic. I also believe that some substance is present in the soil where the fungus has grown which reduced the permeability of the soil.

TURF DISEASE STUDIES IN WESTERN WASHINGTON

Charles J. Gould[1]

The more we study turf diseases in western Washington, the more complex the situation appears. Many different kinds of fungi have been found to be involved, and these vary considerably in pathogenicity. In addition, various enviornmental factors exert their influence. Such factors as air and soil temperatures, relative humidity, soil moisture, soil type, soil nutrition, and others influence disease development, individually and collectively. Nutrition is one factor that we should examine more closely since it is proving to be one of the most important in retarding or stimulating development of the fungi causing such major diseases as Fusarium patch, red thread, and fairy ring. This paper includes comments found in the literature on the effect of nutrition on turf diseases, supplemented with a summary of experiments and observations in western Washington.

General Nutrition

The literature states that low levels of nutrition are conducive to development of fairy ring, rust, and anthracnose, whereas high levels of nutrition favor Cur vularia (causing fading out). The most important factor of general nutrition is probably the presence or lack of nitrogen.

Nitrogen

Nitrogen is the subject of more references in the literature than any other nutrient. Low levels of nitrogen are reported to favor red thread, dollar spot, rust, and fairy ring. High levels of nitrogen favor Fusarium patch, brown patch, damping-off, and powdery mildew. On the other hand, recent work by Couch at Pennsylvania State has demonstrated that extremes of either high or low levels of nitrogen favor the Helminthosporium blights, while Pythium development is unaffected at any level.

Potash and Phosphorus

There are very few references to the effect of the other two major nutrient elements on disease development. Powdery mildew is favored by low levels of potash, but this element is not supposed to influence the development of either dollar shot or Pythium at any level. High levels of phosphorus stimulate red thread development, but brown patch was not affected by any level.

Lime

Low levels of lime favor copper spot. Work done by Smith in England has shown that high levels favor both fusarium patch and Ophiobolus patch.

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[1] Plant Pathologist, Washington State University, Western Washington Experiment Station, Puyallup, Washington

On the other hand, research by Couch at Pennsylvania State has shown that extremes of lime (high and low) favor Pythium.

General

Let us now look at the three major diseases affecting both high-cut (lawn) and low-cut (putting green) turfs in western Washington. 1960 has been an unusually favorable year for turf diseases of all kinds in the Northwest. The mild winter of 1959-60 apparently permitted many of the fungi to survive in large numbers. This condition, together with a prolonged mild, moist spring and short summer, apparently enabled these fungi to build up to very high levels of destructiveness. Fusarium patch has been unusually severe in lawn-type turf during the last few months.

Fairy Ring

For many years we have observed that the fungus causing fairy ring is generally much more destructive on turf which is underwatered and undernourished. Its development also seems to be favored by heavy applications of organic types of fertilizers. The latter apparently serve as sources of food for the fungus. In cases of undernourishment, the fungus appears capable of extracting nutrients and water from the soil more effectively than do grass roots. When turf is well watered and well fertilized, the grass is stimulated and apparently can more effectively compete with the fairy ring fungus. Although the fungus is not eliminated by such treatment, it does become less objectionable. This is our most practical control measure at the present time. The only other solution is a complete renovation by treating infested soil with such materials as methyl bromide, chlorpicrin, or formaldehyde, followed by re-seeding. Directions for this are contained in Washington Agricultural Experiment Stations Circular 330.

Red Thread

As mentioned previously, the literature reports that this disease is increased by heavy applications of lime, phospate, and compost, and by various mixtures of the above. It has been reduced by applications of such fertilizers as ammonium sulfate and sodium nitrate, particularly early in the year. McLean in British Columbia has found that growth of the fungus in culture is stimulated more by nitrogen from nitrate and ammonium sources than from urea.

In cooperative tests in western Washington with Drs. Goss and Austenson, we have found that the use of nitrogen definitely helps overcome the ravages of red thread. So far we haven't noticed any particular difference as to whether the nitrogen came from uramite, urea, or inorganic sources. The most important factor is to apply nitrogen early and to maintain an adequate fertilization program throughout the year. We still do not know how nitrogen works--whether by promoting resistance in grass or by enabling it to grow faster than the fungus can infect.

Although the use of nitrogen has given us good control of the disease, we still believe that a fungicidal program is desirable. In fact, we hope that if a suitable fungicide can be found the benefit from fertilizers will be prolonged. None of the fungicides tested to date have given topnotch control. The mercuries used for Fusarium and other pathogens have proven practically worthless against the red thread fungus under our conditions. The best materials found to date are cadmium compounds and Cyprex. They were tested last year at the rates recommended by the manufacturers. At those levels they gave some promising leads but not sufficient control. Therefore, we intend to re-test them next year at higher rates. We shall also test some new materials.

We are attempting to develop a good laboratory technique that will detect fungicides that have little effect on turf diseases. Such a technique would eliminate the need to field-test them during "screening." After the laboratory screening, only the best materials will be tested for phytotoxicity on grass in the greenhouse. Those surviving this test will then be tried in fescue plots at our station.

Fusarium Patch

There is much literature on the effect of various fertilizers and lime on the development of Fusarium patch disease. One reference published about 50 years ago mentions that manures tend to favor the development of the fungus. Several other works state that organic sources of nitrogen stimulate fungus growth more than do inorganic sources. Urea has also been reported as favoring fungus growth, and some recent work in California indicates that urea-formaldehyde types are worse than urea in this respect. However, heavy rates of any kind of nitrogen will increase the susceptibility of grass to attack by the Fusarium fungus. Also recent work in England indicates that if a fertilizer is unbalanced insofar as N, P, and K are concerned, the disease will be more severe. Of the inorganic sources of nitrogen, calcium nitrate has been reported as one of the least stimulating to the fungus.

In summarizing the effects of nitrogen on Fusarium patch, it appears that the organic types increase the disease most, followed by urea-formaldehyde and urea and finally the inorganic sources. Although both the literature and our observations indicate that organic and related sources of nitrogen favor the Fusarium, we realize that such types have a very definite place in turf maintenance. Therefore, it becomes a matter of using them judiciously; in other words, of putting them on at times of the year when Fusarium attacks are not expected, or, if needed at other times, at as low levels as practicable. If high levels must be used during Fusarium-type (i. e., cool, moist) weather, then it will also be necessary to adhere religiously to a fungicidal treatment program.

Lime has been reported as favoring the Fusarium, but iron sulfate is supposed to reduce attacks. Not much is reported on the effect of other elements.

Tests on Controlling Fusarium Patch

We have reported previously that the PMA types of fungicides are very effective in controlling Fusarium patch disease in western Washington. However, at times they have burned grass also. Therefore, we began searching a few years ago for ways of overcoming such burning. The addition of iron sulfate did not help; in fact it tended to aggravate the trouble. The inclusion of nitrogen compounds appeared promising, so research along this line was expanded. We soon found that the burning was sometimes increased and disease control was decreased by rates of 1/2 lb. and higher of actual nitrogen. This was particularly noticeable with urea and calcium nitrate. However, at rates of 1/8 or 1/4 lb. of actual nitrogen certain materials prevented burning without increasing the disease. After considerable experimentation, we settled upon the nitrate types. Of these, calcium and ammonium nitrates appear to be the most practical to use. The detailed results of these experiments will be published later. Meanwhile, our recommendations for their trail are given below.

Studies are also being initiated in the greenhouse to determine the relationship between nutrition of turf and infection by the Fusarium patch fungus. We are also obtaining data on the development of the disease in unsprayed turf fertilizer plots. This work is being done in cooperation with Roy Goss.

Recommendations for Control of Fusarium Patch

As a result of extensive tests with various fungicides in cooperation with Roy Goss, Vern Miller, and various golf course superintendents, we recommend the following: Use PMA type (10% active as PMAS, Tag, etc.) at 3/4 oz. in 10 gal. of water/1000 sq. feet. Add nitrate nitrogen to this solution at 1/8 lb. of actual nitrogen during periods when PMA-burning may be expected. The nitrogen may be omitted at other times. Since such mercury compounds as the above usually give the most rapid control of the Fusarium patch, they are our preferred recommendation. However, they have shown a tendency to produce thin turf in western Washington.

In contrast to this, many cadmium compounds have produced a dense turf, but the cadmiums tested to date have not been as effective in controlling the Fusarium as the mercurials. Cadmium chloride (tested as Caddy) is the most promising cadmium material found so far. In order to obtain the best qualities of both types of materials, we recommend an alternating schedule of PMA and Caddy, unless the disease develops severely; in such cases we suggest the use of PMA until Fusarium is brought under control.

Needed, of course, is a good combination of such materials in one formulation. We and various chemical companies are working along this line. Such a combination would be highly desirable because we apparently have a complex of different strains and species of Fusarium capable of causing trouble. Since different fungicides control different pathogens, it stands to reason that a mixture generally would be more effective than an individual compound. None of the commercial mixtures now available are adequately effective under our conditions.

Resistant types of grasses are also needed for both putting green and lawn-type turfs. Penncross has shown considerable resistance here, but it hasn't generally produced a good putting turf in western Washington. Seaside has also appeared resistant at times, and yet at other times it has been reported as being susceptible to the fungus. These variations may be explained by the use of different strains of this variety. Many years ago Seaside was reported as being much more susceptible to Fusarium than the Colonial types. Under western Washington conditions, the reverse is true.

Modern research is seldom done without assistance from others. In addition to my associates, Rog Goss and V. L. Miller, I wish to express my appreciation for assistance in the turf disease research program from many golf course superintendents, the Northwest Turf Association, the U.S. Golf Association, California Spray-Chemical Corp., O. M. Scott's Seed Co., and W. A. Cleary Corporation.

CRABGRASS CONTROL TRIALS

A. G. Law and J. K. Patterson

A follow-up trial for crabgrass control was made on the Clarkston Golf Course in the 1960 season (in cooperation with Charles Mitchell, golf course superintendent). Trials in 1959 had shown pre-emergence treatment with Dacthal at 10 and 12 lbs. to be quite effective, with no serious effects of residue and without excessively high rate or cost. Other materials used that were effective were considered potentially dangerous because of residue (Ca arsenate at 500 lbs. per acre) or costly (as chlorodane at 70 lbs. per acre).

One new chemical was also evaluated. Two formulations, of Zytron, both granular and emulsion (including M-1329), were used as pre-emergence chemicals. Two items must be considered in evaluating the treatments. These are:

1. Plots were dry from spring treatment--March 26 until August 10 because of a water shortage. This undoubtedly resulted in some loss of effectiveness of the pre-emergence treatments as there is evidence that these chemicals decompose in the presence of sunlight.

2. In spite of the error in using Dacthal at one-half the recommended rate, control of crabgrass was best with Dacthal. M-1329 (Zytron emulsion) at 8 lbs. per acre was more effective than the other Zytron materials but it is likely this is not a reliable difference because of the variability of the data, variability caused in part by the failure of the water system.

Pre-emerge Treated March 26

Material	Rate	Crabgrass in % check[1]	
Dacthal[2]	$1\frac{1}{4}$ #/acre	40	
	$2\frac{1}{2}$ #/acre	37 37	
	$3\frac{1}{4}$ #/acre	30	Considerable injury to F. rubra
Zytron E	4 oz/1000	53	
	6 oz/1000	50	
	8 oz/1000	70	
Zytron G	3 oz/1000	67	
	5 oz/1000	60	
	7 oz/1000	57	

[1] Rating on September 21, 1960

[2] Dacthal applied at one-half rate intended.

Material	Rate	Crabgrass in % check
M 1329	4 oz/1000	63
	6 oz/1000	60
	8 oz/1000	40 Some F. rubra injury

Post-emerge 2 treatments - August 1 and August 24

Material	Rate	Crabgrass in % check
Rhome Haas	2 #/acre	70
	4 #/acre	60
Fenac	4 #/acre	90
	6 #/acre	50
SD 6622	2 #/acre	70
	4 #/acre	40

The relative effectiveness of Dacthal in 1960 corresponds with the effectiveness of this material in 1959. Data on the carryover effectiveness of Dacthal (1959 plots) show the 10 and 12 lb. rate still free of crabgrass in 1960. The check plot showed 60 per cent coverage of crabgrass. Similar carryover effects were shown on the chlorodane (70#/acre) and Ca arsenate (500 #/acre) plots.

NITROGEN SOURCE TEST

J. K. Patterson and A. G. Law

In the summer of 1959, we received a grant to test barley sprouts (a by-product of the malting process) as a source for nitrogen fertilizer. Plots were established on four bluegrasses: Merion, Newport, Delta, and P. N. W. (a local bluegrass selection) which provided four replications. These bluegrasses were cut as lawn turf, to the height of 1 in. each week.

Since the barley sprouts resembled some of the common organic fertilizers presently available on the market, two of these latter forms were used in the test, one in 1959 and another in 1960.

One source of a slowly available inorganic source was used each year and one soluble nitrate source was used. Since a mixture of organic and soluble inorganics is often commonly used on the turf areas, these mixtures were also included. Table 1 included the data taken as a result of these tests (one pound of nitrogen was applied each month during the summer from the various sources).

TABLE 1. Nitrogen Source Trial

	1959 rating[1]	1960 rating
½ organic and ½ inorganic	5.8	5.0
Barley sprouts	5.0	5.1
Inorganic (slowly available)	4.2	4.8
Organic	5.0	5.0
Inorganic (soluble)	6.8	5.1
½ Barley sprouts and ½ inorganic	5.8	5.1

[1] Rating was on the basis of color with 7 being the best and 3 the lowest.

As can be seen from Table 1, the barley sprouts were equal in effectiveness to the organic fertilizers tested. The soluble inorganic was superior the first year but not in 1960 (the plots in 1960 received the same type fertilizer as had been applied in 1959).

In 1960, the ratings differed very little except that the inorganic slow-release fertilizer still lagged in effectiveness.

It might be noted that the barley sprouts closely resemble some of the commercial organic materials in N P K content having an analysis of approximately 4.4 - 1.5 - 1.5 for these elements.

During some greenhouse trials with a mixture of barley sprouts and soil, it was noted that high rates of barley sprouts prevented the emergence of some of the turfgrasses. It was decided to test other fertilizer materials to see if this was a unique property of barley sprouts. Soil-sand mixture was mixed with various fertilizers so that the approximate nitrogen fertilization was 1200, 2400, and 3600 pounds of "N" per acre (rates 1, 2, and 3 in the table). Sudangrass was then planted to assess the growth increase and any toxic properties of these fertilizers at such high rates. Table 2 contains the data from this trial.

TABLE 2. Effect of High Rates of Nitrogen on Grass Growth

		Growth in per cent of check plot		
Fertilizer	Rate	1st month	2nd and 3rd months	Total
None		100	100	100
Ammonium Sulfate	1	310	540	450
	2	330	730	540
	3	380	550	480
Ammonium Nitrate	1	170	490	330
	2	150	290	240
	3	toxic	toxic	toxic
Inorganic (slow release)	1	350	540	460
	2	260	470	380
	3	200	430	340
Barley sprouts	1	320	400	370
	2	800	630	700
	3	280	520	460
Organic	1	320	510	430
	2	320	550	460
	3	310	470	410

The high rates were all less effective than the medium rate (2) of 2400 pounds of "N" per acre. Two fertilizers, the inorganic slow-release type and the Ammonium nitrate, were slightly toxic at the medium rate as compared to the 1200 pounds of "N" applied. On the average the fertilizers were more effective during the second and third months as compared to the first month's growth, again pointing to some early yield depression due to the high rates. Strangely, the soluble nitrogen sources did not produce any more immediate flush of growth during the first month than did the organics or the slowly available inorganic. Barley sprouts performed as well in this test as did any of the other sources of "N" so it does not appear to be unique in its toxic properties when applied at high rates.

AQUATIC WEED CONTROL

Henry Carsner[1]

Aquatic weed control is becoming an increasingly common practice as our lakes are developed and landowners desire to protect their property values and increase the recreational potential of the waters Weed-infested waters usually degrade adjoining property values and interfere with sales in addition to being a real hazard to bathers. Some aquatic plant species will actually trap a swimmer. Excessive weeds also interfere with fishing, obstruct irrigation machinery, and retard the flow of drainage water.

The purpose of aquatic weed control is to remove or otherwise control objectionable aquatic vegetation for the benefit of water users. Common aquatic plants fall into three general categories, each requiring separate consideration in establishing a chemical control program.

Submerged plants include but are not limited to the following: Elodea, Ceratophyllum, Myrophyllum, and various species of Potamogeton, Najas flexills, Uticularia vulgaris, Chara and several forms of Cyanophyta and Chlorphyta.

Emergent plants are those which are mainly above the surface and are frequently rooted to the bottom. These plants generally include the following: Lemna minor, Azola, Nymphozanthus, Bransenis, Heteranthena, and Alisma plantago.

Marginal plants include numerous species, however we usually think of Polygonum, Typha, Juncus, Scirpus, Salix, Alnus, and various species of Carex as the most common offenders.

Controlling aquatic weeds: mechanical, biological, and chemical are the three common methods in use today.

Mechanical removal is practiced extensively in various sections of the Northwest. An impressive array of mechanical equipment is to be found from the irrigated valleys of Idaho to the river deltas of Washington and Oregon. This equipment includes expensive underwater mowers, heavy anchor chains and cables used as drags, hand cutting, dredging, and drag lines. In general, mechanical weed control is expensive and offers no prospect of diminishing costs. Aside from the expense of the actual drag or cutting operation, it is often necessary to remove the cut weeds physically from the waters, usually at a bar screen.

Fertilization as a means of control is not developed extensively outside the warm waters of the southern states. This method depends upon the development of a dense planktonic algae "bloom" which shades the bottom and interferes with or prevents the growth of submerged plants, since photosynthesis cannot occur in the absence of light. The material cost for annual fertilization is quite high, and is usually justified only on high-producing fish ponds.

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[1] Consulting Biologist, Northwest Weed Service, Tacoma, Washington.

Chemical control is proving to be the most practical and economical method of controlling aquatic weeds. However, it must be remembered that a chemical program can be a two-edged sword in that properly used it can be beneficial and economical, whereas improper use can cause serious damage and expense. In entering into a chemical aquatic program, one assumes far greater responsibility than is encountered in other chemical programs. Chemicals put into the water do not remain in place, therefore it is necessary to predict accurately the movement and concentration of such chemicals during the period of activity. On small closed ponds the problem is reduced, but by no means eliminated. On large lakes the preliminary work often requires a year to complete. The information obtained enables the applicator to select and apply a chemical at the proper concentration in a manner that is safe and without injury to man, fish, animals, or plant life other than that being controlled. In some instances this involves being accurate to 1/10 ppm or about 1/3 cup of chemical to 1 million gallons of water.

Many lakes have outlets which carry water and chemicals out of the lake and to the property of other people and eventually to the salt water This fact creates many problems, particularly on the coastal regions. Some of our aquatic herbicides are more toxic in salt water, and marine organisms are often found to be sensitive to chemicals at trace concentrations. For example, we know that water supplied to oyster tanks in stainless steel pipes will carry enough ionized steel to kill the oyster during the spawning period. Metallic compounds have destroyed marine organisms in entire estuaries.

Irrigation and other use of the effluent pose a most serious problem. For example, a given chemical might be safe at 1.5 ppm in such water but at 2 ppm may cause injury to irrigated plants. Animals and even man often drink such water and the application must be absolutely certain that no injury is possible. Reasonably sure is not enough For example, suppose several children become ill and go home after swimming in water that was treated. The applicator has a legal and moral obligation to know positively that the water was harmless and that humans are in no danger from the chemicals which were used. Water temperature is an important factor in the active period of our organic herbicides, and laboratory work is necessary to establish the point of dissipation. This information is gathered through years of experience and research and often requires separate data for each body of water. Biochemical oxygen demand is a significant factor in water supporting fish life. Some of our best aquatic herbicides are also effective fish toxicants.

Results to expect. There is no one-shot cure-all for aquatic weeds. There is no chemical that can be safely used which will sterilize the bottom of a lake. A realistic program is one of control without excessive ecological disturbance and one that should be entered into on a long-term basis. It must be realized that many aquatic plants reproduce by spores, and the elimination of one species often enables dormant spores of another species to grow where they had not previously existed. It has been my experience that one application of chemicals will give about 90 per cent control of existing plants the first year, but that regrowth usually occurs. The regrowth is generally greatly reduced at the third year and often does not require extensive treatment thereafter.

Swimmer's itch. Schisizome (eccari dermatitis), swimmer's itch, is closely related to aquatic weeds, and I will briefly mention that the same precautions should be observed in its control, particularly as related to fish damage.

I might mention the work done on Steilacoom Lake this year under the provisions of a new law in this state wherein property owners may petition the courts to assess the lakefront property owners a prorated amount of a court-approved program. The preliminary work was completed between May 1959 and June 1960, so that the data were quite well established. The lake was closed to all use from June 20 until June 24 to permit the safe, uninterrupted application of the herbicides. The lake was treated for submerged aquatic plants of the Potamogeton species and for pond lilies and swimmer's itch. After 3 weeks the weeds were all dead, and some were floating upside down on the surface. The water became crystal clear and remained clear for about 3 weeks before the planktonic algae began to develop again. During the first week in August regrowth was noted on about 5 per cent of the area. The swimmer's itch remained controlled until the first week in August when the first case was reported. About 10 subsequent cases were reported during the following week. The reported locations were retreated with good results.

In summary, I would say that the control on Steilacoom Lake was better than 90 per cent effective for both weeds and swimmer's itch.

NEW TECHNIQUES FOR THE STUDY OF ROOTS IN PLACE

V. C. Brink[1]

We see, in the light, the above-ground parts of plants; we see leaves, flower, and fruit grow and turn color; we harvest the aerial parts, feed them, eat them, or use them for ornament. But what images do we have of the underground parts of plants? How do we envision seeds germinating in the soil, roots growing through the interstices of the soil, taking in water and nutrients, excreting substances, dying and decaying, or competing for space and nutrients? To technical man and layman alike the image of the plant root in place is imperfect and feebly developed. Our view of a higher plant is surely incomplete because we seldom see its roots.

Fine turf problems turned my thoughts towards roots. So many questions regarding the management of turf seemed to be directed towards the roots we could not see. What was happening to the root systems of our grasses in winter in our cold, rain-sodden soils in the Pacific slope? How were roots performing under frequent watering, frequent mowing, and heavy traffic in this soil and that one? I sought answers in the literature, and I found uncertainty and some apparent contradictions. Furthermore, the time-honored methods of root study struck me as laborious and expensive. In the manner of all good professors I found a graduate student, Mr. Rex Frederick, to assist me in a search for up-to-date or new methods of root study.

Weaver (1) and his associates in the United States, over thirty years ago, called attention to the long-neglected field of root study. As a result of these tremendous labors it was shown that the root systems of higher plants are remarkably diverse, and that some species have a richly branched system and exploit large soil volumes but that others exploit restricted volumes very thoroughly. Pavlychenko (2) in Canada and Salisbury (3) in England called attention a few years later to the striking reduction of root systems in competition. By and large, however, the difficulty of exhuming entire roots has been too great for most investigators, and serious root studies have been few.

In very recent years there has been a renewed interest in root developments. Chamblee (4) and Burton (5) in the S. E. States pioneered in the use of radio-tracers. In the United Kingdom, Troughton (6) compiled an impressive literature on the underground organs of grasses and Baker (7) and Boggie (8) actively employed new techniques. Goedewaagen (9) in Holland contributed importantly to methodology. This is to mention only a few names.

As stated we decided to direct our attention towards methods of root study rather than experimentation *per se*. We have encountered many difficulties, and at best I report this afternoon progress only.

First of all we felt some method of direct observation of roots would be advised. Customarily this is accomplished by exposing a soil trench and carefully washing away soil particles. However, for fine turf we took cores and

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developed equipment similar to that described by Williams and Baker (10) for washing the roots of each core. In a rotating funnel with a 60-mesh seive, the core is subjected to two jets of water and the soil particles are gently washed from the roots. We have not yet reached the stage of setting our units in series but will do so shortly. We find sawdust, peat, etc., used in top-dressing greens to be a major contaminant of the roots. Ignition of the root samples and subtracting the ash from the crude dry weight give a reasonable correction for mineral matter adhering to washed roots.

Direct washing, no matter how carefully it is done, has inherent weaknesses for root study.

a) In the first place, in turf, it is almost impossible to distinguish the roots of one plant from those of another growing close by. How are we to study the interwoven systems of mixed turf?

b) In the second place distinction of living roots from dead is extremely difficult. How are weakly absorbing or nonabsorbing roots to be distinguished from those which are active? One worker states that one-half of the root system of a perennial grass dies each year and must be replaced. But do we really know? When is it replaced? The literature is not very clear yet on the seasonal cycle of root growth.

c) In the third place, it is rarely possible to retain all of the fine roots and root hairs which are a most important part of the root system. Salisbury says root hairs increase the absorbing area of roots sevenfold or more, and that a good turf may have 3 to 7 tons of roots per acre. A single plant growing without competition, and only 4 months old, was believed by one worker to have a root system, if "lineraly arrayed," 500 miles long, i.e., from Seattle to Boise or thereabouts. The absorbing area of this single plant was estimated to cover a city lot 75' x 100'.

The limitations of direct washing technique impelled us to try other approaches to root development.

At first we tried to construct "windows" through which we could look at roots at a glass-soil interface. We made boxes with glass faces sealed from light except for the purposes of our examination. Belatedly, we found that to "see" roots by this method it was important to keep the soil volume at a minimum or wait a long time for roots to appear. Recently, therefore, we have been using thin glass slides containing thin soil sections.

One thing these "windows" revealed was that roots of closely planted seedlings grew just as fast as those of thinly planted seedlings. Seeding rates of 300 lbs. per acre gave root systems just as long as those of 20 lbs. per acre. Seedlings, no matter how thickly planted, do not begin to exploit the soil volume. Older plants of course probably do have root systems which fully exploit the soil volume but seedlings do not. Seedling roots apparently do not compete in any important way.

Our "windows" had limitations too. Since roots are primarily absorbing organs we wondered if they could not be made to absorb marker substances "strategically" placed in the soil. We asked, for example, how long it took a turf grass root to reach the 4 in. depth, or the 12 in. depth or whether, in fact, it ever reached this depth. We needed to find materials which could be easily recognized in the plant and which could be readily absorbed. We needed to place these substances in the soil so as to distrub the soil and the plant as little as possible.

Placement difficulties were overcome in large measure. At first we tried dyes and substances which fluoresce in ultraviolet light. Acid fuchsin served well when soil volumes were small. But in the field with large plants and large soil volumes we could not get enough dye and fluorescent substance into roots to make it "show" in the aerial parts of the plant.

Next, as our marker substance, we tried lithium, an element which is very limited in soils but which is taken up by plants as readily as is the fertilizer element, potassium (Sayre, 1940). It is an element, too, which becomes associated with the base complex of the soil and does not move with the soil water. By placing small amounts of lithium at various depths in the soil, we could literally, "see" the roots as they reached our lithium locations. Through photometric analysis, we found that the element appeared in the leaves almost as soon as roots reached the placement.

Even better than lithium as a marker substance was P^{32} a radioactive isotope of phosphorus. Beta emanations from this isotope are energetic and are easily recorded with a Geiger counter. Almost as soon as roots reached very small placements of P^{32} we could detect it in the leaves.

Using lithium and P^{32} we were able to ascertain that roots of individual plants in a young, solid turf grow almost straight down; the roots do not spread but exploit the soil directly below them.

Currently we are trying injection and spraying techniques with turf species using radioisotopes and other things. We hope we will be able to obtain x-ray photographs or autoradiographs of roots growing in place.

No one method is likely to give us all the answers needed. Perhaps more methods of root study are needed. On the other hand, maybe the methods at hand are the ones, and we will be able soon to say what happens to roots in winter or what happens to roots when we water and mow turf frequently, or how roots behave under compaction.

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MAINTENANCE OF TREES AND SHRUBS FOR THE GOLF COURSE

Roland Koeph[1]

The subject matter discussed thus far at this 14th Annual Regional Turf Conference has been centered chiefly upon the economics of the production and care of grass, as applied particularly to golf courses and athletic fields. And it is only natural and proper to put the bulk of stress on such topics. Otherwise, what is there of more importance in your business.

Nevertheless, in the over-all picture of golf course management, it would seem neglectful, indeed, not to consider some of the other elements pertinent to grounds management. That is why, I suspect, that I was asked to say something about the maintenance of trees and shurbs.

I would rather like to clarify my interpretation of the title of my subject as printed in the program. It merely says "Maintenance of Trees and Shrubs." I should like to take the liberty to broaden this to "Planning the Maintenance of Trees and Shrubs."

By the way of approach, then, suppose we first examine the reasons for trees and shrubs on the golf course. Besides giving some pleasure and satisfaction in the esthetic sense, do they not at the same time make more work and deliver more headaches in maintenance problems? I'm sure we can accede in some degree to both. Then why have them?

First of all, because of their very useful functions:

1. Separation and screening from sight and sound, as for instance, border plantings adjacent abutting property, roads and highways, or any other disturbing feature.

2. Delineation of direction of play, such as the outlining of fairways, or the background to accent the greens.

3. Windbreak, both for personal comfort of the players, and more important yet, the diminishing of the effects of drying winds upon the grass.

4. Personal comfort to the extent of shelter from sun and rain.

5. Erosion deterrents, as with cover plantings on steep slopes, embankments, or otherwise.

Now, secondly, we like to see trees and shrubs on our golf courses for their landscape effect. I'm sure that there is no need to expand further on this. What courses receive the most patronage? The monotonous barren ones, or those with a good cover of trees and greenery?

So much, then, for the philosophy of trees. Next, to the planning. What kinds or species ought to be used on the golf course? Here we should give cognizance to the following:

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1. Availability
2. Adaptability and suitability
3. Economy (cost)

In the matter of availability, one should by all means give appraisal to trees and shrubs already on hand. Are they sufficient? Are they satisfactory, or should they be replaced? Can you move some to or from other locations on the course.

If it turns out that you must buy additional material, what about the species that you have in mind? Have you taken into account the factors of ultimate habit and growth, available soil and water? Each specie has certain preferences and tolerances which may or may not limit its use in the location contemplated.

Again, will this tree or shrub get along without an abundance of attention, or must you "plant-sit" with it to make it grow or to keep the weeds from overwhelming it? It seems to me, as well as it must to you, I'm sure, that there is already enough to do on the course without such things. In other words, you must have trees and shrubs that can take it - and like it!

Now, a word about buying nursery material. Get what will fill the bill in the best manner, but don't waste your money on exotic, fancy, and high-priced stock. You are not trying to create a botanical garden. Simple mass and utility are your purposes, and the course will look the better for it.

So, therefore, along the lines of selecting planting materials, I would say that native or indigenous species, more often than not, present the best opportunities for landscape material. These we know to be acclimated and hardy, so why not exploit them. If these are not enough, or not readily available, we can look to some of the introduced species which have been already proven in your area.

Among the useful and suitable species of coniferous trees native to the western slope, the following are recommended:

Douglas Fir	Pseudotsuga taxifolia
Western Hemlock	Tsuga heterophylla
Western Red Cedar	Thuja plicata
Incense Cedar	Libocedrus decurrens
Grand Fir	Abies grandis
Coast Redwood	Sequoia sempervirens
California Big Tree	Sequoia gigantea
White Pine	Pinus monticola
Jack Pine	Pinus contorta
Lawson Cypress	Chamaecyparis lawsoniana

In addition, any of the following introduced species generally available from nurseries, will also be found to be suitable:

Austrian Black Pine	Pinus nigra
Scotch Pine	Pinus sylvestris
Deodar Cedar	Cedrus deodara
Atlas Cedar	Cedrus atlantica

Although it may be desirable to keep deciduous trees at a minimum, particularly in close vicinity to the green, for sake of variety and contrast, where they can be used elsewhere, the following will prove satisfactory:

Norway Maple	Acer platanoides
Sycamore Maple	Acer pseudoplatanous
Hedge Maple	Acer campestre
Montpelier Maple	Acer monspessulanum
Paper or Silver Birch	Betula papyrifera
European or White Birch	Betula alba
Oregon White Oak	Quercus garryana
Scarlet Oak	Quercus coccinea
Pacific Dogwood	Cornus nuttallii
Madrona	Arbutus menziesii
European Ash	Sorbus aucuparia
European Beech	Fagus sylvatica
Weeping Willow	Salix babylonica
European Hornbeam	Carpinus betulus
Sweet Gum	Liquidambar styrasiflua
Black Walnut	Juglans nigra
Golden Chain	Laburnum anagyroides
Tulip Tree	Liriodendron tulipifera
London Plane Tree	Platanus acerifolia

So far I have not mentioned anything in the way of shrubs. Where such may seem desirable, in addition to what native material may already be established, a selection from among some of the following old standbys will not be amiss:

Forsythia	Forsythia fortuneii
Weigelia	Weigelia rosea
Tall Spirea	Spirea prunifolia
Pink Flowering Dogwood	Cornus florida
Mock Orange	Philadelphus coronarius
European Cranberry Bush	Viburnum opulus
Regel Privet	Ligustrum regelianum
English Laurel	Prunus Laurocerasus

Occasionally one may encounter the problem of cover plants for steep banks or slopes. And quite often these will be cuts devoid of humus soil and exposing poor-quality subsoil.

In these locations, because of the poor soil, use of leguminous plants is recommended, that is, those which belong to the pea family. Because they are not dependent upon the soil for nitrogen, they prove quite able to make out with poor soil conditions which might discourage other types of shrubs. If planted closely, they also will very quickly make a dense cover and effectively inhibit or suppress the growth of intruding weeds. Those which have been proven successful particularly for dry clay or gravel banks are:

Spanish Broom	Spartium junceum
California Hybrid Broom	Cytisus scoparius var.
Moonlight Broom	Genista praecox
Kew Broom	Genista kewensis
Dwarf Prickly Genista	Genista hispanica
Bladder-senna	Colutea arborescens

None of the aforementioned are flat ground covers, such as ivy, kinnikinnic or similar procumbent creepers. Those types all require too much intimate attention to get to the point of achieving an effective cover. Leave them for the rock garden or the patio.

Launching into my discussion of maintenance proper, as pertaining to trees and shrubs, it seems a logical sequence to begin with planting. I can't hope even to approach an adequate treatment of this phase of maintenance in the time allotted, but I think some fundamentals, at least, might well be reviewed briefly.

Planting

1. Trees and shrubs can be moved with the least possible casualty during the rainy months, but not too late in the spring after deciduous material has set forth fresh leaves.

2. Adequate preparation of the ground should precede moving. For shrubs the area should be spaded or tilled at least, but preferably somewhat deeper than the depth of the roots of the plants which are to be set out. If the existing soil has deficiencies, they should be corrected by the addition of humus, manure or otherwise, at the time of ground preparation.

3. For trees, the planting hole should be prepared in advance, taking special care to dig at least a third again as big in diameter and depth as the rootspread or ball of the tree to be planted. Too large is just right. If the bottom of the excavation should happen to turn out to be hard or impervious soil, unlikely to drain readily, the drainage had better be provided. Very few trees will enjoy wet feet. Likewise if the excavated soil is poor, it had better be discarded and humus topsoil brought in for backfilling.

4. In moving a deciduous tree or shrub, usually bare root, from the nursery or from whatever place it is dug, be careful to keep the bare roots from becoming exposed to drying air. The entire success of the operation depends upon this precaution. I can't emphasize it too strongly! Good protection can be given while moving by keeping the roots heeled in or covered with wet sawdust or wet leaf mulch.

Transportation and handling of balled trees and shrubs also should receive similar attention, although the earth ball in this case may contain enough moisture to dispense with the mulching. If balled plants are to be stored in a service area or the like for some days prior to planting, then by all means cover the balls with plenty of mulch material.

A word more in the matter of handling heavy balled material. Do not pick up the tree by the trunk or branches. Don't carry it like a bunch of carrots. The strain from the weight of the earth ball likely will rupture some of the roots, or perhaps even the entire main system, after which you might as well throw your plant away.

All trees, deciduous or evergreen, should be provided with a sturdy stake when planted. Windsway, which is sure to happen in the absence of support to any newly planted tree, will, ten chances to one, result in severe damage to the roots by wrenching or drying out, or both, and total loss of the tree.

For tall trees, that is, too tall to be adequately staked, provide a three-way wire guy anchored to firm and securely driven stakes in the ground, and protected from girdling the tree by a collar of rubber garden hose.

6. Now that you are ready to plant your tree or shrub, backfill the hole with loose soil so that, when placed, the top of the ball will be about two inches lower than the surface of the ground.

If a tree stake is to be used, it should be placed upright and driven, or at least started, as closely to the stem as possible without severing roots. For balled trees, place the stake next to the ball at an angle, but do not under any circumstances drive the stake through the ball.

Having taken care of these preliminaries and seeing that the roots are spread in a natural fashion, now begin filling in all around them, meanwhile tramping the backfill soil down, at the same time seeing that the tree remains erect and is not forced out of plumb. Do not attempt to correct misalignment after the backfill is made by trying to pull the top of the tree. In finishing the backfill, leave a slight depression all around the trunk as a sink to hold water. Now water-settle thoroughly and anchor the truck securely to the stake near its top, using a piece of garden hose encircling the trunk in figure-eight fashion with the ends nailed securely to the stake.

For balled trees, fasten the trunk to the inclined stake previously mentioned at the point that the stake crosses the trunk.

All these do's and don'ts may seem rediculously elementary, but at the same time too many of them are neglected or ignored - with the obvious result. So much for planting.

Pruning

In connection with the subject of planting, something should be said about pruning. At the same time, it is one of the hardest to describe by words alone --and one of the most involved. I shall not, therefore, go too far into the details, but see if I can just bring out some of the salient points.

Pruning of trees and shrubs comprises the methodical removal of parts of a plant, tree, or shrub with the object of improving it in some respect for the purpose you have in mind. The motives may be one or several of the following:

1. Elimination of dead or useless parts

2. To change the shape, appearance, or character of growth.

3. To improve the growth, vigor, or productiveness by the elimination of excess branches.

To do the job properly, first of all, requires a thorough knowledge of the growth habits of the tree or shrub. Does it normally have a spreading habit when mature, or does it have a straight leader? Will your cutting change that habit? Or do you want to change it? I'll have more to say about this a little later.

Next, what is the best time to prune. Many people have asked me this question, thanked me for my advice, and then have gone right ahead and done as they darn well pleased. So I'm not going to tell you when to prune. There is an old saying to the effect that "the best time to prune is any time you have a sharp knife." To some extent this is not wrong. But at the same time it is not entirely correct from the standpoint of being least harmful, or most beneficial, to the tree or shrub.

Early spring, with some few exceptions, while a tree is still dormant, but before the new growth starts, is the best time to prune deciduous trees because:

1. The framework of the tree is most easily observed and evaluated while the foliage is absent.

2. Wounds will tend to heal more rapidly in the spring.

As to the exceptions I have in mind, some species of trees, such as maples, beech, and cherries exude and waste an excess of sap with spring pruning. We have made a practice of pruning these types after midsummer with better results. With shade trees, moreover, it may be more preferable to do corrective pruning in the late summer while the tree is still in foliage so that you can more completely gauge the extent of necessary branch elimination.

A few other pertinent facts about pruning might briefly be summarized thus:

1. In shortening a branch or tip, cut at a crotch or next to a strong lateral. The lateral will then assume the lead without vast suckering, such as generally occurs if the severance is made at some distance along the branch.

2. Make clean flush cuts next to the trunk or main branch. Don't leave stubs. The bark will never heal over them, but eventually die back to the trunk, or even farther. The stub will rot, and insects and fungus gain entrance to the main bore of the tree.

3. Paint all cuts of two inches, or bigger, with lead and oil paint or preferably a specially prepared fungus-inhibiting tree paint. Don't assume that the purpose of the paint is to "stop the bleeding," or to heal the wound. There is no application of anything that will hasten the healing process on either plants or animals. Nature will take care of that in its own way. All you can do is to try to prevent infection which is the enemy of healing.

I mentioned awhile ago that I would say something more in connection with changing the habit of growth in a tree, and by that I intended to discuss topping of trees and its effect.

Now it will not matter, nor will it change the habit of a tree, if a dead top branch or leader is removed. But, in the case of deciduous trees especially, what happens if you top them? In all likelihood a vast profusion of rapidly growing competing leaders will spring forth, even to witches broom effect. Most likely you will end up with more branches and a bigger top than you started with. The characteristic shape and upper structure of the tree will have changed, generally for the worse - and why?

Let's see if I can tell you in a few words. As you already may be aware of, besides the branches and buds which have normally developed, there exist within and just inside the bark many, actually thousands, more latent or non-emerging buds. They occur most everywhere along the trunk and branches. Sometimes, as you have often seen, they succeed in breaking through and forming clusters of new growth. Generally, however, the most of them remain latent, or at least they never break through and you would never suspect they exist. The amazing fact is, however, that they actually continue to grow as nonemergent buds or branches, elongating as the tree or branch increases in girth. They can be discerned under the microscope in tree sections.

How is it then, you wonder, that more of these buds do not continue to emerge and just cover the tree with branches and foliage? There must be something which prevents them from doing it. And, as it so happens, there is.

The most active parts of the tree, from the standpoint of growth and photosynthesis, are those which receive the most light, that is, the tips or top branches and their tip buds. And herein is contained or produced a growth-regulating hormone, better described, perhaps, as a growth-limiting hormone.

Under normal conditions this hormone is translocated by means of sap circulation to all the lower parts of the tree where it suppresses or arrests the development of the thousands of latent buds. A cessation in the transmission of this hormone at once releases the restraint on these buds, and they immediately set about growth which soon erupts through the exterior bark, and, with no means of regulation thereafter, produces a profusion of new branches.

That, then, is the reason for not topping trees. You will only get a plant with no plan. It will be a dam released.

Before concluding my remarks on pruning, all of which so far has been in relation to trees, I should like to touch on a few things about pruning of shrubs.

As a general axiom, deciduous flowering shrubs should be pruned immediately following the blooming period. Pruning then is done only if you want to reduce the size of the bush, and perhaps at the same time clean out some of the old hard exhausted wood.

In that case, proceed by cutting out all of the dead branches and the oldest branches at the ground, leaving some, a half dozen or more, good vigorous branches. If the remaining branches, for your purpose, are still too high, cut them back somewhere to the height wanted and make the cut next to a minor branchlet or leader.

It is not recommended, though often done, to accomplish pruning of shrubs by merely shearing the whole works off at a convenient height and calling that it. There are occasions when the time that can be spent on pruning is limited, or the man doing the job not as proficient as you'd like. In that case there may be some small justification at taking shortcuts. But you'll get just brush after the new growth again develops! If that's what you want, that's what you'll get.

I should point out something also in the manner of pruning the leguminous plants recommended as bank covers, the Brooms especially. While it is perfectly all right and satisfactory to let them go without pruning, they will, however, after a few years become leggy and apt to be rather top-heavy and breaking over. To forestall this, it is good practice about every third year to shear them off across the top down to a point near, but not below, the green wood. This will produce more sturdy and bushy plants, and that's what you're after.

PROTECTING GOLF GREENS AGAINST WINTERKILL

J. R. Watson[1]

In years when snow cover is light or absent many golf greens in the northern United States and in Canada are severely damaged from "winterkill." The greatest injury seems to occur in late winter - early spring and is apparently a result of desiccation. Greens located on high exposed sites, as well as sites subject to excessive wind movement, generally suffer the greatest damage.

In addition to the direct injury, greens weakened by desiccation suffer more extensive damage when attacked by snowmold and other winter disease-producing organisms. This combination of desiccation and snowmold is probably responsible for more damage to golf greens in the northern latitudes than any other natural phenomenon.

Golf course superintendents employ several techniques to combat winterkill. Some of those in more general use are: (1) The erecting of snow fence and piling of brush to hold snow in place. Snow is an excellent protector or "insulator," and if adequate snowfall occurs, this technique is usually quite effective. (2) Covering the greens with various types of organic mulch, such as straw and peat, which provides adequate insulation and hold sufficient moisture to prevent desiccation. However, it is seldom possible to remove all of the litter from the green in the spring, and, as a result, a substantial amount of undecomposed organic matter is added to the greens each year. This further contributes to the build-up of thatch on the greens. (3) Water is often hauled to greens in tanks and applied in late winter - early spring before irrigation systems can be turned on. This aids in combating desiccation, and if sufficient amounts can be applied often enough will prevent damage. The inconvenience and cost of such an operation are its major limitations.

To determine if the turfgrass on golf greens could be physically protected from winterkill, a study comparing clear polyethylene (4 mil Polyfilm[2]) and black 2" insulated polyethylene (Cell-U-Mat[3]) with unprotected areas was undertaken at the Toro Research and Development Center in the winter of 1959-60.

Materials and Methods

The blankets of the two types of polyethylene were approximately 6 x 12 feet in size. Adjacent areas of comparable size were designated as "unprotected" plots. The test was replicated three times.

Thermocouples were placed at 2, 4, and 6 inch depths under each plot of each replication. Atmospheric temperatures at 3 inches and at 6 feet as

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[1]Director, Agronomy Division, Toro Manufacturing Corporation, Minneapolis 20, Minnesota.

[2]Dow Chemical Co. Trademark.

[3]Wood Conversion Co. Trademark.

well as at the 2, 4, and 6 inch soil depths were recorded periodically through the winter. All readings were made shortly after noon; hence, the extreme lows usually registered at night were not recorded.

It was anticipated that an environment conducive to snowmold activity would be developed; therefore, all plots were treated with a mixture of Milorganite and Calo-Clor prior to laying down the blankets. (See Golf Course Reporter, Vol. 24, No. 7, Sept.-Oct. 1956 and Golfdom, Vol. 30, No. 10, October 1956.)

They were held in place by nailing lath around the edges. Holes were drilled in the lath every 2 or 3 feet and 20-penny spikes were driven through them into the soil. The soil was frozen but not covered with snow. Temperatures were read first on December 18, 1959.

Results

Results of the study are shown in Table 1.

The minimum and maximum temperatures recorded during the period of the test - December 18, 1959 to April 13, 1960 - are shown in Table 1.

TABLE 1. Temperature Ranges Recorded

Plot		Min. Temp.	Date	Max. Temp.	Date
Ambient	3"	-6° F.	Jan. 5	74° F.	April 11
	6'	-9° F.	Jan. 5	68° F.	April 12
Unprotected	2"	4° F.	Jan. 5	57° F.	April 13
	4"	5	Jan. 5	52	April 13
	6"	6	Jan. 5	48	April 13
Clear Polyfilm	2"	10° F.	Jan. 5	73° F.	April 13
	4"	10	Jan. 5	58	April 13
	6"	11	Jan. 5	54	April 13
Black Insulated Cell-U-Mat	2"	18° F.	Jan. 5	40° F.	April 5
	4"	18	Jan. 5	40	April 5
	6"	18	Jan. 5	40	April 5

The minimum temperatures at the 2, 4, and 6 inch soil depths showed little variation under the individual treatments. Such was essentially true until mid-March when atmospheric temperatures began an upward trend.

Discussion

As previously stated, little variation occurred in the temperatures recorded at the 2, 4, and 6 inch soil depths under the individual plots until approximately the middle of March when air temperatures began an upward trend. Between the treatments, however, there were substantial differences, especially during extreme cold spells. During the winter months and prior to the general warm-up, the lowest temperatures were recorded under the unprotected plots. Temperatures at the same time under the insulated Cell-U-Mat plots were substantially higher. Temperatures under the clear Polyfilm were intermediate.

From the middle of March until the end of the study, temperatures under all plots began to rise. The greatest acceleration occurred under the Polyfilm. Temperatures under the Cell-U-Mat increased very gradually and at the end of the study were only a few degrees above freezing. Temperatures under the unprotected areas were intermediate.

The insulating property of the Cell-U-Mat is clearly evident. On April 18 the soil under the Cell-U-Mat plot had thawed only an inch or two, whereas that under the unprotected area was thawed some 8 to 10 inches and under the Polyfilm some 24 to 30 inches.

As would be expected a marked difference in growth activity occurred under the individual plots from the middle of March until the end of the test. Growth activity under the Polyfilm was markedly accelerated in early April, and by the middle of April these plots exhibited growth and density comparable to that normally expected after 4 to 6 weeks of spring weather. Essentially no growth had occurred under the Cell-U-Mat up until the time these blankets were removed. Around the edges and in a few areas where melted snow formed pockets, growth had been initiated, but because of the absence of light the plants were severely etiolated.

The early accelerated growth activity under the Polyfilm was particularly significant. The characteristics of the material are such that it permits transmission of sunlight with a subsequent build-up and storage of heat. In addition, the material conserves moisture evaporating from the soil and transpiring from the plants. The condensation and accumulation of this moisture on the underneath side of the Polyfilm no doubt contribute to further heat storage. Certainly, it provides adequate moisture for growth and completely prevents desiccation. In a sense the material acts as a "greenhouse."

This artificial production of growth in the early spring -- some two to three weeks prior to normal -- may prove especially desirable from the standpoint of producing a healthy vigorous bentgrass able to compete more favorably with Poa annua. The higher temperatures under the Polyfilm should permit the bentgrass to initiate growth as early as Poa annua. The warmer, more deeply thawed soil should likewise permit the production of a functionally deeper root system much earlier than normal. This combination of early accelerated growth and deeper roots would produce more healthy plants with greater density and vigor. Such was evident on the Polyfilm plots under the conditions of this study.

In contrast to the early accelerated growth occurring under the Polyfilm turfgrass under the Cell-U-Mat was essentially dormant when the plots were uncovered. Turfgrass on the unprotected areas was likewise dormant at this time; however, growth started within a few days, whereas on the Cell-U-Mat plots an additional 5 to 7 days were required. These areas did not "catch up" to unprotected areas for some 2 to 3 weeks after removal of the Cell-U-Mat. These plots also contained small patches of Poa annua, which initiated growth earlier than the bentgrass. By early summer, the Poa annua on these areas had increased, while on the Polyfilm plots no increase was evident, in fact, there appeared to be an actual decrease.

In spite of the slow growth on the Cell-U-Mat plots, this material could be advantageous during years when extreme variations in temperature occur in late winter - early spring. Some three weeks after removing the coverings, temperatures dropped to slightly below freezing. Grass on the Cell-U-Mat and unprotected plots was uninjured, whereas tip burn or frost bite did occur on the Polyfilm plots which had not yet been mowed. On the Polyfilm plots which were mowed immediately after removing the coverings, no damage was evident.

It is apparent that the environment produced under the polyethylene blankets is most conducive to snowmold and other disease development. Treatment for snowmold prior to laying down the blankets is an essential requirement. Under the conditions of this study, disease development did not occur -- attesting to the effectiveness of the Milorganite - Calo-Clor treatment made in early December.

Summary

A study to evaluate the effectiveness of two types of polyethylene -- clear 4 mil Polyfilm and black 2" insulated Cell-U-Mat as protectants against winterkill (desiccation) was conducted at the Toro Research and Development Center during the winter of 1959-60. Air temperatures were recorded at 3 inches and 6 feet. Soil temperatures were recorded at 2, 4, and 6 inch depths under both materials as well as under unprotected sites. Treatment for snowmold was made prior to laying down the coverings. Such is considered an essential requirement.

Both types of coverings were effective in preventing desiccation. The insulating properties of the Cell-U-Mat are quite apparent. This material was most effective in maintaining a uniform temperature to the depths studied and may be of particular value where extreme variations in temperature occur in late winter - early spring. It is completely ineffective as far as stimulating early growth.

Polyfilm prevented desiccation but was somewhat less effective as an insulator during extremely cold weather. On the other hand, this material produced a "greenhouse" effect as the air temperatures began an upward trend. The early accelerated growth resulting would appear to be most beneficial under many conditions. The production of healthy, vigorous bentgrass, able to compete favorably with Poa annua seems ample justification for choosing this material.

Although the study has been conducted for only one winter, the results seem to justify publication. The high cost of periodically repairing and replacing winterkilled turf on many golf greens and approaches in the northern latitudes is such that the author feels the use - at least on a trial basis - of polyethylene blankets is worthy of consideration by golf course superintendents.

BUILT-IN HEADACHES ON GOLF COURSES

(A Panel Discussion)

Panel Members:

Mr. A. V. Macan, Golf Course Architect, Victoria, B. C.
Dr. Roy Goss, Assistant Agronomist and Extension Turf Specialist, Western Washington Experiment Station, Puyallup, Washington
Mr Milt Bauman, Superintendent, Overlake Golf and Country Club, Medina, Washington
Mr. Dick Haskell, Director of Golf, City of Seattle, Seattle, Washington

Chairman and Moderator:

Mr. Glen Procter, Superintendent of Rainier Golf and Country Club, Seattle, Washington

The meeting was opened by Mr. Procter and conducted as follows:

This panel is here this morning to discuss with you some of the problems associated with golf course management and is specifically entitled "Built-In Headaches." We know that there are errors in construction and mistakes that should be brought to light so that future repetition of these will not occur. Perhaps by discussing some of these built-in headaches it will give some of you a better understanding of the problems that you have currently and perhaps a few suggestions as to their correction or management which can be brought to your attention.

I would like to point out that questions can be brought up from the floor at any time and directed to any one of the panel members. Feel free to bring up anything you wish, since this is your chance to get in two bits' worth at some of these experts.

Question, Mr. Roland Koepf: What is a sure-fire method of controlling moles?

Answer: Milt Bauman

The best way of getting rid of moles is by trapping. Another good way, if the soils are heavy, is to find a fresh mole hill and stick a hose in there and flush them out since they do not operate deeper than the heavy clay layer below. They can be flushed out and killed upon emergence.

Roy Goss mentioned that there is a publication out on moles published by a gentleman by the name of Mr. R. Glendenning, with the Canadian Department of Agriculture. His work was done at Agassiz, B.C., and covered a study of many years which he made of the life habits of the mole. His conclusions after many years of study and experimenting with all types of eradication were that trapping was the only sure method.

Question, Jim Watson, Toro Company: Has anyone used chlordane for eradication of the mole, by getting rid of the food supply?

Answer: Roy Goss

I don't know if this technique has been tried in this area, but it certainly should be effective in that any method that will effectevely get rid of the mole's food supply will also get rid of the mole, since it will not stay where there are no worms. We have tried methyl bromide for fumigation of our soils, and have found that there have been no moles working within a year after the application of methyl bromide. Mr. Koepf asked if this was due to residual action of methyl bromide in the soil over that period of time, and the answer is no. This is a pure and simple case of complete eradication of the worm, all forms of worms that serve as a food for the mole.

Question, Austin Reger: Can anyone give some suggestions on the proper placement and planting of trees on the golf course?

Answer: Mr. A. V. Macan

I am not an expert on tree planting, since my business is designing the golf course. However, I do indicate in my designs where certain plantings should be placed, and the balance of the trees would be left to the discretion of the golf course. Mr. Macan indicated that the only place that the tree problem has been tackled thoroughly is on the McCleary Golf Course in Vancouver, B.C., whose superintendent is Mr. Jerry Croft. Mr. Macan stated that this is the only place where the first thing that should be done is tree planting on a golf course, and in this case it did occur first.

Glen Procter: Since no questions have come in I presume that none of you fellows have any built-in headaches on golf courses, and I am happy to know that none of you have. I guess I am the only guy that does have.

Question: Would you avoid wet weather in construction of putting green?

Answer: A. V. Macan

I am not a soil expert, but there is no question that when soil is worked in a wet condition you are going to break down and ruin the structure of these soils. This should definitely be avoided during wet weather. We are prone not to do anything about these during our playing season, because that is when everyone wants the course. At the end of the playing season, then, we always want to start in on a construction program, which of course is the wrong time of the year.

Question: What do I do when the green isn't visible from the fairway?

Answer: A. V. Macan

It is the general concensus that everything must be seen. However, I question that. I think that there must be a method of locating the pin, but you don't have to see all of the pin or the green. The playing is the testing of it.

Question: What do you do when the 9th green does not return to the club house?

Answer: A. V. Macan

There is very little argument that the course should be laid out in at least two loops. The advantages of the triangular system are that each fairway is distinct from any other, but you won't be able to make a triangular pattern on a course of this nature unless you have at least 160 acres. In any case you may have to change a hole or two, but you will certainly endeavor to start and finish at the same spot on every golf course if at all possible.

Glen Procter: I think at this point that we have more or less missed the boat in this panel discussion on built-in headaches. Therefore, I would like at this time to start around the circle of the panel members and ask each of them what his idea is on some of these built-in headaches. Perhaps this will stimulate questions along this line from the floor. First I would like to call on Milt Bauman.

Milt: I think perhaps that I have as many built-in headaches as anyone. When Overlake was built, I had built-in headaches on my greens because there was a shortage of topsoil, and all the greens and aprons were made out of clay that was dragged out of a lakebed. This clay and silt when mixed with sand dries out and makes a pretty fair grade of concrete, and in the winter it is almost like mush. The greens are tiled out beneath, but the water doesn't go anywhere. The tiles run around in a circle and were not carried away from the green. If the water could get down through the clay to the tile line it still couldn't go anywhere, and it has created sort of a basin. Believe me, it is a real problem The only way that I know to modify this is by reconstruction. I call that a built-in headache. Another thing that happened was with the water system. By trying to save money and put in old pipe and plastic polyethelene I've had a problem to fight ever since. This past summer I think that I have patched somewhere between 85 and 90 leaks in about $2\frac{1}{2}$ months, and actually we are finally overcoming these. I think the thing that golf course management faces when it first starts is that it just doesn't have enough money to carry out the construction program that it wants.

Dick Haskell: I don't like to call this built-in headaches. I like the word built-in challenges a little better That long walk from the green to the next tee is one of my major complaints of the built-in headaches on the golf course. We can quite often get in as much distance walking from green to tee as we do from tee to green, so that when you get through playing a game of golf you have walked about twice as far as you need to. Looking at it from the city or public golf course standpoint, by stretching out the distance from the green to the tee you slow down your traffic, and you can't put as many people across it in a day. In private clubs this may not be so much of a problem. Another thing is trees. In one case we have maple trees planted too close to the putting green, and there are so many leaves on it you couldn't putt on it if you wanted to. Yet they say the tree is too pretty to cut down. This thing should have been spotted while the problem was developing and eliminated before it got to the point where it was going to create too much trouble to remove the built-in headache. Another problem is that we usually don't make the first few holes easy ones and the balance of the holes toughened up to the point where it makes the course a desirable one to play. In this way you don't get the people off to a good start before they are limbered up and in good shape, and you get fewer people off of the first tee. Otherwise if you put them on tough holes in the beginning, you slow down the play to the point where you don't get enough people over the course in a day. Sloping fairways are another problem. However, as Mr. Macan says, you have to work with what you have, but if there is anything that can be done in the construction of the course to eliminate some of these problems they should be done now instead of later, when the construction is much more expensive.

Roy, what are some of the headaches you have seen when traveling around?

Roy Goss: My first complaint on built-in headaches on golf courses is that of mixing or not putting the green together right in the first place. We get grandiose ideas about what we want to do, but we have a limited pocketbook with which to do it. Therefore, if we cannot build a green right why do it at all? We may have to come back later at perhaps 2 or 3 times the original cost to rebuild this green, plus the fact that we have suffered with a poor green for many years. Another thing is that during this period of reconstruction we have lost the green for all practical purposes during that period of reconstruction. Another point is "on site" mixing instead of mixing soil "off-site." There is no excuse for this on site mixing, since it can be accomplished very easily off site and without running into this layering proposition. Another problem is that we are too prone to use too much of what is at hand. We are prone to use such things as peat from some of these local bogs. This peat is in a highly decomposed state, and after mixing this stuff together in a putting green we come out with a high-class gob of junk. We have specifications and some scientific investigation on the proper techniques of construction. These are well known and are available upon request, and there is no excuse for poor construction when we know some of the right answers at the present time. Here in the Seattle area we can point out several examples of improper construction with the use of poor organic fractions.

Glen Procter: I think we shall terminate the questions on built-in headaches at this time, since we are running a little short of time. We will now call on our next speaker.

ATHLETIC FIELD MANAGEMENT

Norman Goetze[1]

The problems of athletic field management are considerably different than most other turf situations and have received little attention.

First of all, most athletic fields have less total use per unit area than other turf. They are used only during a few months of the year, and do not receive as much uniform management throughout the season. Secondly, the wear is more concentrated during brief times of the season. In other words, a football or baseball field is used intensively for two or three months during that particular sport period. The wear on the turf is quite heavy per week. Most athletic events require a more rapid change of direction and more compacting types of movements by the athletes than golf or home lawn use.

One of the most seriously limiting factors in athletic field management is the personnel used in its management. In many public athletic fields, and especially on schools, it is sometimes rather difficult to determine exactly who has the final authority in its operation. There tends to be a shuffling of authority with no direct responsibility in many cases.

The management procedures should be fit into these above conditions. They must be timed according to the needs of the field first, and according to the needs of the turf second. Over-riding these timing decisions is the general lack of well trained year-around personnel.

Fertilization

The use of nitrogen fertilizer must be very carefully timed so as to avoid all but the lightest possible applications during the time of use of the field. Where fall and winter use is to be made of turf, it is recommended that the nitrogen applications be made just at the end of the use season in late fall, and during the late spring and summer months, prior to any fall use. Fall and spring fertilization is recommended for athletic fields used most heavily in summer periods. The total amount of nitrogen to be used during a season should never exceed 4 pounds of actual nitrogen per 1000 square feet, with no more than 2 pounds during any one application. Ideally, no nitrogen should be used later than two weeks before any use. Preferably the individual applications should be limited to one pound of actual nitrogen per single application, with, of course, the exception when the urea-formaldahyde materials are used. It should be noted, however, that these materials are not effective long lasting nitrogen fertilizers, unless a total of 4 pounds of actual nitrogen is used per 1000 square feet per year. The use of these materials should be considered only when heavier nitrogen rates are used.

It has long been known that phosphorus and potash contribute to good root growth and to better wear resistance by athletic turf. However, the amount of these materials to be used is considerably less than the amount

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of nitrogen used. A material like 6-10-4, in my opinion, has no place in the routine fertilization of an athletic field. Phosphorus and potassium are recommended for use only once during a season, at rates no higher than one pound per 1000 square feet. Phosphorus and potassium applications are best made when the soil moisture conditions are high, so that these materials can move into the soil root zone for use by the plants before they become tied up in soil colloid systems.

Certainly liming plays an important part in athletic field management on acid soils, primarily in that it makes other plant nutrients more available. The application of lime is most effective when it is applied before planting. If it must be applied to old established turf, its effectiveness can be increased with aerification. Some recent success has been obtained by the use of dolomitic limestone in contrast to the conventional calcium carbonate limestone. This success can be contributed to the supply of a minor element, magnesium. It cannot be recommended without a soil test, which would show the need for it.

Other elements have some effects on certain sandy or peat soils. However, in general, we think that with the proper use of lime, nitrogen, phosphorus, and potassium, a desirable turf can be cultured on most soils.

Mowing

The mowing of athletic turf is a controversial subject. Many athletic areas in the Pacific Northwest are pretty much neglected, as far as mowing is concerned, except just prior to the use periods. Allowing the turf to make excessively high growth and then quickly reducing the cutting height contributes to rather shallow root growth and poor resistance to mechanical wear. Ideally, the turf should be mowed throughout the season, as if it were being used. Of course, this creates budget problems in many cases.

The matter of mowing heights also is condusive to some debate. In general, we should never remove more clippings by height than the height of stubble that is left after mowing. If the grass is mowed three inches high, then it can be allowed to reach a height of six inches before mowing. On the other hand, if the turf is mowed at $1\frac{1}{2}$ inches, then it should be mowed every time it makes $1\frac{1}{2}$ inches of growth above the mowing height.

Many coaches prefer to have turf rather closely mowed, because they think they are getting a more uniform turf and less resistance to the movement of athletes. This is usually true, but it also creates other problems. In obtaining a more uniform turf by close mowing, conditions which will not support heavy wear are created.

If budget problems prohibit routine frequent mowing when the field is not in use, it would be better to mow once every two or three weeks than to let the turf grow up into a hay field and then spend three or four mowings on it, in mowing it short at the beginning of the season to get it into shape.

The disposal of clippings sometimes becomes a problem. Usually, however, on most athletic turf, we don't have to remove those clippings if we cut frequently enough. Also, by allowing the clippings to remain on the turf, the requirements for potassium are reduced through the years. Under most athletic turf conditions, I personally prefer the use of the rotary mowers, because they can better handle weeds which may often be associated with athletic fields. Some of the grasses which we use sometimes have seed heads which can be more efficiently handled by the rotary type mower.

Watering

Throughout the Pacific Northwest, watering problems on athletic fields are acute. I feel that much improvement in the watering techniques can be done. Many of the grasses used on these fields are drought tolerant, and don't require frequent watering like some other turfs. When they are watered, the soil should be saturated at least to a 4-6 inch depth, preferably 6-8 inches on some soils. Most of the sprinklers and irrigation systems that are used on these fields apply water too quickly and do not apply enough water. It's an established fact that if we will water thoroughly instead of using many light frequent waterings, a deeper penetrating root system will be developed. It will be much more resistant to mechanical wear. Systems which apply no more than 0.25 inches per hour are recommended. The matter of watering schedules around the use of the field should also be considered. I would prefer that prior to a heavy use period, the turf should be dry to avoid soil compaction. Then, immediately after the athletic event, the turf should be thoroughly watered, so that the grass can recover quickly and so that it will have a chance to dry out before the next heavy use.

Aerification

Compaction is always a problem on athletic fields. The compaction on athletic fields is usually more severe near the surface and usually is not very deep. The shallow compact layer is more easily corrected than compaction on golf greens. A very practical method of solving this problem is the use of field model aerifiers.

Aerification during the late spring or summer periods is more practical than during the wetter fall periods. The effects of aerification will also be more permanent when done when the soil is not saturated. I prefer a consistent program of aerifying at least once a year after spring practice on football fields, or before the start of the baseball season on summer types of athletic areas.

Drainage

One of the most serious problems in construction is that of surface drainage. If sufficient slope can be put onto the field, so that water does not accumulate in puddles during heavy rains or irrigations, many of the needs for renovation can be prevented. Slopes as low as 18 inches crown on a football field, or $\frac{1}{2}$ per cent on other fields, are certainly sufficient to give good surface drainage, if the slope is made uniform. It doesn't take much of a slope to remove water, even from a dense turf, as long as puddling is prevented. Most of the newer construction projects also have sewer drains at the edges of the fields to catch the surface water and remove it from the field before it becomes a problem to other adjacent activities.

Internal soil drainage is also a problem and can usually arise from one of two possible conditions. The first is the layering of different types of soil material during construction. Since water moves freely between soil layers only when the layers are saturated, tile drainage is ineffective in layered construction. If no layers are present, the second problem most often encountered is that of insufficient tile or sub-soil drainage underneath the turf. Routine tile drainage systems involving adequate lateral, sufficient fall, and good outlets are recommended.

Before establishing new athletic fields, a thorough understanding of the individual grass species that can be used must be obtained. Far too often we attempt to develop a field which will be appealing to the crowd without giving enough attention to the grass's wear capabilities. The characteristics for athletic turf of each of the most commonly used species in the Pacific Northwest follows.

Grasses

The bentgrasses develop a rather dense turf, which can quickly repair damaged areas by its vegetative growth. Bentgrass is well adapted to the high acidic nature of many of the western Oregon and Washington conditions, and requires relatively low amounts of fertilizer. Its greatest weakness is its poor wear resistance. It does not stand up to excessively heavy traffic during any season of the year, and is conducive to much slippage and tearing caused by rapid changes of direction, especially when the sod is wet or when the soils are saturated. It should be discouraged on all but the rather lightly used athletic areas. In these conditions, Astoria of Highland is preferred over Seaside.

The bluegrasses are more resistant to wear than bentgrasses, and also have the ability to quickly repair damage resulting from mechanical wear by their extensive rhizome development. They are also quite appealing to the non-participating audience. The bluegrasses are best adapted to areas east of the Cascade Mountains and south of the Willamette Valley in Oregon. In northern Pacific locations, they require much more liming and more fertility than do the bentgrasses, and usually do not persist as long as bentgrasses. Consequently, the bluegrasses are recommended only in the inland areas.

As to the varieties of bluegrasses for those particular areas, common Kentucky bluegrass is just as good as any of the newer varieties, and would require slightly less care than a variety like Merion.

The fescues can be divided into two broad categories. Those are tall fescue, represented by Alta or Kentucky 31, and the fine fescues, which include chewings fescue or named varieties of creeping red fescues. The fine fescues are easily established, develop a usable turf rather quickly, and are more drought resistant than the bentgrasses. Repair of excessive mechanical damage by the fine fescue is not as fast as either the bentgrasses or the bluegrasses. Chewings fescue is slightly more drought resistant than the selections of creeping red fescue. However, this can seldom be noticed under athletic conditions. Both of these fescues are somewhat difficult to mow when the grass is subjected to drought conditions. Of the named varieties of creeping red fescues, there are little differences between Illahee, Rainier, and Pennlawn for athletic use in the Northwest.

The tall fescues are extremely resistant to mechanical wear and are also very drought tolerant. Tall fescues tend to form clumps when mowed as turf and must not be mowed shorter than $2\frac{1}{2}$ to 3 inches, if they are to survive. To avoid this clumping nature, seeding rates of 200 to 400 pounds per acre are recommended. The tall fescues are rather slow to establish and are difficult to mow with reel mowers, because of an extemely tough leaf, and because they tend to form seed heads which are difficult to mow. There is no appreciable difference in varieties of tall fescue for turf use.

The potential of ryegrasses for athletic turf sometimes is overlooked, because the ryegrasses are short-lived. The perennial ryegrass persists under turf conditions for only two or three years, the annual ryegrass lasts only during one season. However, the ryegrasses are the most easily established grasses and for temporary turf uses, are advantageous in that they can be planted after the spring season and can develop turf dense enough for some limited use during the fall period. They can be used in mixtures with other grasses at 25 per cent or less to provide a temporary turf during the first season while the more desirable grasses are being developed.

Seeding

The time of seeding of athletic turf fields, of course, is a problem because of usually high use demands for those particular areas. If one full year is available for the establishment, then early fall planting is preferred. Spring or early summer planting of anything except ryegrass, cannot be safely used during the following summer or fall. However, fall planting can generally be used during the following summer and fall period. A recently used successful method of renovating newly damaged areas is to plant the seeds prior to the last baseball or last football games, so that the player's cleats will tend to develop holes into which many of the seeds will be washed with following irrigations or rain. By the next season, young grass plants will be found developing in most of these cleat holes. This requires, of course, a minimum of tillage and the savings in tillage can be used for higher amounts of seed for this particular technique.

A most successful athletic field is the result of a well-thought-out, year-around management program, keeping in mind, first of all, the use of the area, and adjusting necessary management procedures to fit those use periods. Much effort can be saved by setting up a season-by-season time table to avoid last minute duplicatory operations.

SPECIFICATIONS FOR A METHOD OF PUTTING GREEN CONSTRUCTION

Bill Bengeyfield[1]

Golf course construction is presently enjoying its most accelerated pace since the introduction of the game of golf into the United States. Not only are new courses being built but old ones are being "modernized."

The cost of maintenance has influenced some clubs in their decisions to undertake a rebuilding program. There is a need to do away with features such as sharp contours and abrupt tee slopes which create maintenance problems.

Golf course design and golf course construction have been considered an art rather than a science. The individuality and the character of golf courses in this country have resulted from the artistic talents of some of the great architects in whose minds they were conceived.

Likewise, construction methods have been developed as a result of individual experiences and individual preferences. It is a tribute to those whose efforts have gone into golf course building as well as to those who maintain them that so many courses have stood up well over the years.

The pace of golf activity and the traffic on golf courses is presently at a peak, however, which has never been equaled in our country. Many of the construction methods that were satisfactory in an earlier day will no longer produce greens which will withstand the wear that is now imposed upon them.

Because of these considerations, the Green Section has for the last decade interested itself in construction methods and in a study of the physical problems of soils used in putting greens. Research in these matters has been sponsored by the Green Section at Beltsville; at Oklahoma State University; at UCLA; and during the past six years an intensive program of study has been supported at Texas A. & M. College.

It has been found that the problems of construction procedures and methods and those of physical behavior of soils cannot be separated. The two matters are related and must be considered together if a desired result is to be produced.

The findings of the Green Section-sponsored research are such that a sufficient amount of information is now available to warrant the publication of a suggested method of construction. The procedures which are outlined here may well be used as the basis for specifications which a club may present to the prospective golf course builder.

Such specifications will place no limitations upon the individuality nor the artistry of any architect. They will, however, provide a guide for the builder and for the club which wants to be assured that the greens they build will continue to provide good playing conditions for many years.

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The basic considerations underlying the specifications and methods presented are those of good drainage and resistance to compaction. These ends cannot be achieved without some compromise. A highly permeable soil which drains readily offers some problems in the establishment of turf. It is loose, and sometimes may create difficulty in the changing of cups. These are minor problems, however, when weighed against the advantages of rapid drainage, good aeration, deep rooting, protection against diseases, protection against overwatering, protection against salt problems, a putting surface which holds a shot without being overly wet, and one which resists pitting by golf balls.

The methods and specifications outlined in the following pages represent the best thoughts of the Green Section staff and of numerous soil scientists who have given serious attention to the problem. It is hoped that they will result in more satisfactory and less troublesome putting greens throughout the nation.

Subgrade

The contours of the subgrade should conform to those of the proposed finished grade, within a tolerance of $\pm 1''$. The subgrade should be constructed at an elevation 14 inches below the proposed finished grade. The subgrade should be compacted sufficiently to prevent future settling which might create water-holding depressions in the subgrade surface and corresponding depressions in the putting surface.

Where terrain permits, it is possible to build the subgrade into the existing grade or to cut it into the subsoil. It is not necessary to elevate or "build up" the green unless design considerations dictate the desirability of doing so.

It will be noted that courses of materials above the subgrade consist of 4 inches of gravel, $1\frac{1}{2}$ to 2 inches of coarse sand, and 12 inches of topsoil. Thus the total depth will be $17\frac{1}{2}$ to 18 inches. However, this fill material will settle appreciably, and experience indicates that 14 inches will be the approximate depth of these combined materials after settling.

Drainage

Tile lines of at least 4-inch diameter should be so spaced that water will not have to travel more than 100 feet to reach a tile drain. Any suitable pattern or tile line arrangement may be used, but the herringbone or the gridiron arrangements will fit most situations.

Cut ditches or trenches into the subgrade so tile slopes uniformly. Do not place tile deeper than is necessary to obtain the desired amount of slope. Tile lines should have a minimum fall of .5 per cent. Steeper grades can be used but there will seldom be a need for tile line grades steeper than 3 per cent to 4 per cent on a putting green.

Tile may be agricultural clay tile, concrete, plastic, or perforated asphalt-paper composition. Agricultural tile joints should be butted together with no more than $\frac{1}{4}''$ of space between joints. The tops of tile should be covered with asphalt paper, fibreglass composition, or with plastic spacers and covers designed for this purpose. The covering prevents gravel from falling into the tile.

Tile should be laid on a firm bed of $\frac{1}{2}$" to 1" of gravel to reduce possible wash of subgrade soil up into tile line by fast water flow. If the subgrade consists of undisturbed soil, so that washing is unlikely, it is permissible to lay tile directly on the bottom of the trench.

After the tile is laid, the trenches should be backfilled with gravel, being careful not to displace the covering over the joints.

Gravel and Sand Base

The entire subgrade should be covered with a course of clean washed gravel or crushed stone placed to a minimum thickness of 4 inches.

The preferred material for this purpose is washed pea gravel of about $\frac{1}{4}$" diameter particle size. Larger gravel or stone may be used, but it is important that changes in size between this course of material and the succeeding one overlying it not be too great. Otherwise, smaller particles from overlying material will wash into the gravel, clog the pores or drainageways, and thereby reduce the effectiveness of the gravel.

The maximum allowable discrepancy appears to be 5 to 7 diameters. In other words, if $\frac{1}{4}$" pea gravel (about 6 mm.) is used, then the particles of the overlying course of sand should not be less than 1 mm. in diameter. If stone of 1 inch diameter were used, it would be necessary to include a course of pea gravel to prevent the movement of smaller soil aggregates into the stone.

When the gravel is in place, assuming that pea gravel has been used, a $1\frac{1}{2}$" layer of course washed sand (commercial concrete sand is satisfactory) should be placed to a uniform thickness over the gravel.

The tolerance for error in the thickness of gravel and sand courses should be limited to $\pm$ .5 inch.

A profile of a properly constructed putting green is illustrated in Figure 1.

"Ringing" the Green

When the courses of gravel and sand are in place and outlets have been established for subsurface water (through tile lines), the green should be "ringed" with the soil which is to be used for aprons and collars. This soil should be placed around the green and any contours established in such a way that they will blend into the putting surface.

The next step is to fill the depression, which represents the putting surface, with the prepared topsoil mixture described in the following paragraphs.

Soil Mixture

A covering of topsoil mixture at least 12 inches in thickness should be placed over the sand and gravel layers.

The soil mixture should meet certain physical requirements.

Permeability. After compaction at a moisture content approximately field capacity as described by Ferguson, Howard, and Bloodworth (8), a core of the soil mixture should permit the passage of not less than $\frac{1}{2}$ inch of water per hour nor more than $1\frac{1}{2}$ inches per hour when subjected to a hydraulic head of .25 inches.

Porosity. After compaction, a sample of the soil mixture should have a minimum total pore space of 33 per cent. Of this pore space, the large (non-capillary) pores should comprise from 12 to 18 per cent and capillary pore space from 15 to 21 per cent.

Information with respect to bulk density, moisture retention capacity, mechanical analysis, and degree of aggregation in the hands of a soil physicist may be helpful in further evaluating the potential behavior of a putting green soil.

Few natural soils meet the requirements stated above. It will be necessary to use mixtures of sand, soil, and organic matter. Because of the differences in behavior induced by such factors as sand particle size and gradation, the mineral derivation and degree of aggregation of the clay component, the degree of decomposition of the organic matter, and the silt content of the soil, it is impossible to make satisfactory recommendations for soil mixtures without appropriate laboratory analyses.

The success of the method of construction herein described is dependent upon the proper physical characteristics of the soil and the relationship of that soil to the drainagebed underlying the green. Therefore a physical analysis of soil should be made before the soil components are procured. When the proper proportions of the soil components have been determined, it becomes extremely important that they be mixed in the proportions indicated. A small error in percentages in the case of a plastic clay soil can lead to serious consequences. To insure thorough mixing and the accurate measurement of the soil components, "off-site" mixing is advocated.

Any soil physics laboratory which is equipped with the facilities to carry out the measurement described by Ferguson, et al. (8) can prescribe a soil mixture for putting green use. Green Section offices can provide names of laboratories so equipped upon request.

Soil Covering, Placement, Smoothing, and Firming

When soil has been thoroughly mixed off-site it should be transported to the green site and dumped at the edge of the green. Padding the edge of the green with boards may be necessary to prevent disturbance by wheeled vehicles of the soil previously placed around the outside of the putting surface. A small crawler-type tractor suitably equipped with a blade is useful for pushing the soil mixture out onto the prepared base. If the tractor is always operated with its weight on the soil mixture that has been hauled onto the site, the base will not be disturbed.

Grade stakes spaced at frequent intervals on the putting surface will be helpful in indicating the depth of the soil mixture. Finishing the grade will likely require the use of a level or transit.

When the soil has been spread uniformly over the surface of the putting green it should be compacted or firmed uniformly. A roller usually is not satisfactory because it "bridges" the soft spots.

"Footing" or trampling the surface will tend to eliminate the soft spots. Raking the surface and repeating the footing operation will result in having the seed or stolon bed uniformly firm. It should be emphasized that the raking and footing should be repeated until uniform firmness is obtained.

Whenever possible after construction, complete saturation of the soil by extensive irrigation is suggested. Water is useful in settling and firming the surface. This practice will also reveal any water-holding depressions which might interfere with surface drainage.

Sterilization of Soil and Establishment of Turf

These steps may be accomplished by following well-known conventional procedures.

Conclusions

The foregoing steps in construction have been used successfully in many greens in various parts of the nation. It should be emphasized that each step in construction is dependent upon all the others. It is inadvisable to use a blanket of gravel unless the proper soil mixture is used above. It is inadvisable to use the gravel and the proper soil mixture unless the intermediate layer of sand is used to separate them. The courses of gravel and sand may result in saturation of the lower portions of the topsoil mixture unless the proper soil mixture is used.

In short, do not attempt to incorporate some of these steps into green construction unless they are all used in exact accordance with these recommendations.

The foregoing specifications tell the club how to proceed with the job of building a putting green but they do not tell why one should follow these procedures. There is ample evidence in the body of published literature to support the methods herein advocated. For those who are interested in a study of the principles which are involved and which are used as a basis for the recommendations set fort, a list of references is appended.

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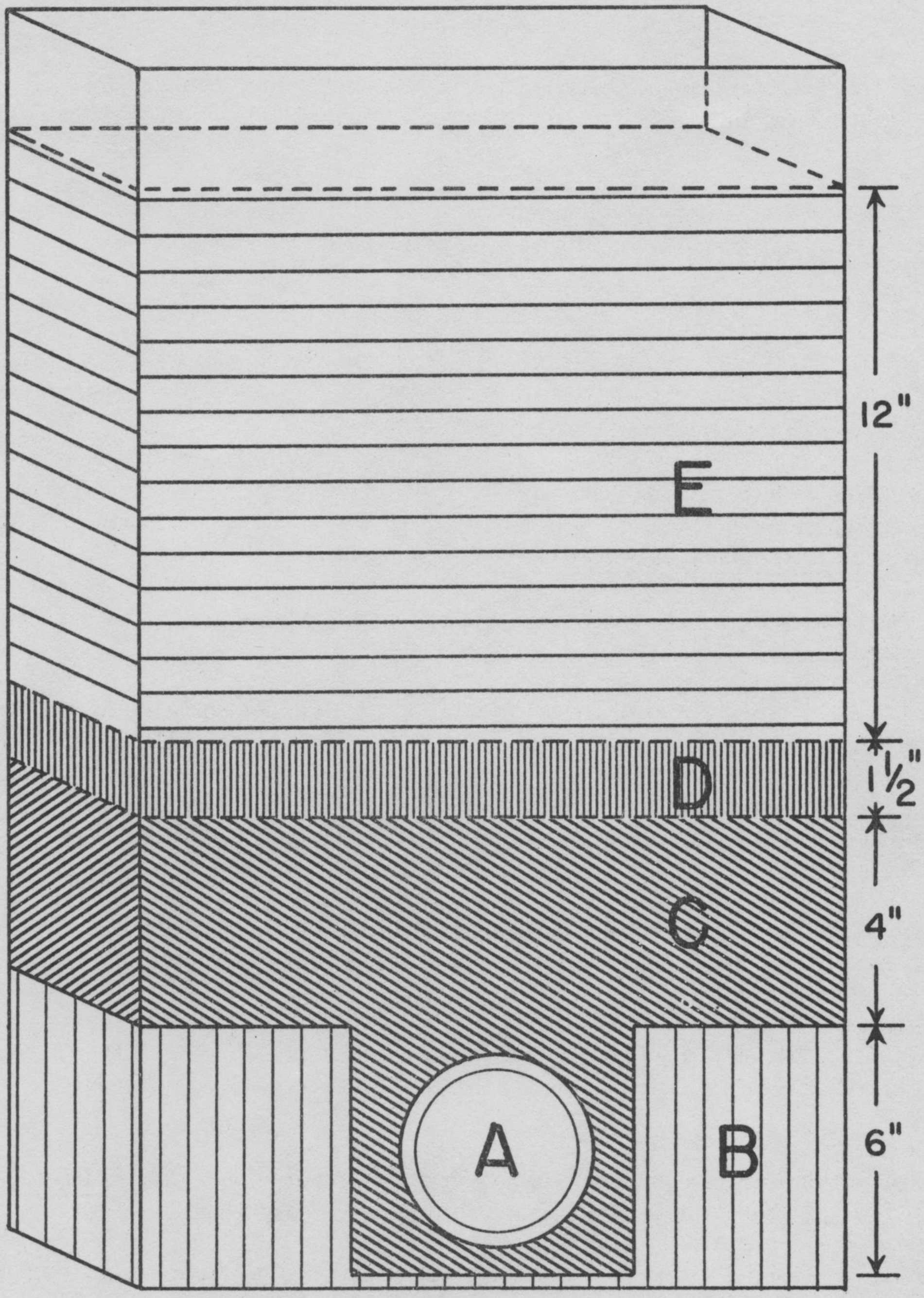

Figure 1. Cross-section of a putting green profile showing a trench and tile line.

(A) 4-inch diameter tile; (B) subgrade of native soil or fill material; (C) gravel - preferably pea gravel of approximately 1/4" diameter. Minimum thickness 4 inches; (D) coarse sand - this sand should be of a size of 1 mm. or greater. One and one-half to 2 inches in thickness; (E) topsoil mixture, minimum thickness of 12 inches.

SOILS FOR HEAVILY TRAFFICKED TURF AREAS

Roy Goss[1]

When we use the term soil, we are being just about as general as we are when we say people, for there are perhaps more variations in soils than there are in people. One important difference existing between these comparisons is that we can easily change our soils, whereas the people--well, that is a different matter. The soil with which we have to work in specialized turf is perhaps the most important single consideration, but yet is probably explored as little as any other factor. Why is it that we tend to disregard this importance in construction programs when it is a certainty that this most important phase can determine the success or failure of the operation?

Many communities vote for increased taxes to build a lovely, durable school with excellent utilization of facilities. However, no consideration is given to the ground where physical education and sports are just as important to healthy bodies as chemistry, mathematics, and English are to healthy minds. Golf courses will pay extremely high prices for land on which to construct a golf course, and then adorn this land with beautiful club houses, swimming pools, and other items for member luxury, but turn little thought or attention to the construction of the basic commodity, the golf course. If it were not for the building of the golf course, then the beautiful club house and all other facilities probably would not have been built in the first place, because club privileges can be gotten anywhere downtown. Golf course superintendents, school maintenance personnel, park superintendents, and others all have the same problems when it comes down to the basic commodity, soil. We are so prone to look at what is above the ground that we rarely stop to analyze what is beneath the surface.

In this paper, then, I shall try to bring out a few of the important points that should be considered by turf people, especially if these areas are to receive considerable traffic.

Importance of Soils

Water. A good soil for turfgrass areas that must withstand heavy traffic is one that will hold reasonably large amounts of water, but yet not excessive amounts. This soil both in structure and texture must have such qualities so as to allow rapid percolation and escape of applied water or excessive rainfall. This soil must drain out as rapidly as possible in order to prevent puddling and compaction due to traffic following the application of water, either by irrigation or rainfall. The portion of the soil that is concerned with water storage is called "pore space." The portion of the pore space that is concerned with water storage is called "micropores." The greater the soil volume is in micropores, the greater the water-holding capacity of the soil. Clay soils have a very high percentage of the total pore space as micropores.

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Air. Air or oxygen in the soil is just as important to growing plants as the air that we breathe. Soils without air are generally those that are water-logged or otherwise stagnant. Here we will find only limited plant growth and then only specialized types of plants. Soils must readily accept air and have considerable storage for this important commodity. Water and air are inversely proportional to each other. That is, as the water decreases, the amount of air in the soil increases, and likewise all of the air in the soil can be completely replaced by water if excessive amounts are applied. The portion of the total pore space concerned with air storage is called the "macropores." These air spaces, or voids, are so large that water drains from them readily due to forces of gravity. Now, both the micropores and macropores are dependent upon two factors, that is, the texture and structure of these soils. For example, a clay soil which is considered a heavy-textured soil has a very high percentage of pore space. However, the greater portion of this is micropores and little of it macropores. Hence, the water-holding capacity of clay soil is very high, and it has little ability to aerate. The texture of this soil is determined by its mechanical composition, that is, the percentage of sand, silt, clay and organic matter. The structure of this soil, which is extremely important for the macropore capacity, is determined by the arrangement of these particles. If the heavier fractions of the soil are well aggregated, then macropore space is highly increased. However, if these particles are disentegrated, that is, puddled or packed, there is a resultant loss of macropores and an increase of micropores, making the soils then increasingly wetter.

Compaction. Texture and structure have already been briefly touched upon; however, they should be mentioned again here, because these are the two factors affecting compaction, assuming that there are compaction forces at play. Basicly, the finer the soil texture, the more compaction one can expect if mechanical forces are set up. Clay soils perhaps compact better or easier than any other soil because, broken down to their individual particles, they are the smallest. Compaction, in this sense then, is related to soil texture. Even in the fine ranges of the sands, which compared to clay are very coarse, we can achieve quite a high state of compaction. Due to the action of decaying organic material and organic adhesives the finer soil particles, such as clay, are bound together in what is termed aggregates. Well-aggregated soils have a high amount of pore space, and a large amount of this total pore space is macropore space which will hold a considerable amount of air. It perhaps should be pointed out here that a good soil will have at least 50 per cent pore space, and at least one-half of this total pore space is macropore space, which will not hold water against the forces of gravity. This, then, is the pore space available for air storage. If soils containing aggregates are worked, or packed, or otherwise puddled in a wet condition, these aggregates most often break down. When these aggregates break down, they return to their individual forms, and this is where sealed and compacted surfaces originate. Sandy soils will not aggregate to any degree, especially in the coarser ranges. This means that we can get considerable compaction with sand, but due to the very large particle size the pore space found is almost entirely macropore space, that is, that which will hold air and not water.

Mechanical Fractions

As stated previously the percentage of sand, silt, clay, and organic matter in a soil all go together to make up what is termed texture. How then do we determine the texture or the mechanical percentage of these various separates in a soil? The most practical methods of determining this are by sieving and by analyzing any soil sample that is to be used in a construction program. Then there is no question as to whether or not you are using the proper soil for the job. Persons with good judgment and ample experience can quite often come fairly close to determining the texture of the soil by feeling it. This method, however, is only an estimate of the soil fraction in a sample and should not be relied upon when an expensive construction program is being anticipated. Areas such as golf courses and bowling greens should consider this problem very carefully before launching on any construction program. Also construction programs involving playfields and football fields should be concerned with using the proper soil and taking the necessary precautions to do the job right in the beginning.

Sand

Percentage. The amount of sand in the total soil mixture should make from at least 70 per cent to 85 per cent of the total volume. As mentioned previously, the function of sand in this case is to serve as the framework in the soil mixture. Sand has little or no nutrient-holding capacity. However, its pore spaces are composed almost entirely of macropores which will allow large amounts of air in the soil.

The role of sand. Framework and large macropores or air spaces are the chief functions of sand. This of course will prevent compaction to any great degree.

Properties. The properties of sand for construction should conform approximately to some of the following standards. Very little of the sand used should be larger in size than 0.4 mm. and likewise little should be less than 0.2 mm. Therefore about 75 per cent of the sand should fall between the sizes of 0.4 mm. and 0.2 mm. No more than 10 per cent of the sand should be less than 0.10 mm. Any particle size smaller than 0.10 mm. should definitely be avoided. In order to convert millimeters to meshes per inch, which is a common designation for purchasing from sand and gravel yards, we can say that the particle size should fall between 60 mesh and 175 mesh, about 75 per cent should fall between 60 and 80 mesh, and 25 per cent between 125 and 175 mesh. This will seem rather coarse, and compared to silt and clay it is. However, we are after macropores and resistance to compaction.

Silt

Percentage. Theoretically if we could avoid any percentage of silt in a soil mixture for soils being subjected to heavy traffic we would be better off. Soils with silt percentages ranging higher than 30 per cent should be avoided in any construction program.

Properties. Since the coarser silt particles are so similar in fine sands in regard to the amount of surface exposed they have little part in the chemical activity. The finer silts have sufficient surfaces exposed so that they do have some chemical activity. However, this amount is even negligible and cannot be looked upon as an important part of the chemical activity of the soil. Silt particles as such have undergone little weathering and exist in a relatively raw state similar to the parent material.

Clay

Percentage. The percentage of clay in this ideal soil mixture that we are referring to is from 6 to 15 per cent. Amounts less than 6 per cent will not furnish enough chemical activity in the soil, and when we run into amounts over 15 per cent we are running the risk of causing compaction, decreasing our macropores, and slowing down water permeation. We usually do not incorporate clay in a soil mixture as the pure clay mineral, but it more often exists in the form of clay-loam or sandy clay-loam. Either of these two soils named above contains very high portions of clay in them.

Role. The role of clay is to furnish or bring about chemical activity in the soil. These clay particles serve as a storehouse for our mineral elements upon which the plant is dependent. Clay along with other organic-cementing agents is a primary source of soil aggregates. Clay usually does not exist as single particles in the soil, but is most often aggregated and will allow relatively free movement of both water and plant roots through the soil. By the act of becoming aggregated, clay particles tend to increase the macropore space allowing better aeration when this phenomenon occurs.

Properties. As stated previously, clay is the chemically active portion of the soil. Clay colloids (very small particle sizes) are made up of various minerals including silicon, aluminum and water, with other quantities of iron, calcium, magnesium, potassium, and sodium. These clay minerals are built up of layers or plates of silicon and aluminum. The clay minerals are negatively charged particles and attract such positively charged ions as potassium, sodium, calcium, magnesium, and so forth. These positively charged ions are held closely to the surface of the clay mineral and are usually obtained by the plant in a complex exchange reaction.

Organic Matter

Percentage. The percentage of organic matter for our ideal soil should be between 8 and 20 per cent. In no instance should this amount of organic material be less than 8, and perhaps on our sandier soils we may have need for amounts greater than 20 per cent to facilitate the storing of a larger volume of nutrients.

Role. Organic matter functions in much the same way as clay. It tends to bind or aggregate smaller particles into granules which will allow better water, air, and food penetration into the soil. It tends to overcome the puddling and packing effect. When the organic matter exists in a relatively raw or undecomposed state such as fibrous peat moss, it furnishes an extremely high amount of pore space due to the large amount of space it occupies in relation to its density. The organic matter will also hold large amounts of water, and this is vitally important in extremely sandy soils.

Properties. Organic matter is any form of vegetation or animal material which has not completely undergone decay. We normally consider organic matter for soil applications as being undecomposed vegetative matter. Some of the more common types of organic matter are peat moss, generally of the sphagnum group, sawdust, straws, etc. When organic matter is completely decomposed to its final products, it is then called humus. Organic matter serves as one of our major storehouses of nutrients and water, and this organic matter is extremely important, particularly for holding nitrogen.

Organic matter on a dry weight basis has a water-holding capacity of several hundred per cent. Another important property of organic matter is that it improves the soil by the growth of microorganisms. These microorganisms are the agents whereby the plant food elements of the soil are kept in circulation and serve as a source of food and energy for the majority of these organisms.

If we will observe the rules as set down above in our ideal soil construction for heavily trafficked turf areas, I feel certain that we will not go wrong with this type of management in our construction programs. I believe it has been amply pointed out that the soil is our most important commodity in construction and turf management, and that where sums of money which are required in the amounts to construct bowling greens and putting greens are being considered, we should not guess at the percentages of materials in these soils but should have them definitely analyzed and approach this in a businesslike manner.

Just remember that good planning, construction, and management doesn't cost anything. It Pays!!

IRRIGATION PUMPS

John F. Schrunk[1]

It is indeed a pleasure to address you on the subject assigned by your chairman, because we believe it can be stated within the bounds of modesty that the pump is the heart of the sprinkling system. It follows, therefore, that we must give the most careful thought to the selection and correct application of the pump. We shall, therefore, endeavor to point up those factors to be considered by all who have anything to do with the pump's selection and application.

Centrifugal Pumps

Because of its simple design, ruggedness, the ease with which adjustments and repairs can be made, and its reasonable cost, the centrifugal pump is most commonly used in irrigation installations.

Advantages of Centrifugal Pumps

1. High efficiency obtainable.

2. High discharge rate possible.

3. Simplicity and economy.

4. Ease of installation.

5. Adaptability to different speeds- operating speeds which allow direct-connection to electric motors.

6. No excessive pressure with valve closed.

7. Almost all end thrust can be eliminated.

8. Nonoverloading with increased heads.

9. Smooth flow through pump and uniform pressure in discharge pipe.

Limitations of Centrifugal Pumps

1. Available head per stage is limited.

2. Suction lift is limited.

3. Susceptible to losing prime.

4. May be some danger of overloading if head is decreased.

5. Usually requires more space than a turbine.

6. Efficiency will drop if operating conditions differ greatly from those for which pump was selected.

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[1] Cornell Manufacturing Company.

7. Wearing rings must be replaced when worn.

8. Water seal is required on some bearings to hold suction.

How they Work

The basic principle of centrifugal pumps may be demonstrated by a rotating wheel or a whirling bucket. If a bucket partly filled with water is whirled rapidly enough, centrifugal force will hold the water against the bottom and not a drop will be spilled.

If a pipe were inserted in the bottom of the bucket and your arm were a pipe supplying water to the pail, a continuous stream of water would be pushed out of the pipe in the bottom.

If a casing were arranged to collect and guide the water after it squirts from the hole in the bottom of the pail, a simple centrifugal pump would be the result with your arm as the suction pipe, the pail as impeller, and the casing as volute.

The Parts of a Pump and How They Work

The function of the impeller is to transmit energy or velocity head to the water, and the function of the volute casing which surrounds the impeller is to transform this velocity head into pressure head. The volute is spiral shaped, increasing in size and clearance from the tip of the impeller in the direction of rotation of the impeller. This spiral shape is to accommodate a greater quantity of flow as the water nears the pump discharge and to reduce gradually and smoothly its velocity as it enters the discharge line.

Unlike positive-acting types of pumps, centrifugal pumps have relatively few wearing parts. Bearings are usually bronze or babbit and may be lubricated by oil, grease, or water. It is important that the manufacturers' specifications for lubricants be followed closely.

The centrifugal volute pump may be obtained in sizes varying from 25 gallons per minute to almost any size desired. It may be either direct connected or belted. There are two main types of horizontal-centrifugal pumps--the side or single suction, and the double suction. Three different types of impellers are commonly used. They are open, semi-enclosed, and enclosed. Ordinarily the enclosed impeller will show the highest efficiency because of lesser clearance between parts separating the pressure and suction chambers. Efficiency drops when this clearance increases, allowing water to slip by. Many pumps are equipped with wearing rings which may be replaced when the clearance becomes excessive.

With water entering on both sides of the impeller, the double-suction pump is theoretically in hydraulic balance. Actually some end thrust may result from lack of symmetry of impeller, unbalanced flow of water in suction line, unequal wear of wearing rings, or blockage on one side of the impeller. With the single-suction pump, pressure builds up behind the impeller hub and causes a thrust toward the suction side. Manufacturers use various approaches to overcome this, such as an external balancer or with holes through the impeller near the hub of single-suction impellers.

Each centrifugal pump manufactured is designed for one particular operating condition--one combination of head, capacity, and speed that gives highest efficiency. However the same design can be used to cover a range of conditions with some reduction in efficiency by making one of the two following changes:

1. The rpm at which the pump operates may be changed.

2. The diameter of the impeller may be reduced.

Affinity Laws

From the equation of continuity, $V=Q/A$, any change in velocity of water through the pump will cause a proportionate change in the quantity of water discharged. Similarly, as the speed of the impeller changes, the relative velocity of the water changes in direct proportion. Therefore, discharge must vary directly with speed. Also since $H=V^2/2g$, the head varies as the square of the speed. Since power is proportional to the product of the discharge and head, power must vary as the cube of the speed.

$$Q \propto V \propto n$$

$$H \propto V^2 \propto n^2$$

$$bhp \propto QH \propto n^3$$

Similar analysis shows that the discharge will vary directly as the diameter and width of impeller.

Of course, these relationships are exact only when the efficiency is constant, and there are certain hydraulic and mechanical limitations beyond which the relationships break down. They are more nearly true for small increments rather than for large increments.

Method of Changing Pumps to Fit New Conditions

If conditions change after a pump has been in operation, or the conditions were not correctly determined in the first place, it may be desirable to make certain changes. A pump-performance curve should always be demanded with the pump. This may prove most useful if there is ever any trouble with the pump.

If capacity of well or other water supply is less than capacity of the pump, the capacity may be decreased by:

1. Throttling

2. Reducing speed

3. Turning down impeller

Changing the speed is most satisfactory on engine-driven plants. If the source is a well, before attempting any changes the actual capacity of the well when operating against the desired head should be determined. This can be done by partially closing the discharge valve until the drawdown is reduced to a constant, safe value. After the drawdown has remained constant during several hours of pumping, the discharge should be measured by flume or other means.

Example of Effect of Change of Speed

A centrifugal pump operating at 1450 rpm requires 60 bhp to discharge 800 gpm against 200 ft. head. Find capacity, head, and power required at 1750 rpm at same efficiency.

Solution: Since discharge will vary directly with change in speed

$$\text{gpm} = \frac{1750 \times 800}{1450} = 965 \text{ gpm}$$

Head varies as the square of the speed

$$H = \frac{(1750)^2}{(1450)} \times 200 = 292 \text{ ft.}$$

bhp varies as the cube of speed

$$\text{bhp} = \frac{(1750)^3}{(1450)} \times 60 = 105$$

If the impeller in the preceding example were one inch wide, the capacity could be approximately doubled if a 2" width were substituted. Likewise, if the impeller diameter is 10" and reduced to 9", the capacity would be reduced approximately by the ratio 10/9.

Speed may be increased or decreased by changing the pulley diameter or the speed of the driver, but in the same pump the diameter of the impeller can only be decreased. The impeller can be put in a lathe and turned down to any diameter desired. Efficiency drops with large impeller cuts, because the guidance of the water in the impeller is impaired and the favorable velocity ratios are altered. Impeller cuts result in decreased capacity and head of the pump.

Utilizing the relationship between the head, speed, discharge, and power of centrifugal pumps, it is possible to determine the correct speed for the new conditions. For example,

A pump operates at 1750 rpm and delivers 500 gpm against a total head of 200 feet. Since gpm varies directly as speed and head varies as the square of speed, if the pump were slowed down to 1150 rpm the,

$$\frac{500 \text{ gpm}}{X} = \frac{1750}{1150} \text{ and } X = \frac{1150 \times 500}{1750} = 330 \text{ gpm}$$

$$\frac{200 \text{ ft.}}{X} = \frac{(1750)^2}{(1150)} \quad X = \frac{200\,(1150)^2}{(1750)} = 86 \text{ ft.}$$

Example of Effect of Change in Impeller Diameter

Direct-connected, motor-driven units can best be made to fit new conditions by changing the diameter of the impeller, because the speed is fixed. As in the above example, if the unit were direct-connected with a 12" runner and delivers 500 gpm against 200 ft. head and it is desired to reduce the operating head to 175 ft., then since gpm varies directly as runner diameter and head varies as the square of the runner diameter,

$$\frac{175 \text{ ft.}}{200 \text{ ft.}} = \frac{X^2}{(12)^2} \qquad X = \sqrt{\frac{(12)^2 \times 175}{200}} = 11.2''$$

$$\frac{11.2''}{12''} = \frac{X \text{ gpm}}{500 \text{ gpm}} \qquad X = \frac{500 \times 11.2}{12} = 465 \text{ gpm}$$

If the performance curve of the pump shows head-capacity curves for different impeller diameters, the diameter for any desired gpm and head may be determined by interpolation.

Changes in speed or impeller diameter will also change efficiency and horsepower so that the relationships between head, speed, power, discharge, etc., are only approximations but give good results if the changes required are small.

Considering the above as sufficient to acquaint us somewhat with the personality of the pump -- let's now consider its application.

The chart presented here tells the story much better than words.

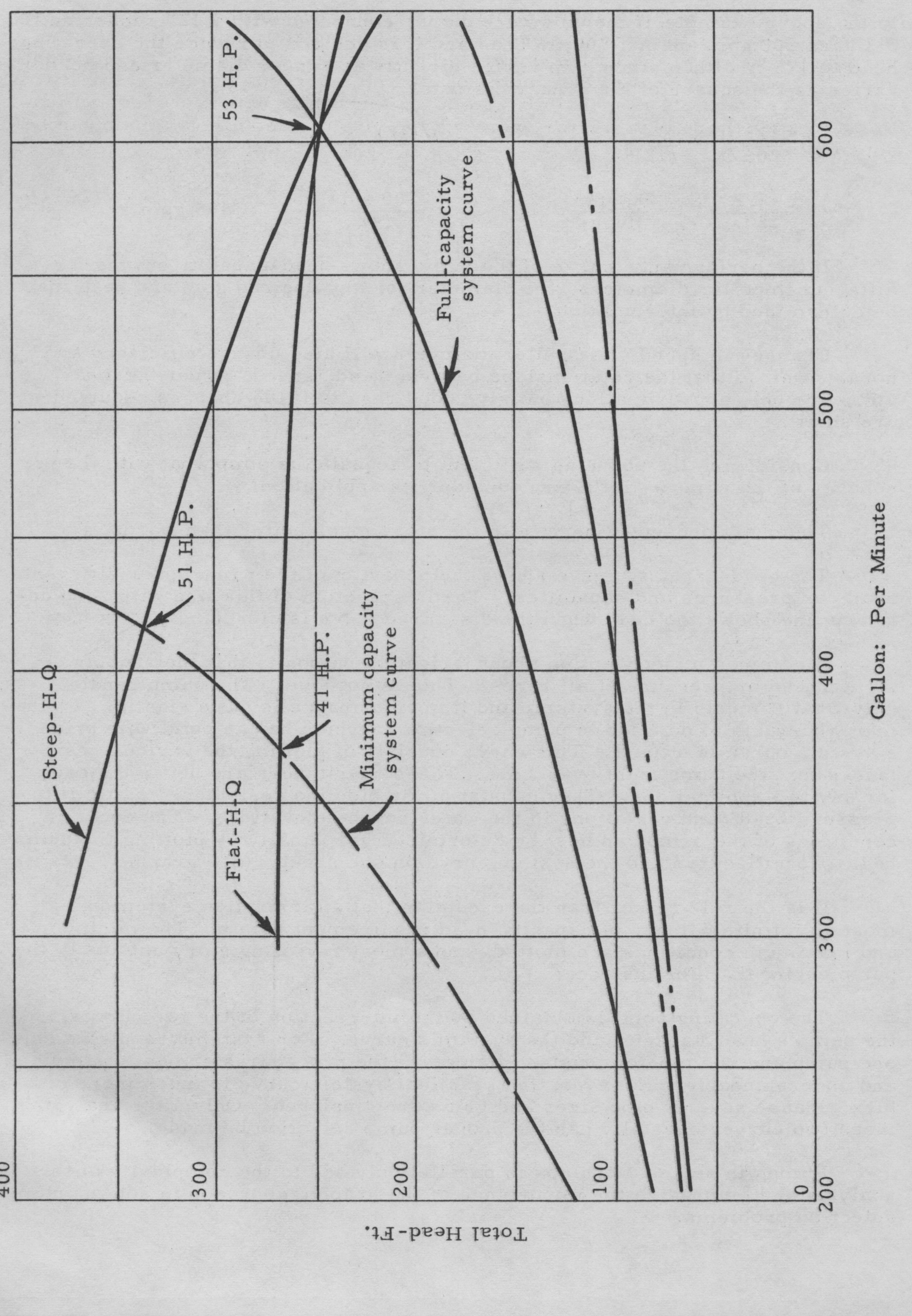
The head-capacity curve shows the behavior of the pump under different heads or pressures and capacities. The intersection of this line with zero delivery line shows the head when the discharge valve is closed.

A common misconception about irrigation pumps is that they supply designed head or pressure at all times. This is not true. The pump handles only what it meets in the system, and its performance is quite elastic. To the man who wants to do a job in pump selection to which he can point with pride, a system curve is a must. This curve consists of plotting the various resistances that the pump must overcome. These resistances are never the same for any two applications. They consist of the pipeline resistance, static lifts, pressure head, and variations in the water source elevations. The operating conditions of the pump can best be determined graphically by plotting the pump-head-capacity curve and the system curve on one sheet. (See graph.)

It is the rule rather than the exception that an irrigation system has almost an infinite number of capacity-head requirement points. The minimum and maximum conditions are plotted, and a most revealing story unfolds to the pump engineer. For instance:

The operating point is obtained by the intersection of the two curves, i.e., the pump's head capacity and the system's curve. For systems requiring only one pump and one pipe of constant diameter, the procedures are quite simple and understandable. However, the practical system curve is much more complex because several pipe sizes and grids are employed. Only after analyzing these two curves carefully can the proper pump selection be made.

Pumps in series or pumps in parallel only add to the complexity of this analysis and emphasize the importance of the graphic approach in solving pump-selection problems.


53 H. P.
51 H. P.
41 H.P.
Steep-H-Q
Flat-H-Q
Full-capacity system curve
Minimum capacity system curve
Total Head-Ft.
400
300
200
100
0
200
300
400
500
600
Gallon: Per Minute

In conclusion, good engineering dictates a careful study of conditions to insure obtaining efficient equipment which will adequately perform under the variable demands of the turf irrigator. There are no systems with a constant-capacity demand, and the very nature of a pump's personality dictates that it is the design engineer's responsibility to do its thinking. With a proper application approach, most satisfactory performance from a centrifugal pump can be obtained.

RANDOM THOUGHTS FROM AFAR

Fred V. Grau[1]

Circumstances have prevented acceptance of Dr. Patterson's kind invitation to participate in your 1960 WSU Turfgrass Conference. In lieu of making the trip, for which I am not physically prepared at present, I have agreed to send a few notes which, when published in the PROCEEDINGS, may be of interest to some.

Many of my "Random Thoughts" have been gleaned from talking with superintendents. Some have come from letters to "Grau's Answers in Golfdom." Each represents a phase of golf course maintenance with indicates PROGRESS.

New Construction

Low-cost machine maintenance to replace expensive hand methods is the order of the day on new courses. This principle deserves to be an integral part of each new architectural and construction contract.

Good drainage is so essential to easy turfgrass maintenance that it comes as a rude shock to realize that many new courses are built and paid for before the new owners realize that they have a "bad-drainage lemon" on their hands. It is rough on the superintendent who assumes responsibility for keeping the new course in top condition, only to find that it is not possible without extensive alterations, modifications, and rebuilding. Some superintendents have been fired for daring to rebuild a green that had been in play less than a year.

Thatch Control

Visits to courses in the U.S. and Canada clearly indicate that the problem of thatch is continuous and will increase with time. In order to have <u>enough</u> grass to build a <u>desirable</u> cushion on which to play golf, we need to grow <u>too much</u> grass for its own good. The excess grass creates thatch which demands periodic thinning and removal in order to provide good aeration and water penetration. Years ago I visited a course in the Pacific Northwest. It was raining at the time, and it had been raining most of the winter. The greens looked bad. My diagnosis was "the soil is dry." You can well imagine the incredulity and lack of enthusiasm with which my statement was received. Upon cutting a plug with a jacknife the powder-dry soil was exposed one inch below the surface. Thatch had acted the same as a thatched roof in Scotland or Ireland - no water could enter.

Machines for removing thatch and aerating the soil are easily available and should be in every superintendent's shed. This operation has become standard on many courses. It is of deep significance to golfers that the playing surface is unimpaired, even though the operation itself gives the impression that the place is being plowed.

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[1] Agronomist, College Park, Maryland.

Training Men

The turfgrass profession is in desperate need of college-trained men, preferably four-year students. Those superintendents who earned their Bachelor's or Master's degrees are in prime positions with top salaries. But, just so long as management shops around for a man who is willing to accept a low salary scale without fringe benefits, just that much longer we will have to wait for advancement in the profession. After all, the least costly item in the budget is a generous salary for a competent superintendent. We can ill afford to elevate an unschooled mechanic to a management position when a single mistake in the use of modern chemicals could cost the club many times the value of the false "saving."

Interference with Play

As the number of golfers increases without a comparable increase in the number of golf holes, it is inevitable that courses will become more crowded. The natural consequence is more interference with play while necessary maintenance operations are being conducted.

One plan that is being tried is to do major mowing and cleanup late in the afternoon and evening to minimize insofar as possible the early morning activities. It is assumed that, regardless of dew or anything else, the greens still must be mowed in early morning to prepare them for the day's play. Labor, of course, must be willing to cooperate if the other work is to be done late in the day. It would seem that the idea has merit and deserves a good trial.

Equipment

A needed piece of equipment would seem to be a fast, efficient vacuum sweeper for fairways. Removal of clippings, leaves, and other debris has seemed to me for years to be a prime objective in sanitation and in providing more pleasurable playing conditions. Suction harvesters have been designed for filberts, for buffalograss seed, and for certain other crops. To design one for unencumbered fairway areas should be an engineer's dream. Does anyone know of one in existence.

Close Mowing

Good golf turf is predicated on close mowing which aids in providing dense firm playing surfaces. This development for tees and fairways starting about 15 years ago has brought about some interesting changes in the grasses that are being used on tees and fairways. Ordinary bluegrass couldn't take it. Fescues fared little better. Then came improved bluegrasses which thrived under close mowing. Now we have improved fescues which tolerate close cutting. Many reports indicate that tees are being cut 1/4 inch to 3/8 inch; fairways 1/2 inch to 3/4 inch. Bents, of course, always have been adapted to very close mowing. Here, too, we have improved varieties which do a better job all around.

Public Relations

The fact that a superintendent can grow good grass may have little or nothing to do with his salary scale. His ability and willingness to get along with people may be much more important in determining the size of his check each month. Many superintendents tell me that their chief problem is coping with the individual quirks and moods of managers, owners, and committee chairmen. The sooner this phase of training of superintendents is recognized by universities (and by the superintendents), the sooner we will see the profession elevated to its well-deserved place.

Getting to Know Materials

It would be senseless for a message such as this to attempt to influence anyone to use this or that material. This paragraph is an earnest plea for more intensive study of each chemical, each fertilizer material, each fungicide - so that there is a better understanding of how and why a material works and what can be expected of it. We have heard foolish "conclusions" drawn after a single half-hearted attempt to compare one material with another without trying to understand the principles involved. Let us strive for honest, open performance trials over a long enough span of time to justify the drawing of conclusions.

It has been disappointing to be denied the privilege of meeting with you. For now, this written message must suffice. I would like to leave with you the thought that the turfgrass profession is an honorable one and one that is steadily growing in stature and importance. The secret of success is continued study, experimentation, self improvement, and attendance at conferences where experiences can be shared.

Conference Attendance 1960

Allen, Milton	1923 Pioneer Street Encumclaw, Washington	Maintenance gardner
Anderson, Frank A.	County Ext. Service K 10 Blgd. Kennewick, Washington	
Barclay, Earl	Route 1, Box 646 West Linn Oswego, Oregon	Oswego C & GC
Barr, H. E.	1011 Woodland Drive Vancouver, British Columbia	Marine Drive G & CC
Baruth, C. Wm., Mrs.	2434 South 158th Street, Four Oaks Seattle, Washington	Home Owner
Bauman, Clayton	2036 9th Street, West Kirkland, Washington	Glendale G & CC
Bauman, Milton	235 10th Avenue, West Kirkland, Washington	Overlake G & CC
Beardsley, Norris	Route 5 Spokane, Washington	Spokane G & CC
Beggs, Bert	118 - Joseph Street Victoria, British Columbia	Victoria, British Columbia
Bengeyfield, Wm.	P. O. Box 567 Garden Grove, California	U S G A
Bytelaar, J.	Vancouver British Columbia	Fraser G C
Blaskowsky, A.	Box 317 Leavenworth, Washington	Leavenworth G C
Brink, V. C.	University of British Columbia Vancouver, British Columbia	Agronomist
Brinkworth, W. H.	Los Altos California	Toro Manufacturing Company
Brown, Paul	3308 Harbor Avenue, S. W. Seattle 6, Washington	Pacific Agro
Carper, John	2400 Sixth Avenue South Seattle 4, Washington	Ed Short Co.
Clark, Dave	3365 Wallace Street Vancouver, British Columbia	Point Grey G C
Croft, Jerry	7506 Carnation Street Vancouver 13, British Columbia	McClury G C
Daniels, Jack	2437 1st Street, S. W. Seattle 66, Washington	Greenup Spray Service
Elliott, Art	1200 Stewart Street Seattle, Washington	Washington Turf and Toro
Everhart, Cliff	P. O. Box 8025 Manito Station Spokane 36, Washington	Manito G and CC

Filer, Ted	Washington State University Pullman, Washington	Plant Pathologist
Fluter, Ed	14015 N. Glisan Street Portland, Oregon	Glendoover G C
Fortier, Bud	Route 4, Box 548 F Albany, Oregon	Springhill G & CC
Fryer, Lee	3308 Harbor Avenue, S. W. Seattle 6, Washington	Pacific Agro
Gese, Pete	Box 68 Snoqualmie, Washington	Mount Si G C
Gettle, Richard	1425 Pacific Highway Bellingham, Washington	Bellingham G C
Goddard, Murl	807 N. 3rd Street Yakima, Washington	Elks G C
Goetze, Norman	Corvallis Oregon	Oregon State College
Gorley, Boyd	Box 146 Pinehurst, Washington	Everett G & CC
Gray, Homer	Corvallis Oregon	Corvallis G & CC
Gould, Charles, Dr.	Western Wash. Experiment Station Puyallup, Washington	Plant Pathology
Goss, Roy, Dr.	Western Wash. Experiment Station Puyallup, Washington	Research Agronomist
Gueho, E. M.	771 Austin Road New Westminster, British Columbia	Vancouver
Harrison, George	19445 Normandy Park Drive Seattle 66, Washington	New Life Fertilizer
Harrison, John	Hayden Lake Idaho	Hayden Lake G & CC
Harvey, George	Route 1 Warrenton, Oregon	Astoria G & GC
Haskell, Dick	10132 Ranier Avenue Seattle 88, Washington	Seattle Park Department
Hess, James	409 Filbert Road Alderwood Manor, Washington	Garden of Floral Hills
Hoggatt, George	P. O. Box 1479 Wenatchee, Washington	Wenatchee G C
Holm, John	Box 1196 Fairbanks, Alaska	Northern Lights Nursery
Hogan, Don	1910 Minor Avenue Seattle, Washington	Professional Engineer
Hulo, Dave	3110 Ruston Way Tacoma, Washington	Western Plastic Corporation

Imhoff,	Route 2 Ellensburg, Washington	
Ingram, Ted	1819 East 14th Avenue Vancouver, British Columbia	Seymour G C
Jackson, Ed	901 Lane Street Seattle, Washington	H. D. Fowler Co., Incorporated
Jangeward, Don	Ellensburg Washington	Central Washington College
Jaslowski, John	2906 12th Avenue N. Renton, Washington	Broadmore G C
Johnson, Dale	15 West Yakima Avenue Yakima, Washington	Penn Salt Company
Junor, Harvey	6585 S. W. Scholls Ferry Road Portland, Oregon	Portland G C
Carsner, Henry	4502 Westwood Square East Tacoma, Washington	Specialist in Aquatic Weed Control
Katlan, Marvin	7723 24th N. W. Seattle, Washington	Ed. Short Company
Koeph, Roland	Volenteer Park Seattle, Washington	Director of Horticulture
Kuhn, Carl	901 Lane Street Seattle, Washington	H. D. Fowler Co., Incorporated
Land, Henry, Jr.	23012 Brier Road Alderwood Manor, Washington	Sandpoint G & CC
Land, Henry, Sr.	9210 Winona Avenue, S. W. Tacoma 99, Washington	Tacoma G & CC
Latham, Jim	Milwaukee Wisconsin	Milwaukee Sewerage
Latimer, Dean	11804 Woodbine Lane Tacoma 99, Washington	Fort Lewis GC
Lawton, George	1919 Madison Olympia, Washington	Olympia G & CC
Macan, Vernon A.	1110 Beach Drive Victoria, British Columbia	Golf Course Architect
McKenzie, Ken	2428 Alaskan Way Seattle, Washington	Galbraith Company
McKay, Gordon	Chilliwack, British Columbia	Chilliwack G C
Marston, Art	7723 24th Avenue, S. W. Seattle 7, Washington	Northwest Mower and Marine
Matsumato	Caldwell Idaho	Caldwell G C
Mihelich, Joe	Route 3, Box 599 Enumclaw, Washington	Enumclaw G & CC

Miller, Don	520 South 53rd Street Tacoma, Washington	A - 1 Spray Service
Munro, Jerry	7622 Simmonds Road Bothell, Washington	Highland Point Gardens
Nanto, T. K.	2903 Lakeside Drive Moses Lake, Washington	
Palmer, Mary, Mrs.	6th and Wall Seattle, Washington	Seattle P. I.
Patterson, J. K., Dr.	Washington State University Pullman, Washington	Agronomy Department
Pottenger, Joe	2704 Willow Yakima, Washington	Yakima GC
Proctor, Glen	2222 South 111th Seattle, Washington	Ranier G & CC
Putnam, Ken	122 9 N. 172nd Seattle 33, Washington	Seattle G C
Reed, Byron	43 N. E. 202nd Portland, Oregon	E. P. Baltz and Son
Reger, Austin	Box 235 Liberty Lake, Washington	Liberty Lake G C
Ripley, Clarence	Route 5 Spokane, Washington	Wandemere G C
Rogers, Ed	7723 24th N. W. Seattle, Washington	Northwest Mower and Marine Co.
Rowe, Chen	P. O. Box 468 Tacoma, Washington	Tacoma Seed Company
Rogers, Tom	4126 Airport Way Seattle, Washington	The Bentley Company
Rolfson, Harold	2012 North Bethel Olympia, Washington	State Parks and Recreation Comm.
Schrunk, J. F.	2323 Harvester Drive Portland 22, Oregon	Cornell Pump and Irrigation
Scott, Lloyd	13017 41st South Seattle, Washington	West Seattle G C
Small, William	St. Louis Missouri	Mallinchrodt Chemical Works
Smith, Harold	West Vancouver British Columbia	Capilano G C
Spaulding, Jack	11301 N. E. 95th Street Kirkland, Washington	Anglewood G & CC
Strahl, Bill	1246 South 130th Seattle, Washington	The Bentley Company
Telfer, Ray	300 Willowdale Road Prineville, Oregon	

Thorson, Lloyd	City of Seattle Seattle, Washington	Civil Service Department
Venable, Marc	7723 24th N. W. Seattle, Washington	Northwest Mower and Marine Co.
Venison, J. C.	605 23rd Street Milwaukie, Oregon	Western Golf Course Supply Co.
Ward, Joe	435 East 6th Street Bend, Oregon	Bend G C
Warren, C. C.	2323 Harvester Drive Portland 22, Oregon	Cornell Pump and Irrigation
Watauabe	2434 South 158th Seattle 88, Washington	Gardner
Watson, Jim	300 West 82nd Street Minneapolis 20, Minnesota	Toro Manufacturing Company
Wallenbrink, B.	65 East 3rd Avenue Vancouver, British Columbia	Pacific Lawn Sprinklers
Wells, Perry	12005 N. E. 112th Kirkland, Washington	Perry Wells Company
Werth, Rudy	8023 27th N. W. Seattle, Washington	Jackson Park G C
White, Sidney	Route 3, Chenowith Road The Dalles, Oregon	Dalles G & CC
Wieting, Carol	13504 21st N. E. Seattle 55, Washington	Nursery
Wyman, Harry	1125 North 4th Pasco, Washington	City of Pasco
Zoller, John	375 Country Club Drive Eugene, Oregon	Eugene G & CC
Zook, Sam	1100 S. E. Waverley Drive Portland 22, Oregon	Waverlly G & CC