A REPORT OF THE PROCEEDINGS
OF THE TENTH ANNIVERSARY
CONFERENCE AND SHOW OF THE ILLINOIS
TURFGRASS FOUNDATION, INC.,
DEC. 1-3, 1969, ARLINGTON HEIGHTS,
ILLINOIS

Tenth Anniversary Turfgrass Conference and Show

PUBLISHED BY THE
COOPERATIVE EXTENSION SERVICE
COLLEGE OF AGRICULTURE
UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN,
IN COOPERATION WITH THE
ILLINOIS TURFGRASS
FOUNDATION, INC.

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Choosing the Grass to Fit the Need

HOWARD KAERWER

In the not too distant past, only common strains of turfgrasses were available. There was no opportunity to adapt the grass to specific requirements. A limited number of varieties have been released during recent years. While each is adapted to somewhat different environment and management conditions, they still were not developed with specific turf requirements in mind. Today, the situation is changing. Improved breeding and evaluation techniques are available to expedite this change. Requirements for turf needs are being spelled out. Economic, as well as aesthetic, demands are being voiced for grasses to fill specific requirements.

To date we have hardly taken advantage of the variability which is potentially available in the turfgrass species. Grasses are extremely adaptable. Desired characteristics can be isolated and bred into new varieties.

First, let's consider some of the characteristics of the species with which we are familiar.

Kentucky bluegrass, the old standby in the Midwest, is known for its aggressiveness and ability to provide cover and maintain itself when mown or grazed close. Within the population are upright growing plants while other plants range to the very prostrate. There are those which grow rapidly and others which are slow growers. Some bluegrass plants require high fertility levels and there are those which grow well under limited fertility. It is this variability which has made Kentucky bluegrass so adaptable and desirable in the Midwest.

The fine fescues (the red fescues and Chewings fescue) are noted for their shade and drouth tolerance, their ability to grow under low fertility conditions, and their narrow pin-like leaves. Within the species are rapid creepers, as well as those strains which do not creep at all. Some are salt tolerant, while others prefer acid soils. The fine fescues can be highly compatible with Kentucky bluegrass, excessively competitive, or disappear almost completely when the turf is managed to the benefit of bluegrass.

Tall fescue is known for toughness and ability to stand up under heat, low fertility, and drouth conditions where bluegrass and fine fescues will disappear. Leaves of tall fescue are broad and coarse. Tall fescues are often used on athletic fields and on roadside embankments. It is often the preferred grass in those areas of the country where neither the bluegrasses and fine fescues nor bermudagrasses perform adequately.

The ryegrasses are an interesting species. Not long ago, only common forms of annual ryegrass and perennial ryegrass were available. Both are used asmajor components in "cheap" nonpersistent grass mixtures. However, times are changing. Ryegrasses are now available which are fine-leaved, dark green, and form a dense, perennial turf. New, more summer hardy, as well as more winter hardy strains are on their way. Ryegrasses often adapt to conditions where bluegrasses and fine fescues do not perform well.

The bentgrasses are also a versatile lot. Emphasis has been placed on the fine turf quality of creeping bentgrasses when mown under greens conditions. There are extremely coarse and upright bentgrass strains as well as selections that are even finer textured than the creeping bents we know today. The colonial type bents have considerably more adaption for general turf use than the creeping bentgrasses. There are major differences in the performance of colonial bentgrass varieties, too. Varieties are now becoming available which adapt to moderate management and can be handled in a manner similar to bluegrass.

Let's not forget the versatility of other species as well--redtop, timothy, the meadow fescues and others. They do serve a limited purpose now. Perhaps when bred for specific purposes, these species will become of greater importance.

Varieties also react differently. We can't go into detail, but let's consider a few of the varieties we already know. Do you want a bluegrass which will take short mowing and maintain a dense turf? If so, you can consider Pennstar, Prato, Fylking, Sodco, A-20, and, to some extent, Merion. Do you want a bluegrass adapted to moderate or limited fertility and management? If so, consider Park or Delta or perhaps even some of the common strains. How about a Kentucky bluegrass for shade? This is a tough place for bluegrasses, but you might consider Newport or perhaps Warren's A-34.

We can illustrate similar range in adaptability between the varieties of the other species.

Will a certain variety of any one species serve all the performance requirements at any particular location? The answer is no, not completely. Can we expect one variety of a grass to be best adapted to a complete temperature range throughout a year, to all moisture variables, to all soil and fertility variables and the ravages of diseases, insects, and traffic? The answer is no. What can we do about it? The answer is to consider formulations consisting of species and varieties which will most closely fill the total use requirement projected for any turf area. It would be interesting to consider what might be possible as new varieties are developed, but this speculation will not help to solve today's problems. Instead, let's look at a few ideas which might be possible now.

Establishment can be a problem. Slopes are especially bad. What can be done to alleviate this situation? There are a number of potential solutions. The varieties to use need to be considered from the standpoint of the mature turfs we are seeking to provide, as well as initial establishment.

Ryegrasses establish rapidly. Can you use them? Yes. However, if common ryegrass is used, remember, it is very competitive. Limit the quantity applied to 10 or 15 percent of the mix and then be prepared to have occasional plants persist which disfigure the turf for several years. If the very rapid establishment of ryegrass is required, why not consider the new, narrow-leaved perennial ryegrasses such as NK-100, Pelo, or Manhattan. They get going fast, but are not as competitive to the establishment of the bluegrasses and fescues. Also, from a visual standpoint, they are compatible with bluegrass. The fine fescues are also faster establishing than bluegrass. For problem spots, as much as 60% of a formula might be fine fescue. The more open creeping red fescue varieties such as Ruby, Illahee, or Rainier tend to establish faster than the tighter growing strains such as Pennlawn, Jamestown, and Chewings fescue.

There are also differences in the establishment rate of the bluegrasses. Park is probably the fastest establishing although Delta is quite rapid and Newport is good when sown in the fall. The new bluegrasses which can be cut short are all a bit slower in starting out although once well rooted, they fill rapidly.

Is there anything wrong in using short-term grasses which may live for one, two, or a few more years before disappearing from the turf? I believe there is nothing wrong as long as they serve an initial use and do not produce problems as the sod matures.

Fertility can be a problem. The same mixture planted on different soils and fertilized in a differential manner will develop with different grasses as the dominance. Merion bluegrass is noted for its need for high levels of nitrogen. It is capable of producing quality turf with adequate management. However, the new high-quality bluegrass varieties such as Fylking, Pennstar, Sodco, and Prato require less nitrogen than Merion to produce top-quality turf. If less fertilizer is to be applied, Park and Delta are good varieties to consider.

When limited fertilizing practices are expected, consider the fine fescues as an essential component of the turf. Chewings fescue should be used if conditions are expected to be very infertile and drouthy. Pennlawn prefers a bit more fertility. Like Chewings, Pennlawn may become dominant to the bluegrass if fertility levels are too low to favor the bluegrass. Ruby creeping red fescue is adapted to higher fertility levels. Illahee, Jamestown, and Rainier are probably intermediate in their requirements.

The narrow-leaved perennial ryegrasses also do reasonably well at moderate fertility levels.

Are you having problems with shade? Before choosing the grasses to use, consider the existing conditions. Can they be modified to provide improved growing conditions? If so, take these steps before seeding. The growing of grass in shade is a subject for an entire talk and cannot be readily dealt with here. Use Poa trivialis where conditions are likely to be moist and cool. Use the fine fescues when there is good air drainage, roots are

likely to be close to the surface, or the soil tends to be drouthy. Warren's A-34 Kentucky bluegrass was selected for shade tolerance, and Newport offers a bluegrass which survives partial shade. These bluegrasses, in a formula, will aid transition from a bluegrass turf under full sun to the shaded areas.

Both the colonial bentgrasses and the narrow-leaved perennial ryegrasses seem to tolerate partial shade reasonably well. NK-100 and Pelo perennial ryegrasses have proved their worth on shady-problem tees.

How will the turf be mowed and managed? If management will be nonintensive such as often occurs in parks and on playgrounds, consider the use of Park, Delta, and Newport Kentucky bluegrasses. Any of the fine fescues may help provide a dense turf. If kids are running and sliding, consider including the less slippery species of tall fescue and timothy even though they may not provide as neat a turf appearance. For heavily trafficked areas such as football fields and around pools, consider the narrow-leaved perennial ryegrasses as a mixture component.

What to do about older turf areas? If there has been a history of a thin stand, it may be necessary to tear up the lawn and start over with soil amendments, rebalancing fertility and a new grass population. However, few people want to undertake this drastic approach. Perhaps first you should consider a revitalizing program including the appropriate herbicides, fertilizer, the possibility of reducing surface compaction through spiking or aerifing, and the introduction of a new grass population. Many lawns older than ten years will respond favorably. If none of these practices are to be undertaken other than perhaps an application of fertilizer, consider common ryegrass. It does establish easily and provides color and dust control. The new narrow-leaved perennial ryegrasses have most of the attributes of common ryegrass, plus improved persistence, better textural qualities, and the ability to provide a quality turf where bluegrasses and the fine fescues have difficulty establishing and multiplying.

Grasses also differ in color, textural qualities, and density. For best appearance, these characteristics need to be taken into consideration when seeding new turf areas or interseeding older turf. Perhaps you can even utilize these differences where accenting your landscaping plans.

There is still room for further improvements in grasses to meet the multitude of turf requirements. However, a knowledgeable use of our present varieties and species can go a long way in providing quality turf under most conditions.

A Realistic Turf Fertility Program

P. E. RIEKE

Fertilizing turfgrass is only one very important management practice necessary for the development of a quality turf. A fertilizer is a material added to the soil to supplement nutrients provided by the soil to increase plant growth and quality. In fertilizing turf, primary emphasis is on the quality of the turf, although growth is intimately involved in quality turf.

Fertilizing turf presents a wide range of problems, from those found in fertilizing an intensively managed, bentgrass or annual bluegrass golf green on sand, to those associated with a minimum maintenance area, such as a roadside or a relatively undeveloped park area. Because of this range of problems, it is necessary to deal with principles in this discussion. Two basic questions which may be asked in designing a realistic turf fertility program are: (1) What is my objective in growing the turfgrass? (2) What resources do I have which will influence the factors affecting turfgrass fertility.

Several key factors must be considered in designing a turf fertility program. They include the soil nutrient level, soil physical properties, species, variety, environmental conditions, budget and labor, clipping removal, irrigation practices, condition of the turf, and quality of turf desired.

Evaluation of soil nutrient levels can best be determined by soil tests for the major nutrients except nitrogen. Unfortunately, there is not a good soil nitrogen test because of our inability to control the environmental conditions that lead to predictable nitrogen release from organic sources. Researchers will continue to look for meaningful measures of soil nitrogen to predict nitrogen needs for turfgrasses.

Other soil tests are more dependable, however. A measure of soil acidity is important, especially because of the influence of pH on the very important microbial activities. The optimum pH range for microorganisms in soils is generally suggested at pH 6.0 to 7.0, although most turfgrasses can grow adequately above or below these pH ranges. Micronutrient availability, especially iron, is also affected markedly by pH. In Michigan, as well as in northern Illinois, many water sources are high in calcium and magnesium carbonates and bicarbonates. Continued use of this water for irrigation often leads to alkaline conditions (pH values well above 7.0), and may result in a development of iron deficiency on bentgrass and annual bluegrass greens. Iron fertilization then becomes necessary, usually being applied as ferrous sulfate or as an iron chelate. Some complete fertilizers now contain iron.

The determination of soil pH is basic to recommendations for lime or acidifying agents. Depth of sampling is a critical factor in this regard. How deep does the liming (or acidifying) influence penetrate? It is generally suggested that the sample be obtained from a 2- to 3-inch depth under turfgrass conditions. In addition, if an acidifying agent has been added and it is found that only the surface inch is quite acid from this application, what influence does this acid surface layer have on microbial activity and thatch accumulation in that layer? Elemental sulfur can be utilized for reducing soil pH if necessary. Ammonium nitrogen fertilizers will also perform some acidifying action over a period of years. These materials should be used with care, and the sulfur should be applied only at recommended levels. Before additional amounts are applied, pH should be checked again.

Most states have specific phosphorus and potassium recommendations for turfgrasses based on soil tests. These recommendations are not often established from good correlation research between soil nutrient level and turfgrass response. One of the problems is how to measure a turfgrass response. Such factors as resistance to disease, the various stress conditions, and traffic are often difficult to measure. For example, it is not feasible at the present time to precisely control the environment under field conditions that will encourage the activity of a specific disease organism.

Among the soil physical properties, soil texture (percent sand, silt, and clay) is perhaps the most significant in its effect on a turfgrass fertility program. Texture directly affects the cation exchange capacity and the pore size distribution. For example, a sandy soil with a high percentage of non-capillary pore spaces and a low cation-exchange capacity will require more frequent irrigation. This combination of circumstances leads to greater susceptibility to leaching of the nutrients, particularly nitrogen and potassium. Nitrate nitrogen, of course, will leach from any soil through which drainage water can move, but usually less leaching occurs from soils higher in clay because less total water moves through the soil. The degree of leaching of potassium as a soil cation would be reduced significantly as well in a soil containing appreciable quantities of clay because of its cation exchange capacity. The degree of soil compaction may also affect the response of turf to fertilization.

The species of grass must be considered in determining nitrogen needs. In Michigan 6 to 8 pounds of nitrogen per 1,000 square feet are suggested annually for the bentgrasses and Merion Kentucky bluegrass. The variety of grass is also important in that common Kentucky bluegrass usually performs best at rates of 2 to 4 pounds of nitrogen, while some of the improved bluegrass cultivars can effectively utilize 4 to 6 pounds of nitrogen per 1,000 square feet per year. Red fescues will usually perform best in the 1- to 3-pound range under Michigan conditions. These ranges are suggested as guidelines, since both lower and higher nitrogen levels can produce adequate turf.

Less nitrogen means less mowing, a significantly time-consuming management practice. At the same time, additional increments of nitrogen above the suggested ranges often lead to a higher quality of turf under Michigan conditions (Table 1). Higher nitrogen rates often result in increased incidence of leaf spot on common Kentucky bluegrass and red fescues. It has also been reported that some diseases increase under higher nitrogen levels, while certain other disease problems, such as dollar spot and rust, are reduced under higher nitrogen levels.

Excessive nitrogen can lead to reduced root growth; may contribute to increased thatch formation; and may increase the susceptibility of the turfgrass plant to moisture, to high and low temperature stress, and to wear. Higher nitrogen rates help grass compete favorably against weed invasion (Table 1). Similar responses have been observed on a sandy soil at Traverse City where crabgrass infested plots with lower nitrogen applications much more seriously than plots receiving higher nitrogen rates.

Table 1. The Influence of Nitrogen Rate on 1967-1969 Visual Quality Ratings of Merion Kentucky Bluegrass, and Dandelion Counts on Sandy Loam Soil at East Lansing, Michigan. Average of three replications.

Nitrogen rate lb. per 1,000 sq. ft.	Quality rating (7 dates) 1 = best 10 = poorest	Dandelions per 1,000 sq. ft.
0	7.3	907
2	5.2	605
4	3.9	179
6	2.8	52
8	2.1	47
10	1.6	12
12	1.3	11
14	1.2	3

Nitrogen rate will affect the ecology of grass mixtures and blends. High nitrogen will cause loss of red fescue in a red fescue-Merion bluegrass mixture, while the opposite often results with a limited nitrogen application level. In most cases higher nitrogen will lead to increased recuperative ability from injury caused by stress conditions.

Environmental conditions such as shade, air movement, and water drainage are significant factors. The time of year and unseasonable weather conditions (usually the case reported by turf managers) must also be considered. The condition of the turf and the soil temperature are two important aspects. The latter has a marked influence on the release of nitrogen from organic carriers. Cold soil temperatures in May and June often result in poorer quality turf if organic nitrogen sources are applied. Release then occurs in July and August when soil temperatures are higher. This situation occurs occasionally in Michigan and greatly complicates the decisions which must be made by the turf manager. The current disease situation is also an important contributing factor.

The cost of the fertilizer and the cost of its application are additional points which can be considered together. The experience of the individual applying the fertilizer should be evaluated. Inexperience in handling fertilizers can lead to serious difficulties. The turf manager must decide whether the safety factor in using a "non-burning" nitrogen fertilizer is more desirable than a cheaper soluble carrier which may need to be applied more frequently. What is the cost per application, considering fringe benefits and irrigation requirements? Can the higher cost of an organic fertilizer be justified? Can the turf manager hire and train personnel who can adequately handle soluble nitrogen carriers? These and other questions need to be answered by the turf manager in selecting nitrogen sources.

Removal of clippings leads to removal of plant nutrients from the soil. When clippings are left on the turf the nutrients are recycled into the soil. As a result, nutrient deficiencies are more common on turf where clippings are removed (exemplified by the need for iron on many golf greens). Nitrogen needs, however, are based primarily on annual requirements, since excess nitrogen is lost by leaching or perhaps as a gas. J. B. Beard of Michigan State University reports that clipping return can reduce the nitrogen requirement of Merion Kentucky bluegrass by 2 pounds per 1,000 square feet per year. A general figure used often is to reduce nitrogen needs by 25 percent if clippings are returned.

Liberal irrigation will lead to higher nitrogen requirements for turf, especially on sandy soils. Rates as high as 12 to 14 pounds of nitrogen per 1,000 square feet annually are

used on certain sandy golf greens in Michigan. The excess nitrogen is leached away under these conditions. Increased growth usually occurs under the higher nitrogen levels, thus more nutrient removal in the clippings.

The condition of the turf is another significant factor. In the spring, for example, if the turf is open and thinned by disease or low temperature injury, early spring application should be made so the turf will become denser and compete favorably with weeds. On the other hand, a turf that comes into spring in a healthy condition with good density could be fertilized more sparingly. This would reduce the requirement for early spring mowing. Susceptibility to potential stress conditions such as high temperature, drouth, and disease are other factors which should influence the turf manager's decision as to which fertilizer he will use, when to apply it, and at what rate.

A discussion about a turfgrass fertility program must include information on the source of nitrogen. Nitrogen carriers can be classified in several different ways, but basically there are the water soluble, natural organic, synthetic organic, nitrification inhibitors, coated fertilizers, and materials which have a low solubility. The last three categories are primarily of an experimental nature at the present time, although some of them have been under experimental trial for some years. Cost and knowledge of optimum utilization are limiting factors for many of these materials at the present time, but it is hoped that they will make a significant contribution to the range and choices available to the turfgrass manager in the future.

Data in Table 2 illustrate the influence of the carrier and of the time of nitrogen application on quality of Merion Kentucky bluegrass on a sandy loam in East Lansing. Also included are dandelion counts per 1,000 square feet in 1969. Treatments which lead to a dense turf in April and May result in reduced dandelion count. In addition, the activated sewage sludge and urea-formaldehyde treatments, giving a slower response during the cooler early season conditions, lead to higher dandelion counts and generally lower quality turf. On the other hand, reduced growth early in the season necessitates less mowing.

Much more could be said about turfgrass fertilizers, about the complexity of determining the need for different types of fertilizers under an intensive management condition. However, evaluating the factors discussed above and relating them to the objectives for the turf area and the resources at the disposal of the turf manager, a turf fertility program can be developed which is realistic for the specific situation. Obviously, a certain amount of flexibility is necessary. If the fertility program is not realistic, it is imperative to obtain the facts concerning this, determine the weaknesses, and initiate the necessary action to make a change in the program.

Table 2. Influence of Nitrogen Treatment (6 Pounds Nitrogen per 1,000 Square Feet Annually) on 1968-69 Visual Quality Ratings of Merion Kentucky Bluegrass, and Dandelion Counts on Sandy Loam Soil at East Lansing, Michigan. Average of three replications.

Nitrogen carrier	Dates applied	Quality rating 1 = best 10 = poorest	Dandelions per 1,000 sq. ft.
33-0-0	April	3.3	50
33-0-0	May	3.3	65
33-0-0	April + August	3.3	162
33-0-0	April + May + August	2.9	80
33-0-0	April + August + September	3.3	121
33-0-0	August	4.1	157
6-3-0	April	3.6	139
6-3-0	April + May + August	3.5	235
Urea-form	April	4.0	174
Urea-form	April + May + August	4.2	236
Check	--	8.3	903

Ultimately, the turf manager is the one who must determine which role each of these factors plays. The assumption is that a higher quality turf will require more intensive fertilization, as well as other management practices. The turf manager can be given guidelines for designing his fertility program, but each specific situation varies somewhat, so it is the turf manager who must weigh these factors and determine whether his program is realistic.

Making a Turf Weed Control Program Work

J. A. LONG

The main thrust in making a weed control program work in turfgrass areas should be in employing maintenance practices that discourage weed encroachment into the turf. As one evaluates a turf situation where weeds are prevalent it is normally possible to trace down some deficiency in the maintenance program which will account for the weed problem.

In newly planted turf areas, weeds often develop as a serious problem when some planting or early maintenance practice is not carried out properly. In established turf areas the three critical maintenance operations that influence weed development are irrigation, fertilization, and mowing.

Chemical control of weeds comes into play in turf areas when it is not possible or practical to maintain a proper balance of other turf cultural practices to discourage weed invasion.

TURF ESTABLISHMENT AND WEED DEVELOPMENT

The factors in turf establishment that contribute to making a weed control program work successfully include: (1) selection of the turfgrass best adapted for use in a specific situation; (2) use of seed with high viability and purity; (3) thorough seedbed preparation; (4) adjustment of the nutrient level in the seedbed; (5) uniform seeding; (6) irrigation programed to avoid moisture stress problems; and (7) postemergence mowing and fertilization.

Great emphasis should be placed on lessening weed encroachment during the establishment period. Doesn't it make sense to avoid a weed problem if you have a choice?

Select turfgrass varieties that are well adapted to the area in which they will be used. For example, in the large industrial turf areas where maintenance will not be intense, you may wish to consider blends instead of pure varieties. People attending this conference are more concerned with cool-climate turfgrasses, so the choice of grasses is narrowed down to varieties of Kentucky bluegrass, fine and coarse fescue, annual and perennial ryegrass, and the bentgrasses.

Selecting seed of high viability and purity should be at the top of your list of priorities for insuring that you start out with the best possible chance of lessening weed problems. Physical purity of seed as reflected in seed analysis will alert you to potential weed problems that could develop from your selection of seed.

Seedbed preparation provides an opportunity to eliminate many annual weeds that have germinated. It will be effective in destroying perennial weed plants that may be present. This step also is essential to provide a suitable medium for seeding.

In seedbed preparation, plan to incorporate fertilizer when required. If soil analysis shows that such elements as phosphorus are deficient, then some adjustment in fertilizer applications may be made.

Frequent light irrigation after seeding is the key to successful turf stands if each preceding step reviewed above is followed. Improper irrigation (particularly too frequent watering) no doubt accounts for more failures in developing turf plantings than any other maintenance step. Weed populations are significantly affected by this maintenance practice.

Properly timed mowing of new plantings has a two-fold effect on weed populations. Mowing stimulates lateral shoot development in grasses, which gives them a competitive edge over

many weeds. Secondly, mowing is effective in killing a number of annual broad-leaved weeds. This occurs because the growing points in a number of annual broad-leaved weeds are cut in the mowing process. This eliminates the regrowth capability of such weeds.

ESTABLISHED TURFGRASS AND WEED DEVELOPMENT

Making a weed control program work in established turf is also heavily dependent on how we conduct standard maintenance procedures. Mowing, fertilization, and irrigation represent major influencing cultural factors.

This year's conference (as well as conferences in previous years) touches on these maintenance practices, so no attempt will be made here to review such practices in detail. We emphasize here that weed control through balanced maintenance on established turf areas does much to lessen weed problems.

Even though we work toward optimum programs to encourage dense, vigorous turf, other forces are at work which cancel part of the effort. Turf diseases, insects, nematodes, and traffic represent some of these other forces. Still another factor is the weed plant. Recent research has shown that some of our turfgrasses are inefficient users of carbon dioxide. What does this mean to a golf course superintendent in Urbana, Illinois? This tends to confirm that certain weeds are better adapted to a given environment than the turfgrass or, in other words, they are more competitive than the turfgrass. This would mean that in Urbana some weeds probably would be better adapted to the area and use than any turfgrass available for that area, thus a favorable maintenance program may actually give the weed plant a definite competitive advantage. Fortunately, today we have a very effective line-up of herbicides that will accommodate many of the serious weeds invading turf areas. At the same time an additional number of serious weeds cannot be controlled with currently available herbicides.

WEED CONTROL WITH HERBICIDES

When it is essential to adopt a problem-solving maintenance practice, such as the use of herbicides, several factors should be considered. A logical sequence of events occurs in selecting and using herbicides. Initially, proper diagnosis of the weed problem and identification of the weed species must be made, as this often is the key to selecting the proper herbicide. After selection of the herbicide is made, application is the next factor one must consider. Follow-up cultural practices to discourage re-infestation are worthy of consideration, but are often overlooked in practice.

Proper identification of the weed or weeds directs you to the herbicide in cases where herbicides are available for the problem weed. Homeowners often write to us complaining about a product not providing weed control. Often we find that the individual has used a preemergence herbicide to control established tall fescue.

Herbicides are classified into three broad groups based on method of application or the way they are used in relation to the weed. Preplant herbicides are used on plant beds before seeding or emergence of weeds. Herbicides used before weed germination in established turf or on plant beds after seeding are classified as preemergence herbicides. Postemergence herbicides include those used after weed emergence.

If you properly diagnose the weed problem and make the right selection of the herbicide, yet do not optimize the application operation, then acceptable weed control may not be achieved. All too frequently we find professional turf managers not mixing herbicides properly in the use of liquid applications. Inadequate equipment calibration and adjustment are also very common errors made in the trade. Variable weed control and turf injury are often the results.

Recommendations for application rates given by your suppliers or the state extension service should be followed carefully. The turf manager who selects his own rate of application, disregarding label information, very often is gambling with the odds stacked against him. Manufacturers of herbicides have carefully researched which rates of application are required for weed-kill. Recommended rates take into account turf tolerance requirements.

Caution should be exercised in deviating from manufacturers' recommendations for mixing herbicides, insecticides, and fungicides to be used in a combined application. Commercial formulations of combined pesticides have been researched well and should be used where you desire using the combination pesticide.

Adjuvants including wetting agents, spreaders, stickers, penetrants, emulsifiers, and so on, may have a significant effect on herbicidal activity. Follow available recommendations for the use of such additives.

The growth condition of weed plants when treatment is made influences levels of kill obtained. Mature weeds under stress generally are not effectively controlled with recommended rates of some herbicides. Applications should be directed to weeds when they are in the early rapid growth stage and not under stress.

Preemergence herbicides in general should be applied several weeks before weed seed germination is expected to occur. Exceptions would include siduron which shows activity on seedling crabgrass.

SUMMARY

1. Select well-adapted turfgrass varieties.
2. Consider how the turfgrass variety will be used.
3. Use high-quality seed.
4. In the establishment phase, use thorough seedbed preparation, plus starter fertilizers where the need is indicated.
5. Maintain a balanced program with irrigation, fertilization, and mowing.
6. Select herbicides on the basis of accurate weed identification.
7. Proper application of herbicides will insure more success in weed control programs.

Disease Control—Yes or No?

M. C. SHURTLEFF and J. D. BUTLER

Whether it "pays" to control turfgrass diseases depends on YOU, your budget, available manpower and equipment, grasses grown, and whether the turf is a home lawn, municipal or state park, cemetery, golf course, church or school grounds, athletic turf, highway shoulder or median strip, industrial site, or airport. Obviously, "pampered" golf greens and tees require much more disease control than highway shoulders or turf along an airport runway. Major diseases often can't be ignored but many minor ones are more unsightly than serious.

There are two principal ways of controlling turf diseases: cultural and chemical. Both are basically preventive in action and are interrelated. Fungicides--no matter how efficient and long-lasting--cannot hope to do the job by themselves without a good cultural management program.

There are few diseases of lawn grasses which are "eliminating," i.e., kill out all grass plants over an area several square feet or more in diameter. Usually there are enough grass plants within an infected area that recover naturally and fill in for those killed over a period of days or weeks. Now that we have excellent herbicides to control most turfgrass weeds, why not select out naturally those resistant plants in a turfgrass population by letting certain diseases run their course? The decision is up to you and goes back to our opening statement. If you are a golf course superintendent or sod grower you obviously can't do this under most circumstances. But if the disease is a minor one and can be largely controlled by changes in management, natural selection in a home lawn and similar areas often makes good sense.

Many turfgrass managers will probably steer a middle path; ignore minor diseases, let natural selection work as much as possible, use the best management practices, and have fungicides on hand for emergency situations.

Current fungicide recommendations for turfgrass disease control in Illinois are given elsewhere in these proceedings. We are concerned here primarily with cultural practices that (a) keep disease attacks at a minimum, (b) help diseased turf recover quickly, and (c) get the most disease control for the dollar spent with the least amount of effort.

Proper management helps maintain healthy turf that can withstand traffic or other abuse, and in which weeds find it difficult to compete.

Steps that help keep turf vigorous are:

A. Before seeding, sodding, or sprigging:

1. Remove large roots, stumps, and construction debris.
2. Provide for good surface and sub-surface drainage. Fill in low spots.
3. Select grass species and varieties adapted to local conditions and resistant to one or more of the most troublesome and common diseases. Resistance is a matter of degree and a grass noted to be resistant may have a very low level of resistance. Examples: (a) A-20, A-34, Anheuser, Fylking, Merion, Pennstar, and Prato bluegrasses, Pennlawn red fescue, Cohansey creeping bent, and Suwanee Bermudagrass are resistant to one or more Helminthosporium leaf diseases. (b) Bluegrasses with varying amounts of resistance to powdery mildew include: Anheuser, A-20, A-34, Cougar, Delta, Fylking, and Windsor. (c) There are several rusts, each composed of a number of races or strains, that attack bluegrasses. Varieties that commonly may resist to a certain degree one or more rusts include A-20, A-34, Cougar, Fylking, Newport, Park, and Windsor. (d) Grasses reported to be resistant to certain strains of Sclerotinia dollar spot: Bentgrasses--Arlington, Astoria, Collins, Congressional, Highland, Holfior, Nimisilla, Old Orchard, Penncross, Pennpar, Seaside, and Toronto; Bermudagrasses--Ormond, Sunturf, Tifway, and Uganda. (e) Bentgrasses somewhat resistant to Fusarium patch include Cohansey, Penncross, and Pennlu. (f) Stripe and flag smuts are now major disease problems. Bluegrasses reported as resistant to one or both smuts include A-20, A-34, Pa.(K-1 and K-34), Dwarf, Fylking, Park, and Pennstar. (g) Fylking and Newport have been reported resistant to Fusarium blight. Many turf experts believe in planting a mixture of two or more compatible grass varieties or species differing in their susceptability to turfgrass diseases. Then "survival of the fittest" is allowed to occur.
4. Have the soil tested and follow soil fertility recommendations accompanying the report. Work recommended amounts of limestone and N, P, and K into the soil. The phosphorus and potassium levels should be high. Add lime if the pH is below about 6.0; add sulfur, ammonium sulfate, or other acid-forming fertilizers if recommended.

B. At time of planting:

1. Sow top-quality seed in a fertile, well-prepared seedbed; or use top-quality sod and sprigs from a reputable dealer.
2. Provide the correct amount of fertilizer for the variety of grass being grown. Weak grass is especially susceptible to attack by certain disease-causing fungi.

C. Regular maintenance:

1. Keep new turfgrass plantings moist without being overly wet. Water established turf thoroughly and deeply (6 to 8 inches) and as infrequently as possible. Remember that essentially all turf-infecting fungi require moisture on the grass leaves, sheaths, or stems to cause infection. The more often grass is wet, and the longer free moisture remains, the greater the chances for disease infection. In most years, even dry ones, three to five good waterings are usually sufficient for lawn turf. Avoid frequent light sprinklings, especially at night or in late afternoon.
2. Follow a recommended fertilizer program. Avoid overstimulation with a quickly available, high-nitrogen fertilizer, especially in hot weather. Severe snow mold damage can often be prevented by not fertilizing after about mid-September. If rust is a problem, fertilize with nitrogen and water in late summer or early fall so that the grass grows steadily at the rate of about one inch per week.
3. Mow regularly at the height-of-cut recommended for the grasses being grown and for the conditions in your area. Wherever possible, mow as high as practical. This results in a deep root system with less likelihood of serious disease and weed problems. It requires less water to maintain and results in fewer athletic or playground injuries. Maintain grasses of the bluegrass type at a height of 2 to 3 inches. Prostrate or creeping grasses, e.g., bents, zoysia, and bermuda, may be maintained at a cutting height of one-half inch and golf greens at about one-fourth inch. To avoid snow-mold problems, keep turf cut in late fall until grass growth ceases. Mow frequently to remove no more than one-third of the leaf surface at one time. Avoid scalping.
4. Whenever possible, collect clippings at each mowing. This helps (a) reduce or slow thatch formation, (b) remove an important source of inoculum for disease-causing fungi, and (c) prevent a high-moisture condition. Disease attacks often start in or under thick masses of long clippings left on lawn turf.
5. Remove excess thatch in spring or fall, or both. Various machines, in many different sizes and types, are available. Avoid most serious disease problems by not allowing thatch to build up over one-fourth-inch deep.

6. Improve air flow, increase light, and promote faster drying of the turf surface by pruning or removing dense trees and shrubs that shade or border turfgrass areas.
7. Aerify to reduce compaction that may result in algae, moss, weed, and other problems. A wide range of hand and power equipment is available. Sometimes it is best to make heavy traffic areas into walks, drives, parking, or hedge plantings, or to erect a fence.
8. Control insects and weeds following recommended programs for your area and grasses. Insects may transmit disease-causing fungi. Grassy weeds often harbor the same disease organisms that infect desirable turfgrasses.

What Fault Turf Insect Control?

ROSCOE RANDELL

There are many serious questions asked about the use of pesticides, especially insecticides. Many of these questions are about possible misuse of these chemicals.

Since about 1945 the use of organic insecticides has increased rapidly on many agricultural commodities, urban lawns, and many other places. In Illinois approximately 7 million acres are treated each year with insecticides.

From 1945 until about 1960, the major group of chemicals used was the chlorinated hydrocarbon complex including dieldrin, chlordane, heptachlor, and aldrin, as well as DDT. The sale and use of DDT in Illinois was prohibited as of January, 1970. Since the mid-1950's, organic phosphorous compounds have been used. These chemicals include diazinon, malathion, dimethoate, and parathion, along with others.

Soon another new class or group of insecticides, the carbamates, began to be cleared for use; examples are carbaryl and temik.

Today we have many effective insecticides from these three major groups to control insects, especially lawn insects. During the initial uses of chlorinated hydrocarbons, such as dieldrin, their broad spectrum of insecticidal activity, long-term residualness, and fumigant activity made them excellent soil insecticides. With chemicals such as dieldrin and chlordane as soil insecticides in turf areas, grubs, wireworms, and other soil-infesting insects were all but eliminated.

At present, I believe we must consider some of the consequences of such insect-control practices. There is serious doubt whether preventive insect control has a place in today's environment. Except for the control of white grubs in the soil, there is serious doubt about turf preventive insect control.

There are two major reasons for this attitude. First, many of our newer insecticides will give a high percentage of control of an insect population when present, so annual preventive programs are not needed. This is true for controlling foliar feeding insects, such as cutworms, armyworms, and lawn webworms. Second, using residual insecticides can lead to selecting resistant strains of an insect species, and this practice can possibly have other adverse effects.

University of Illinois entomologists are still suggesting 5 pounds of actual chlordane per acre for white grub control. This treatment should be effective for 5 years, if incorporated into the soil or watered in thoroughly. For insects above the ground, especially caterpillars such as webworms, we suggest the use of a phosphate such as diazinon or a carbamate such as carbaryl. Repeated applications of a residual chlorinated hydrocarbon throughout a growing season may or may not be controlling caterpillars, but it may be creating other problems for the caretaker of turfgrass. These problems could include a build-up of thatch, an indirect result of residual insecticides.

In conclusion, the day has arrived when those who supervise the maintenance of turf areas should be familiar with life history and habits of the major lawn insects and be capable of observing symptoms or warning signs of potential damage. They also need to be capable of selecting proper treatment if it is needed. If chemical control is needed, the chemical should be reasonably safe to apply, should be as selective as possible, should give a high degree of control, and should only be residual enough to control the existing infestation.

Renewing Worn-Out Turf

W. H. DANIEL

If a turf area is worn out, you should find out why. Was it intense use? Has it been accumulating gradually for several years? Is it a large area now out of play, or must it be used again soon? Is it a cart path, the center of a football field, the center of a tee, or an approach to a green or play area?

When can you repair it? In the late fall only, in the summer only, in the winter only, in two weeks or in two months? How long will it last? Will it be another three years or just three weeks before it is badly worn? Must it be used immediately?

Another question is how will it be repaired? Will it be sodded, will it be overseeded or mulched? How much fertilizer or how much irrigation will be used? Then finally how can you extend the service once the area is repaired? Such questions must be applied to each area the turf manager supervises. Many of the questions have alternate best solutions. Let's review.

In Sweden many of their golf courses are using two cocoa-mat tees placed onto a platform so that you stand on one and hit from the other. Each mat will last three to five years. They add sand when it is new, shake out the soil when it gets too hard, and it is their way of having tees on rocks in accessible areas and with economy budgets.

We see on campuses a constant attempt to widen sidewalks to make up for the indiscretion of users who have less interest or less time and apparently less concern for turf survival. Because of intense use we see sidewalks and roadsides where repeated salt applications have caused a killing of the turf in adjacent areas. The need for sidewalks has damaged turf. There are other stresses, such as poor soils, compaction, and shade that also reduce turf quality.

Germination of seedlings

Species	Germination time (temp. 70°-80°)
	Days
Bluegrass	6 - 21
Bentgrass	5 - 10
Red fescue	5 - 12
Ryegrass	4 - 12

We know that quick emergence and establishment often give some erosion control, some shading of the soil, and some semblance of color. Throughout the south and in many special areas copious quantities of ryegrass are used, not because of performance, but because of the ability to germinate fast, to provide initial cover, and to give a semblance of greenness for a short period.

We all know that bluegrass germinates slowly. Six weeks after germination it may have three leaves and be 3 inches high under good conditions. Although some varieties are faster than others, Merion rates as one of the slow varieties, and Park is even slow compared to some other species. Vigorous grasses, such as A-20, by their rhizomeous spread, provide additional turf cover and additional wear. We are short on aggressive bluegrasses for play areas, athletic fields, roadsides, and special areas.

FERTILIZATION

Obviously fertilization should be maximum for the species' management, water, and climatic limitations. If slightly worn areas can be protected from wear, skip one or two mowings. With early fertilizing and watering as needed, such areas may recover quite rapidly rather than continue to grow thinner and thinner.

Can the golf carts be moved over for ten days? Can the band practice somewhere else? Can the intermural field bases be moved slightly? Once wear penetrates through the crown and the area becomes bare, time is a poor healer.

SEEDING

In renovation work, put on the seed as early as possible. Do mechanical work on top, such as thinning, sweeping, aerifying; then when work is finished put on water at a high rate so seed tends to be washed into the cracks and crevices. This gives the most uniform seedling germination and seed scattering.

If the athletic area can be topdressed, then it should be done. Recently we have learned that letting the cleats work the leaves and topdressing into the crown greatly increases wear tolerance.

HERBICIDES CAN HELP

Today's herbicides are a real resource for turf managers. We can selectively kill knotweed or crabgrass. We can prevent crabgrass, Poa annua, and chickweed. We can remove broadleaves before they compete. Two guidelines are:

1. Preventing the weed is the best policy. Dense turf is one good control. Timely, careful, and uniform preemergence applications are good controls.
2. Plan to kill the weed before it competes for space and weakens desired turf.

On the other hand, young knotweed may serve a school very well until school is out, then it can be killed as a part of renovation so the grass will fill in and be ready for fall.

MULCHING

Around homes, in small areas, incorporating soil amendments including mulch materials at the surface may be most helpful. Crushed corncobs make a good mulch; a thin layer of pea gravel along sidewalks makes a good mulch. There are numerous materials available--pine needles are one of the better mulch materials.

Artificial mulches of numerous kinds have been tested, particularly by Dr. James Watson of Toro. In 1959 we tested a grass seed roll for the 3-M Company. It was a good mulch, but never got beyond experimental stages. In 1966 we tested Famcomat, which works very well in cool weather. It traps heat and encourages germination. It was on the market for awhile, but is no longer available. All supplies are gone.

In 1965 tests were run on an excelsior mulch held together by netting. It was rather thick and was made for highway usage. It works well in hot weather as it gives a shading effect. It is still on the market in limited quantity.

More recently, in 1967, Conwed produced numerous wood fiber blankets. These have strong, bonded edges. Most of them are quite thick with more insulation and more shade than desired. These are still experimental. Commercially made woven or fiber mulches have been difficult to produce in quantity for widespread distribution.

Currently we are working with plastic sheeting, which is not new, but we are starting with one-quarter-inch holes punched on 4-inch centers, with the idea that in the spring additional holes will be punched, perhaps with golf cleats on site, so that the plastic can be left down during the spring period, thus encouraging modest growth. The secret will be holes for ventilation.

SOIL WARMING

Research at Purdue using electric cable in five different experiments indicates that soil warming can greatly improve turf performance. We can force growth every day of the year. There have been some interesting responses. Soil warming, plus overseeding, plus plastic mulching during January forced germination and growth where adjacent turf deteriorated.

In Edinburgh, Scotland, and in England electric cable is extending the football season. In Sweden they have soil warming with heating cable combined with field covers designed to roll over and off the field in 15 minutes. With such cables they secure the benefit of insulation, temperature pickup from sunshine, and conservation of heat.

More recently they have had excellent results with combining freezing and heating. One of the newest installations at Bellinghus in central Sweden is a sports complex which houses all sports. A portion of this includes a power plant, a tunnel for delivering heated or

cool solution to the soccer field where there are pipes placed 4 inches apart and 2 inches deep. Imagine the feet, yards, and miles of pipe involved! However, they expect to convert from turf into a solid ice freeze within two weeks starting November 1, and to convert from solid ice to playable turf within three weeks starting April 1. They expect more revenue in the winter than they do from summer sports.

In summary, renovating turf areas is perhaps the most challenging phase of wise turf management. Often it is done under difficult and variable conditions with unfortunate limitations on equipment, supplies, labor, weather, and all those factors that influence turf management.

Turf Equipment and Its Use

J. R. WATSON and E. A. HUNNICUTT

The central problems facing the turfgrass and recreational field today are to provide adequate facilities and produce the kind of turfgrass that can stand up under the heavy usage to which it will be subjected in the future. And this has to be accomplished while all the business costs--labor, materials, and taxes--are increasing. This is a real challenge. There may be many ways and means to meet this challenge, but as industry found out, mechanization, automation, and labor saving will play a key role.

REDUCE LABOR AND COSTS

The turf industry has been reducing operating costs and, at the same time, improving the general quality of turfgrass areas. Yet, today labor costs are estimated to be 65 to 75 percent of the annual maintenance budget for turfgrass areas, more specifically for golf courses. Cutting labor costs provides the greatest opportunity for efficient operation. Efficiency in this case implies the development and maintenance of the highest possible degree of turfgrass quality and player acceptance commensurate with a given expenditure of time, energy, and money.

Selection and effective use of equipment (large and small) to conserve costs by reducing labor are basic to efficient operation. Choosing greater capacity machines that handle more acres per day per man, machines that have increased maneuverability, and greater durability, and that are less fatiguing for the operator, aids substantially in reducing labor costs. The effective use of equipment will contribute to improved efficiency in the total operation.

To determine if the proper size of equipment has been chosen and if it is being used effectively, one should ask certain questions. For example, what, when, why, where, and how is a job to be done? Who can do it best and how long does it take to do the job? If you can answer all these questions and can be assured that you have given the best possible answers, then your equipment has been chosen wisely and chances are good that it will be used effectively.

Good planning and adequate records are basic to effective use of equipment. Good plans will provide many of the answers to the above questions.

Planning for effective use of equipment begins with a detailed study of the layout of the turfgrass area or areas. Ideally, a scaled layout of the golf course, park, school grounds, and so on should be prepared. If you manage more than one park, campus, or cemetery, all should be mapped individually and then brought together (on a reduced scale) on a master layout. Such a layout should show the various landscape and terrain features, roadways, and bridges, and the location, size, and shape of special features such as ball fields. When a golf course is under study, it may prove advantageous to show the entire course. Plans for effective use of equipment may be developed from a layout and from a knowledge of the necessary maintenance practices and capabilities of the machines to be used.

These plans should be developed along two lines--an immediate or short-range plan and a long-range program.

IMMEDIATE PROGRAM

The objective of this program should be to determine if the area or areas concerned, in their present condition, are being maintained as efficiently as is possible with equipment on hand or available for purchase. This involves, among other things, an examination of the equipment's capacity, mobility, maneuverability, sturdiness, and durability, as well as a study of the maintenance records of each piece of equipment to determine annual service and repair costs. When contemplating the purchase of new or replacement equipment, satisfy yourself that you are making a wise choice. Know the actual time involved in cutting and the transport time between cutting areas. Compare the performance of the old versus the new. Determine, for example, the time involved in cutting with pull-type gangs versus integrally mounted, hydraulically operated 30-inch cutting units. Replacement of inadequate and costly (from the standpoint of operation) equipment with units that will produce more work per man-hour of operation will permit more effective use of equipment. However, since equipment purchases are essentially capital expenditures and certain types may last from 5 to 15 years, no equipment should be purchased except within the framework of a long-range program.

In addition, the manufacturer or his representative should be consulted on the type of equipment needed. Information about new equipment and improved features, as well as the suitability of their equipment for the job at hand, is readily available from the reliable manufacturer. The availability of parts and service facilities is of prime importance when selecting equipment. If repair parts are not available when needed and a machine is inoperable for extended periods, it is of questionable value and certainly will contribute little to effective use of the equipment.

LONG-RANGE PROGRAM

This approach is basically a modernization program. Many of our turfgrass areas were designed and constructed during an era when labor costs were negligible and mechanization of little importance. This created many time-consuming operations requiring the use of low capacity, and often costly, equipment. Landscaping may not have been planned. Instead, it may have grown haphazardly over the years with little thought to the maintenance demands created. Shrubs and trees requiring specialized care in the way of spraying, trimming, and so on, are often located so as to interfere with high-capacity mowing equipment. This requires additional time-consuming operations to maintain surrounding turfgrass and does not contribute to efficient operation. Such areas should be ready for a face-lifting. Without a face-lifting, the use of several small units or a combination of one large and one or more smaller units may be the more effective way to use equipment.

The following factors contribute to efficient operations and effective equipment use: a long-range program of redesign in keeping with modern trends; landscaping that eliminates problem trees and shrubs; substitution of more hardy species requiring minimum maintenance and located to accommodate equipment with greater capacity; replacement of obsolete irrigation systems with modern automatic systems; and, perhaps most important, the construction of specialized, intensively used areas such as golf greens and athletic fields, employing the latest materials and techniques developed through research.

WORK PLANS

Plans and programs to cut labor costs with larger equipment involve effective use of the equipment and, in addition, they should stimulate constructive thinking about the jobs to be done. If the job is cup setting, which holes are to be reset? This decision then determines where the employee goes to do the work. The sequence of greens cut or holes reset may be chosen to require the least travel time between holes or they may be chosen because a particular mower is more suitable for cutting the contours of certain greens. A scaled layout will help with this decision.

Maintenance work may be done on equipment in the field, in a shed, or in a well-equipped shop. The most economical answer may not be the most obvious. Do not be fooled into thinking that because a certain route or certain practice has always been done in a certain manner, that the job cannot be accomplished in a more efficient way if it is carefully analyzed and studied. The objective is to keep the equipment operating efficiently--then it is being used effectively!

How long does it take to do a job and how is it to be done? As you prepare plans and study employees' activities, two questions are going to keep coming up:

1. How much time should it take to do the job?
2. How much time does it actually take to do the job?

The second question can be answered by keeping records of how many man-hours are required to cut a certain area or to perform any of the other projects and jobs. Such records do not usually tell how well the job was done or by what method it was done or how much idle time (for the machine and for the operator) occurred while the job was being done. Often, too often, there is a vast difference between how long it takes to do a job and how long it should take to do the job. Studies of industrial operations show that 10 to 50 percent of a man's day may be spent in idleness or nonproductive work. An interesting fact about this idle or nonproductive time is that roughly two-thirds of the idleness is the result of inadequate supervision or management and on the average only one-third is chargeable to the man himself. To properly answer the question of how long the job should take, break it down into elements or steps and determine how long each takes by the best available method. Then put together the necessary steps to arrive at the total time the job should take if there are no delays or wasted time.

A good supervisor must know what he wants his men to do with equipment, tell them what he wants done, and help them do it the best possible way. By so doing, the operators will be properly instructed in why they are using a piece of equipment and what they are using it for. Effective use will be the result.

MAINTENANCE

As we move into the development and use of more complex equipment, more knowledge becomes imperative. Those charged with supervision and maintenance of this equipment must thoroughly understand its function, design, and service requirements.

For the present, read and study service manuals. Attend manufacturer- and distributor-sponsored service schools. Train operators to handle routine service checks.

KEEP RECORDS

Consult with the manufacturer and his representative to see if your records of operation and performance conform to the expected levels for the particular unit. If not, why not? What phase of your operation or maintenance is contributing to the failure of the equipment to perform as designed? Only with adequate records showing hours of operation and annual service and repair costs will you be able to pinpoint responsibility and to determine if the equipment is being used effectively. And, further, such data and information will serve as a basis for the wise selection and purchase of larger equipment that will cut labor costs.

LEASING

Equipment purchase of large or small units should be classed or budgeted as a capital, rather than an operating, expenditure. Capital budgeting has significant long-range implications and may have a major impact on the economic well-being of a turfgrass facility. When dependable estimates and reliable projections indicate the desirability of the investment and funds are not available, or if the large commitment would jeopardize the financial structure of the organization then a leasing program should be considered. Most major manufacturers offer practical leasing arrangements or programs to qualified organizations. The major advantage of the lease-buy program is to reduce or eliminate the requirement for an immediate capital expenditure. Instead, the equipment purchase is programmed in the operating budget and handled on an annual basis. Also, there may be a tax advantage. Such a program is particularly suitable for new turf and recreational facilities, for those desiring to expand their current operation, or for any organization concerned with new equipment purchases.

Lawn Turf Session

Care in Starting a Lawn Pays Big Dividends

J. D. BUTLER

Whether a seeded lawn will prove satisfactory depends on several factors, many of which cannot be controlled. Here we will review some of the more common problems and consider possible solutions for getting a seeded lawn off to a good start.

Many logical points can be made in favor of sodding over seeding. It appears that the rapid increases in sodding may not necessarily be caused by the desire for an "instant lawn," but by the fact that the amateur has neither the knowledge nor inclination to do the seeding job right, thus causing him to fail at starting his own lawn. If he decides to seed, then he must do the best job possible.

The considerations in lawn establishment are discussed below in the order that they would most likely occur.

TIME OF SEEDING

The Kentucky bluegrasses and other cool-season grasses of the Midwest will do best when seeded in the last half of August in northern Illinois; while in southern Illinois late September seedings may excel. The primary advantages of late summer and fall seedings are that the soil temperature is high enough and the moisture is adequate to germinate Kentucky bluegrass in a week or less. Temperatures at this time also allow rapid seedling growth and establishment.

Virtual elimination of annual weeds is another outstanding advantage of fall seeding. In successive plantings made this past year at Urbana, crabgrass was a serious problem on areas seeded on June 16 and 30, but was not present in seedings made on July 14. Another advantage of fall seeding is the fact that, by the following spring, most of the selective weed control materials can be used on the established turf.

The soil can be summer fallowed to destroy certain perennial weeds that might be serious problems once the turf is established. Also, a proper seedbed can be prepared for fall seeding.

Diseases are seldom a problem with fall seedings since diseases are fairly well taken care of by cold weather.

Some disadvantages of fall seedings include the frequent extended dry periods in August through October. If sufficient irrigation equipment is not available, fall seedings may be only a waste of time, and a dormant seeding or spring seeding may achieve cover just as soon.

One of the biggest problems with fall seedings, especially when only poor cover has developed by the time cold weather arrives, is the heaving of the individual plants, which are often still growing as a bunch or as clump grass. The partial destruction of the root system by heaving, coupled with winter drying, can destroy or greatly set back a new seeding. An early spring rolling after a fall seeding would provide a beneficial smoothing, and would get the grass back into contact with the soil.

People often ask what is the cut-off date for fall seeding. No definite answer can be given because of annual fall weather differences. However, the grass to be planted will have some effect on the date of seeding. The success at Urbana with seeding after October 10 to 15 with Merion has been poor, while some of the more vigorous grasses might do very well if seeded a little later.

Although "spring" seeding may not be best, home construction and personal preference may dictate a spring seeding. At one time it was commonly recommended that spring-seeded turf areas should be of a temporary nature. Current recommendations are for a permanent turf establishment, although this may not be ideal.

Spring seedings in northern Illinois will probably be best in April, while late winter or very early spring would probably be best in southern Illinois. Spring seedbed preparation is usually almost impossible because of heavy rainfall and high soil moisture. By the time the soil can be properly worked for seeding, summer is usually at hand. Often the soil must be well worked since erosion problems that develop during the winter and early spring must be remedied to achieve satisfactory results.

The earlier the seed is planted, the more growth and competition can be expected for control of both annual and perennial weeds. Also, as the grass should be better from earlier seeding, chemical weed control can be relied upon earlier in the year and to a greater extent.

The earlier the seeding, the less the disease problem should be. The established grasses certainly seem to have a higher disease resistance than those in the seedling state.

If spring seedings can be gotten in properly, initial watering may not be widely needed. But to keep the young grass growing through a dry summer, large quantities of water will be needed. Observations often substantiate the fact that the second-year stand may be as good or better from a fall seeding, as from one made in the spring.

Late spring and early summer seedings usually present the greatest problems in getting a satisfactory lawn. Summer seedings can be quite successful with great care. Proper watering practices are especially important at this time of year.

Although weeds can decimate seedings made in the summer, often the greatest problem comes from one disease--pythium. Under normal conditions it might be better to delay seeding at this time until fall. Seldom would a temporary cover crop be worth the effort required, since many seeded "temporary" grasses may persist as perennial weeds, and the time that the soil would be bare or covered with weeds would be only a few weeks. Annual grasses and broadleaf weeds can be reduced by fallowing the soil until the fall seeding is made, and any perennial weeds that could be controlled only with non-selective herbicides could be spot sprayed during the waiting period.

CHOICE OF SEED

The question of which seed to choose for a lawn still generally comes down to a choice of Kentucky bluegrasses, sometimes as a mixture with red fescue. Several new varieties that seem superior to the older common types must be considered on their individual merits and their performance in the geographical area. In general, the new varieties seem quite superior to most of those available in the past. A few of the newer perennial ryegrasses are showing some promise and may be used rather widely in Illinois. If the lawn to be seeded has characteristics which make it different from other lawns in the area these should be given prime consideration in choosing the grass. For example, if a lawn has heavy shade from trees: a seed mixture with a high percentage of red fescue with Kentucky bluegrass would probably perform best; a shade-tolerant Kentucky bluegrass might persist; do not use Merion since it will not persist under these conditions.

For home lawns high-quality seed should always be used and it is seriously doubtful if the seed price should be considered. If you want a good lawn, get the best varieties and the highest quality available.

SOIL IMPROVEMENTS

Although soil amendments are often discussed they are virtually never used on home lawns. At one time topsoil additions were commonly recommended. Today, although it would be conceded that good topsoil would be beneficial, topsoil is used on only a few lawns. Normally, the larger a lawn is, the more undisturbed will be the topsoil, and the better will be the lawn. It is becoming increasingly apparent that there must be more emphasis on selection and testing grasses under poor soil conditions.

SOIL PREPARATION

After removing any sizable debris from the lawn, the soil should be worked to form a relatively fine seedbed. Over-working may pack the soil to such an extent that the seed cannot be covered, and a rain may wash away the seed.

STARTER FERTILIZER

A starter fertilizer is necessary to get a lawn off to a good start. A fertilizer ratio of 1:1:1 ($N:P_2O_5:K_2O$) is commonly recommended. A ratio that would supply more phosphorus (P), or a separate application of phosphorus fertilizer may be beneficial, especially if available P is low or is thought to be low. Commonly 15 to 20 pounds per 1,000 square feet of a 10-10-10 or similar analysis fertilizer is recommended for lawn establishment. At the Dixon Springs Agricultural Center, on a very low P soil, seedings of Kentucky bluegrass responded dramatically to applications of P fertilizers. On more fertile soils at Urbana, additions of P above those in the starter fertilizer have not given noticeable responses.

SEEDING

It is possible, if one is willing to wait long enough, to get a satisfactory cover with very low seeding rates. At Urbana with 1-foot spacing of individual Kentucky bluegrass plants a solid cover is possible under ideal conditions in 2 to 3 years, and with creeping bentgrass a putting surface can be obtained in one year or less. However, the advantages of seeding an "adequate" amount of seed greatly outweighs the slightly greater expense involved.

Below are the standard recommendations for the homeowner; however, with professional attention, in some instances the rates may be as much as 50 percent over what is needed to provide an optimum plant population.

Amounts of Seed Recommended for Starting a Lawn

PURE STANDS

Grass	Approximate number of seed per lb.	Lb. of seed per 1,000 sq. ft.
Kentucky bluegrass (all varieties)	2,500,000	2–3
Red fescue (chewings and creeping)	600,000	3–4
Bentgrass (colonial and creeping)	6,000,000	1–2
Tall fescue	250,000	4–5
Redtop	5,000,000	1–2
Perennial ryegrass	250,000	4–5

MIXTURES

Type of area	Grasses	Pct. of each	Lb. of seed per 1,000 sq. ft.
Shady or sandy	Red fescue	75	3–4
	Kentucky bluegrass	25	
Steep slopes	Perennial ryegrass	75	3–4
	Kentucky bluegrass	25	
Sunny or slightly shaded	2, 3, or 4 Kentucky bluegrasses	50, 33⅓, or 25	2–3

The seed should be distributed as uniformly as possible, and raked or matted into the soil. The commercial equipment that covers and firms the soil about the seed works well when it can be used.

WEED CONTROL

Since the success of spring seeding often depends on the weed competition, particular attention should be given to this problem. Some newly seeded areas may not have an extremely high weed population potential, and a spring seeding may be brought on without undue problems. Generally the farther south one goes in Illinois, the more weed problems occur with spring seedings. At Dixon Springs, which must certainly be in the "crabgrass belt," we have never successfully established a spring seeding without resorting to chemicals. Crabgrass control with siduron (Tupersan) has been outstanding at both Dixon Springs and Urbana. On experiment plots in central Illinois the use of Brominil on young grass has not caused any noticeable injury to the Kentucky bluegrass and certain other turfgrasses, while

giving satisfactory control of the young weeds that were causing competition for the grass. These two chemicals used together have helped produce exceptionally good cover in 2 to 3 months with Kentucky bluegrass seeded in late spring.

WATERING

A sound watering program on a new seeding cannot be over-emphasized. The soil should be kept moist--this may require three to four waterings a day depending on the wind velocity, temperature, and so on. Often it seems that allowing the soil to dry excessively for an hour or more will delay the growth of the grass. After the grass has been up for a week or so, one or two waterings a day should be adequate. The watering frequency should be decreased as the grass grows. At the first mowing one-half inch of water on the surface every 2 to 4 days should be adequate.

DISEASE

Diseases can be devastating on spring seedings. In the greenhouse Pythium blight often becomes quite severe. For the last few years in the greenhouse Dexon has been used to maintain our seedling grasses, which undoubtedly would have been lost without Pythium control. This past summer in the field at Urbana, Pythium blight was a serious problem on young grass plants, especially on perennial ryegrass, tall fescue, and bentgrass, but created no noticeable problem on Kentucky bluegrass.

In the Chicago area this summer several newly seeded lawns--primarily in ryegrass--were attacked by Pythium blight. At Urbana Koban was used on some newly seeded field plots in order not to lose them. Although Pythium blight certainly is not expected to be a problem every year in the Chicago area, it should always be considered a potential problem on spring-seeded grass, and taken into consideration when choosing grasses, time of planting, and so on.

MOWING

A seeded lawn should be mowed as soon as a mower set at the desired mowing height will cut the grass. Subsequent mowings should be made so that no more than a third (better a fourth or less) of the grass on a height basis is removed.

Whether a seeded lawn will be satisfactory depends a great deal on the management and planning that go into it. In the long run the success of a seeding depends greatly on making a few correct decisions and carrying through with these.

Grass Substitutes

F. A. GILES

There has always been an attempt to replace grass with a substitute in order to lessen maintenance and to increase durability.

In all cases to date, the substitutes have fallen short, especially with regard to beauty.

I think to discuss ground cover or grass substitutes properly one must divide them into living and artificial ground covers.

The reasons for ground cover are, in the order of importance: First, the need for something to cover areas that will not support grass growth, for example in dense shade of trees on the north side of large buildings. Second, the need to lessen labor or maintenance. This is usually misleading because these areas create new labor requirements at different times of the year.

Ground covers should be used to frame or set aside turf areas. This makes the turf more important in the overall landscape.

A change of vegetation texture is very useful in landscape design. This low vegetation completes planting bed design without the excessive use of shrubs. Living ground cover

does this much better than some of the non-living materials such as gravel. Living material creates a mulch, and this in turn creates a more favorable micro-climate for the shrubbery.

Living ground cover is not used to replace grass in most cases. It is used to fill in areas where grass will not grow, as in planting beds, to supply texture.

Architects sometimes need a plant to complete a structural design or add color variation. Living ground cover does these jobs quite well in many cases. Sometimes the structure needs to be masked or softened and here ground cover works much better than grass.

I feel it is a fallacy to give erosion control as a reason for the use of non-grass ground cover. If erosion control is needed, grass can do the job much better than any of the non-grass ground covers.

Traffic control is sometimes a problem and ground covers are used to border or delineate traffic areas. This will work to some extent if care is given to the proper selection of ground cover materials. Examples of proper selection might be plants that create a barrier of dense growth, thorns, or a tangled mat that will be difficult or uncomfortable to walk through.

Following is a list of some of the more popular living ground covers:

Ajuga pyramidalis
Ajuga reptans, Carpet Bugle, Carpet Bugleweed
Arabis alpina, Alpine Rockcress
Arenaria verna Caespitosa, Moss Sandwort
Calluna vulgaris, Scotch Heather
Ceratostigma plumbaginoides (Plumbago larpentae), Blue Ceratostigma, Leadwort
Chaenomeles japonica alpina, Alpine Flowering Quince
Convallaria majalis, Lily of the Valley
Coronilla varia, Crown Vetch
Cotoneaster horizontalis, Rock Spray, Rock Cotoneaster
Dianthus arenarius, Sand Pink, Finland Pink
Diervilla ionicera (D. trifida), Dwarf Bush Honeysuckle
Erica carnea, Spring Heath
Euonymus fortunei (E. radicans, E. radicans acutus), Wintercreeper
Euonymus fortunei coloratus, Purple Leaf Wintercreeper
Euonymus fortunei minimus, Baby Wintercreeper
Hedera helix baltica, Baltic English Ivy, or Hedera helix Bulgaria, Bulgarian English Ivy
Hemerocallis fulva, Tawny Daylily
Hydrangea petiolaris, Climbing Hydrangea
Hypericum calycinum, Aaronsbeard, St. Johnswort
Iberis sempervirens, Evergreen Candytuft
Juniperus Chinensis sargenti, Sargent Juniper
Juniperus horizontalis, Creeping Juniper
Juniperus horizontalis roman varieties, Bar Harbor or Waukegan Juniper
Juniperus horizontalis plumosa, Andorra Juniper
Lonicera japonica Chinensis, Purple Japanese Honeysuckle
Lonicera japonica halliana, Halls Honeysuckle
Pachistima canbyi, Canby Pachistima, Ratstripper
Pachysandra terminalis, Japanese Spurge, Japanese Pachysandra
Parthenocissus quinquefolia (Ampelopsis quinquefolia), Virginia Creeper, Woodbine
Phlox subulata, Ground Pink, Moss Pink
Polygonum reynoutria, Reynoutria Fleece-Flower
Rhus aromatica, Fragrant Sumac
Robinia hispida, Rose-Acacia
Symphoricarpos orbiculatus (S. vulgaris), Indian Currant, Coralberry
Teucrium chamaedrys, (Chamaedrys Germander, Shrubby Germander)
Thymus serphyllum, Mother-of-Thyme, Creeping Thyme
Veronica incana, Woolly Speedwell
Vinca minor, Common Periwinkle, Myrtle
Viola cultivars, Violets

Materials used as artificial ground covers have increased in recent years. Some of these are good and some very poor.

The most popular artificial material is stone, which ranges from boulders to sand. Boulders serve as statuary and a terrain change; they are best used in conjunction with other rock material. When using stone, the rule should be to use the earth tones and natural shapes. Where possible keep the gravel or stone in scale with the structure. This holds true for any material.

Stone should be contained, perhaps behind a curb or inside a header. A good way to hold gravel in place is to set it in concrete, as in exposed aggregate or mosaic work.

Sand is very popular in Japanese gardens to simulate water. In controlled patio areas this can be quite attractive but not very serviceable.

Wood products have the largest variation in artificial ground covers. Wood materials are good when used as mulch, but they require much more control to keep them in place than do the living ground covers. When using wood products as a mulch with plant material nitrogen should be used to offset that used when the wood breaks down. If nitrogen is not replaced, serious damage can occur to the plant material. Materials that particularly influence nitrogen are sawdust, wood chips, and nutshells.

Wood rounds, redwood planking, and railroad ties have received wide acceptance as patio construction materials and need little special care. However, the material should be properly placed and anchored to insure lasting beauty and serviceability.

Brick is the traditional material for walk and patio construction. It has been widely accepted because of its color, availability, and ease of installation. Other clay materials, such as tile make a surface that is both formal and extremely durable, especially where the surface receives a lot of water.

Concrete, of course, is still the most used and probably the best material for high-traffic areas. Nothing looks more cold or plain than a slab of smooth concrete. One of the quickest ways to treat concrete is to use the exposed aggregate finish or a carbo-jet treatment. Carbo-jet is a gray dye that softens the color of concrete and allows it to blend with its surroundings. This material gives the entire surface an even color without the blotches that always occur on untreated concrete.

Asphalt paving has been in use for many years, but asphalt tile is relatively new. The popularity of asphalt tile is primarily because of the demand for and price of used brick. Asphalt tile needs to be properly laid, or it will severely crumble and break up under pressure of traffic.

Crop waste in general and corn cobs in particular have long been popular to mulch and cover the soil in planting beds. Corn cobs are still one of the best materials available, except that the cost is rising as the supply diminishes. Cobs are being left in the fields by the new harvesting machines and will probably be off the market in a short time. The wood products industry hopes to serve this resulting market with sawdust and bark.

Many of the cover materials are applied over black plastic (polyethylene) to curtail weeds and grass. Gravel over black plastic is especially popular. This combination has killed great numbers of shrubs and trees. Black plastic will cut off all air and moisture exchange in the soil. Therefore if enough open space is not allowed for each plant, the plant will die. If the soil is dry at the time the plastic is applied, it will remain dry. If it is not, it will remain wet. Either extreme will stunt and kill plants.

The length of time this plastic is effective as a weed control is much shorter than most people expect. The plastic becomes brittle and easily pierced by the gravel laid over it. Dirt and trash build up on top, giving a medium in which plants can germinate and pierce the plastic. Pets and children also increase the problem of plastic breakdown through traffic and play.

Once penetration of the plastic occurs, weeds begin to grow immediately. When using plastic, use it double thickness on a smooth surface in a low traffic area. The major rule to follow in Illinois is to decide if gravel is really necessary in the landscape.

Artificial turf is currently receiving attention, and it will probably be tried and found satisfactory in some places and unsatisfactory in others. After this exploratory period is over, it will find its place and disturb the turfgrass industry very little.

Water is one of the most attractive ground covers we have. Granted, water can only be used in small areas, but pools and fountains can add a great deal to a garden if they are properly designed.

In summary, ground covers, grass substitutes, and mulches are good if used properly in the correct places. Grass substitutes do not eliminate labor, and they certainly do not eliminate expense. Artificial ground covers require constant attention to keep down the invasion of grass and weeds. All of the grass substitutes should be used as a part of the overall landscape, not as a labor saver.

ARTIFICIAL GROUND COVERS

Stone

Gravel--use only natural stone, smooth or weathered, natural colors and earth tones are best

Large stone or boulders

Flagstones

Pebble mosaic

Sand--Japanese dry gardens, play areas, utility areas

Clay Products

Brick

Tile

Brick chips

Concrete Products

Precast stone

Poured concrete

Exposed aggregate

Blocks

Asphalt

Paving

Blocks

Wood Products

Tanbark

Wood fiber

Wood chips

Sawdust--mix with 1½ pounds of 21-percent ammonium sulfate per bushel

Redwood planking

Wood rounds

Railroad ties

Nutshells

Peat Moss

Crop Wastes

Corn cobs, chaff--add 1½ pounds of ammonium sulfate per bushel

Compost--mix 1/2 pound of 10-6-4 and 1/5 pound of finely ground limestone per cubic foot of material at time of composting

Polyethylene (black plastic)--This is mentioned because it is used under many other ground covers, stone in particular. When this material is properly used, it can add to the function and life of the ground cover. It can cause trouble when used in planting beds or around shrubbery by stopping water and air circulation. This will kill shrubbery in a short time.

Water

Garden pools

Fountains

Lily ponds

Artificial Turf

Athletic fields

Office building or apartment putting greens

Roof-top green areas

Selecting Ground Maintenance Equipment

R. F. ESPENSCHIED

The selection of ground maintenance equipment is often governed by such things as first cost, brand loyalty, dealer loyalty, dealer reliability, maintenance cost, and others. Any one of these or all of them may influence your decision, but the first item should be safety. This equipment will be used by men, unskilled or skilled, foolish or wise, careless or careful, hired by you or assigned to you, but when they are working for you, you are responsible for their safety. Make safety the first item on your shopping list. If the equipment meets all other criteria, but is unsafe, then it is an unwise choice!

An authorized equipment dealer who is trying to serve you well does the following things. He attends workshops and seminars to become familiar with new products and new service techniques. He conducts service schools to familiarize customers with service equipment, maintenance techniques, and so forth, on the items he sells. He maintains files of service literature, catalogs, and parts literature. He stocks an inventory of thousands of parts, and perhaps only 20 percent of these turn over rapidly, but he has that special part when the rare need for it occurs. He provides warranty service to replace defective parts that fail. He maintains a neat, orderly store to impress you that he has an organized business. He hires competent employees and he pays them a fair and competitive rate of pay for their work. But he also needs your business and your support for him to stay in business.

The story of a farm implement dealership is a good example of what can happen if you do not support him. Some farmers felt no loyalty to a local dealer. They would drive several hundred miles to save $50 on a $4,000 piece of machinery. The local dealer could not survive on parts sales, short-line sales, and so on, and he went out of business. Now these farmers must drive over 50 miles to buy a $2.00 part for this machinery. Consider where you would be without this authorized dealer and keep him in business. You really need him as a partner.

This may be the space age, but it is also the age of the small gasoline engine. A large number of lawn and grounds maintenance items require the use of small, single-cylinder, gasoline engines. Among these items are lawn mowers, pumps, generators, tillers, sprayers, tractors, mulchers, edgers, and snow blowers. These items make man more productive and his work more efficient. They also make us more dependent on the integrity and ability of those who sell the equipment and those who service it.

ENGINE SELECTION

Any item of powered equipment must have a power unit that is properly matched to the load, or it will not operate satisfactorily. Manufacturers will usually supply an engine that will work well under ideal conditions, but some will provide an engine that is actually underpowered when greater demands are placed on it. As a prospective purchaser here are a few things to consider to help you make a wise selection.

Horsepower. Engines are rated on the peak power that they will develop during laboratory testing. The manufacturers guarantee that an engine will produce at least 85 percent of this horsepower when new and 95 percent after it is fully broken in. These engine ratings are based on performance at a temperature of 60° F. at sea level. The power will decrease about 3½ percent for each 1,000 feet above sea level and 1 percent for each 10° F. above 60° F. If an engine on a tiller is rated at 2.5 horsepower it will develop 2.125 h.p. (2.5 x 0.85). If the new tiller is used at 1,000 feet elevation in 90° F. heat, this would be a further reduction of 6½ percent. This means that the engine will develop 1.98 horsepower.

Fuel systems. There are several kinds of fuel systems used on small engines.

A suction-feed carburetor has two important advantages which are simplicity and low first cost. These carburetors are used on smaller lawn mowers, tillers, and garden tractors.

The tank is wide and shallow, so the tank serves as a carburetor bowl to insure more uniform fuel flow.

A float-feed carburetor has a more constant air-fuel ratio than a suction-feed carburetor. The power output generally is from 20 to 25 percent greater than for a suction-feed carburetor on an engine of the same displacement. These carburetors are more expensive and are probably worth the additional cost.

The fuel tank usually has sufficient capacity for operating the engine for an hour or two at full throttle. If the unit is to be operated for half days, a tank of greater capacity may be specified. It is usually more economical and safer to install a larger tank than to spend the time and effort necessary to carry additional fuel and refill the tank more often. Each time the fuel tank is opened there is a chance for dirt to enter the engine.

Clutch. A clutch is a convenient accessory that permits the engine to be started without starting the driven unit. With self-propelled equipment this is almost mandatory, although some units do not have a clutch. Clutches are generally either centrifugal or manual.

Governors. There are two types of governors commonly used on small engines. These are the air vane and mechanical.

Air-vane governors are activated by the flow of air from the fins of the flywheel. The pressure on the air vane is offset by the governor spring. When the air pressure on the air vane is greater than that of the governor spring, the throttle is closed and the engine speed decreases.

Mechanical governors are more expensive than the air-vane type. They are a fly-ball type and are activated by the centrifugal force of weights. These governors are more accurate and if the engine must operate within close speed tolerances, as on a generator, then an engine with a mechanical governor should be chosen.

Starters. There are at least five types of starters currently available on small engines. The one chosen depends on individual preference and the cost.

The rope starter is the least expensive to produce, but may be most expensive in the long run. There is always the problem of the lost or misplaced pull rope, and the danger of the knot on the end of the rope striking the operator in the eye.

The recoil starter is very popular on small gasoline engines and most current models are equipped with them. They are inexpensive and give comparatively long and useful service.

The handcrank is still used on larger engines.

The impulse (windup) starting devices are popular with some homeowners, but frequently need replacing long before the rest of the equipment is worn. They may not be worth the additional cost. These are often marketed as a safety feature, but they can also be hazardous if not used correctly.

The electric starters seem like the answer to the problems of a hard-starting engine. They may be battery powered or use 120-volt electric power. These starters add to the weight of the equipment, but they eliminate hand starting. If the equipment is to be used at a distance from electric current, then the battery starter is needed.

Type of engine. The type of engine to choose may often be guided more by emotion than by reason. Some men feel as strongly about 2-cycle (or 4-cycle) engines as they do about politics and religion. Two-cycle engines are lighter and often less expensive than 4-cycle engines. They have fewer moving parts and a higher power to weight ratio. At one time they were considered noisier than 4-cycle engines and harder to start, but these criticisms are no longer true. Each engine has its Achilles heel where it is vulnerable. A careless operator will ruin a 4-cycle engine by not putting oil in the crankcase or he will burn straight gasoline in a 2-cycle engine and ruin it. Maintenance costs are directly proportional to the lack of care and the amount of abuse the engine receives.

SPRAYER SELECTION

Sprayers are widely used for the application of herbicides, fungicides, insecticides, and fertilizers. They may be small hand sprayers or power sprayers.

The hand nozzle should be the swivel type and continuously adjustable from a fog or hollow-cone to a stream. The wand should be designed so it can be directed easily to cover

difficult-to-reach places. The control should be of a squeeze type that can be locked in the "on" position. The hose should be chemical resistant and long enough to be easily handled by the operator.

Hand sprayers include several types. The stored-compressed-air sprayer is most widely used and the one- to four-gallon sizes are most popular. The hose-end sprayer has become popular in recent years, but it has the ever-present danger of backflow. The slide pump uses no pressure container and is tiring to use. Knapsack sprayers are also popular, but should not be so large that their weight makes them too heavy to carry.

Power sprayers chosen for one employee should be very maneuverable. A 10-gallon sprayer should be able to deliver up to 2.5 gallons per minute at pressures up to 150 pounds. A 30-gallon sprayer should deliver 3 gallons per minute at pressures up to 400 p.s.i. The pump should be a heavy-duty type and there should be some sort of agitator for uniform application of sediment-type materials.

Compare tank mountings and select one that will withstand rough service. The pressure regulator should be convenient to use. The pressure gauge should be easily read and located where it will not be easily broken. The sprayer should be equipped with three screens: one on the suction hose, one in the line, and another near the nozzle. The screens should be easily accessible for quick cleaning.

Corrosion is the principle enemy of sprayers. Select a sprayer that can be easily cleaned. Sprayers are used in a busy season and if they are difficult to clean, then they will simply not be cleaned. If they are not cleaned promptly, their first season will also be their last.

GRANULAR FERTILIZER SPREADER SELECTION

Many factors affect the selection of fertilizer spreaders. Small hoppers require frequent filling and this inefficiency increases labor costs. Large hoppers require high flotation tires or tandem axles to prevent the weight from causing ruts in the lawn. Some authorities feel that centrifugal spreaders provide high-speed, high-capacity application. They feel that gravity spreaders provide the greatest accuracy.

Centrifugal (spinner, broadcast, rotary) spreaders are generally more maneuverable. They require fewer trips because they cover a wider area. There are some problems with drift causing uneven distribution on windy days. The larger particles travel farthest and the smaller ones do not go as far. These spreaders range in size from 20-pound to 4,000-pound capacity. The minimum rate of application is about 20 pounds per acre.

Gravity (drop, full-width) spreaders are not as maneuverable because of their width. A low rate can be applied (5 pounds per acre). They are easy to load because of the low profile. They can carry up to 100 pounds per foot of width. If a diffuser is not used, they tend to apply materials in bands or ribbons that give a streaked appearance.

Since precision is vital, select materials that have fluidity and resist bridging, that do not absorb moisture too readily, and that are not subject to degradation caused by over-agitation.

MOWER SELECTION

Mowers should be selected for the kind of turf to be mowed, cutting height, mowing frequency, terrain, planting layout, and level of maintenance required.

Reel mowers have the following advantages. They leave a smooth, well-groomed appearance. They are the most economical to use per acre. They require less power. They are best for turf grasses. Their limitations include the following. They cost more to maintain and are more susceptible to damage than rotary mowers. The height of cut is limited by reel diameter. They must be used on comparatively smooth ground.

Since a reel mower cuts like a scissors, the mowing quality is affected by the number of blades on the reel. The diameter of the reel affects cutting height and the width of reel affects the width of cut. Steel wheels give better traction. Pneumatic tires are better for high-speed work and for transport over paved roadways.

Rotary mowers can be used on rough ground, can be sharpened easier, can be used to mulch leaves, are easier to maneuver, easier to adjust, require lower maintenance costs, cut

closer to trees and fences, and are better for tall grasses, weeds, and high tough growth. Their limitations include: more hazardous to operators, rough appearing finished cut, higher power requirements, and higher cost per acre.

SNOW THROWER SELECTION

Snow throwers move snow easier than a blade or plow and provide welcome relief from the heavy chores of shoveling snow.

Select a snow thrower with an engine that is well winterized. The controls should be big so they can be easily handled with mittens or heavy gloves. Enclosed gears and chains are less hazardous than those that are exposed. Be sure there is some safety device (shear pin) for protection in case the unit strikes something it cannot move.

Electric-start motors may be less frustrating on a cold morning. If the unit is heavy, then it should be self-propelled.

Injuries from snow blowers usually occur to fingers and toes when the operator attempts to clear the debris from the auger or paddles that bite into the snow.

This equipment is valuable in saving time and labor, preventing over-exertion, and providing clear walks. As with other equipment, be sure it is adequately powered and provided with accessories and guards that make for safe operation.

Crew men in large ground maintenance operations are responsible for one operation--spraying, mowing, edging, and so forth. Since these men work a full day every day, the equipment must be selected for continuous use. To reduce down time, purchase high-quality equipment that can withstand handling by unskilled labor for a full working day.

REFERENCES

1. Picking a Small Gasoline Engine Power Package. Leo Lechtenberg, Product Engineering, June 1954, pp. 156-160.
2. Selecting Gang-Type Reel Mowers. Mark Zimmerman, Grounds Maintenance, April 1968, pp. 17-20.
3. Small Power-Tool Selection--Sprayers. Tom Dickerson, Grounds Maintenance, May 1969, p. 48.
4. Understanding the Basic Fertilizer Spreader. Mark Zimmerman, Grounds Maintenance, April 1969, pp. 18-20, 22, 85.
5. Small Power Tool Selection--Chain Saws. Tom Dickerson, Grounds Maintenance, July 1969, p. 31.

Fertilizing Small Lawn Areas

R. C. NEWMAN

Fertilizing the home lawn should be a relatively simple procedure, since we have a pretty fair idea of what good lawns should look like. We have reasonable knowledge of the various turfgrasses and their behavior, and we know that all grasses require a total of 16 essential elements for growth and development. But I'm afraid we can't make blanket fertilizer recommendations that fit all situations at all times.

Where do we start when making fertilizer recommendations? Certainly we must consider the wants of the lawn owner. Homeowners desire lawns that are both attractive and useful for whatever purpose the owner uses his lawn. A steady, moderate growth rate from spring through fall is desirable. Most lawn owners prefer a dense stand of grasses dark green in color and competitive enough to prevent encroachment of weeds. Rapid recovery from physical wear and the effects of insect and disease attacks are also demanded. What we see, walk on, and are interested in growing is green foliage or leaves.

Lawn grasses are divided into two groups--the cool-season grasses, such as bluegrass, red fescue, and bentgrass, and the warm-season grasses, such as zoysia and bermudagrass.

Cool-season grasses are adapted to the northern part of the country, and warm-season grasses to the mid-south and southern areas. The area in which the lawn is found dictates what types of grass will be grown. Cool-season grasses grow best in the cool spring and fall, and may become semi-dormant in mid-summer. Warm-season grasses grow best in the warm part of the summer and are dormant when temperatures reach the freezing mark. There is just no grass that performs equally well in both the cool and hot parts of the growing season, so we already have a growth limitation we must recognize.

Temperature fluctuations are only one of many stress factors imposed on lawn grasses. Others that we must consider are:

Soil moisture and drainage
Soil pH
Soil texture and structure
Soil compaction
Mowing height and frequency
Shade
Diseases
Insects
Thatch
Physical wear by man and machines
Toxic residues of various pesticides

We try to manage our lawns to minimize detrimental effects from stress factors that affect our grass.

Fertilization is certainly one of the major lawn management procedures. As stated before, grass plants require 16 essential elements. Air and water supply three of these elements--carbon, hydrogen, and oxygen--and these three elements make up roughly 93 to 95 percent of the dry weight of a grass plant. The soil and fertilizers supply the remaining 13 elements. Of the 13 soil-supplied elements, nitrogen (N), phosphorus (P), and potassium (K) are used in relatively large quantities by grasses, and soils are often deficient in one or more of these three elements.

When we analyze grass clippings we usually find about two to three parts of nitrogen to one part of phosphorus to one and one-half parts of potassium. A typical analysis of Kentucky bluegrass might show that leaves contain 5 percent nitrogen on a dry-weight basis. Tissue analysis gives us an idea of the ratio of N to P to K required by the plant. When we collect Kentucky bluegrass clippings for an entire season, we find 3 to 4 pounds of nitrogen have been utilized by the grass on a 1,000-square-foot area.

Lawns are mostly grass leaves, and nitrogen encourages leaf growth and gives leaves their dark green color as contrasted to the yellowish appearance of nitrogen-starved grass. Nitrogen is often called the key to turfgrass fertilization.

It seems sensible to fertilize grass using a fertilizer with an N to P to K ratio which is similar to the N-P-K ratio of grass clippings. Many excellent lawn fertilizers are available with 3-1-2, 3-1-1, or 2-1-1 ratios of N-P-K.

We want steady growth of grass throughout the season, and we want to avoid both the excessive flushes of growth caused by excessive fertilization and the periods of inactivity caused by a lack of fertilizer.

A sensible fertilizing program should provide for season-long availability of the fertilizer elements as demanded by the grass.

Phosphorus and potassium are fixed in the soil and little loss from leaching occurs. This means we can fertilize to obtain optimum P and K levels in the soil. Nitrogen is the element that doesn't stay put in the soil. Nitrogen in the nitrate form is a water-soluble anion that leaches readily. Grass plants use nitrogen in excessive amounts when excessive amounts are available.

A soil test is the only reliable method to determine soil pH and the P and K levels of the soil. pH is important since almost all grasses grow best near or at pH 7.0. Both low and high soil pH may seriously influence the availability of several elements required by grasses.

Best results are usually obtained by applying a complete fertilizer to grasses. Unless there is some special reason for not using a complete fertilizer, application of the three macroelements, N, P, and K, generally is recommended.

Fertilizers can be classified in several ways, such as inorganic fertilizers, organic fertilizers, synthetic organic fertilizers, and other slow-release fertilizer types. Any one of the different types may be used to supply the plant nutrients that grasses need. Inorganic fertilizers are fast-acting, generally high-analysis salts of nitrogen and potassium and various phosphorus compounds. Their serious drawbacks are that they may cause fertilizer burn and that the inorganic nitrogen is rapidly utilized by the grass. Small quantities must be used frequently. Organic fertilizers are of low analysis, insoluble, and release nutrients over a longer period of time as they are decomposed in the soil. Organic fertilizers cause no burn problems, but they are of little value when soil temperatures are below 60° F. when bacterial breakdown is extremely slow.

Slow-release fertilizers of various types are now available for turf fertilization. Urea has been combined with formaldehyde to make ureaforms. These synthetic organic fertilizers release N over long periods of time as the long-chain molecules are broken down in the soil. Isobutylidene diurea (IBDU) is another slow-release nitrogen fertilizer. Resin-coated particles may also be utilized for their slow-release properties.

The cost of the slow-release fertilizers is high in comparison with the inorganic fertilizers, so their use has been limited. It is doubtful if there is a superior N source for grass. It is more a matter of the amount and timing of applications.

Kentucky bluegrass and bluegrass-red fescue mixtures require about three pounds of N per 1,000 square feet each season. A 3-1-2, 2-1-1, or 3-1-1 ratio fertilizer is adequate unless levels of soil P or K, or both, are extremely low. About 2 pounds of the nitrogen should be applied in late August or early September, and the remaining 1 pound in April or May. When the grass is heavily irrigated and clippings removed, fertilizer rates should be increased by one-half to two-thirds. Merion Kentucky bluegrass requires about 5 to 6 pounds of N per 1,000 square feet per season.

The danger of fertilizer burn can be decreased by these means:
1. Applying organic or slow-release fertilizer.
2. Applying no more than 1½ pounds of N per 1,000 square feet in one application.
3. Using granular or pelleted fertilizers rather than dusty types.
4. Applying N only to dry leaves.
5. Applying N only when the weather is cool.
6. Washing all fertilizer off the leaves.

Dissolved or liquid fertilizers are basically no different from nor more effective than dry forms. Many are simply dry soluble fertilizers added to water. The soil supplies almost all the minor and trace elements required by grasses. Iron is sometimes required under alkaline conditions that make iron in the soil unavailable to plants.

Lime should not be applied to lawns unless a soil test indicates pH is low. Irrigation with hard water adds calcium and magnesium to lawns.

In the final analysis, it is the grass plant that is the best indicator of fertilizer needs. General guidelines for fertilization have been established, but these usually need to be modified to fit the exact needs of any lawn. Grasses can make use of fertilizers only when environmental conditions favor growth. Fertilizers will not stimulate cool-season grasses to grow when the grasses are semi-dormant in mid-summer. Excessive fertilizer can kill grasses but the lack of fertilizer rarely does.

How I Sell a Turf Maintenance Program

J. F. KRAMER

I have been asked to describe how we sell a turf maintenance program to a prospective customer. We find the best approach is to sell yourself and your ability to do a professional job. Since we have the latest turf knowledge gathered by our universities, sod production companies, fertilizer manufacturers, golf courses, equipment manufacturers and others who have shared their knowledge through meetings such as this, the customer is most willing to assign the responsibility of the turf management to us. We find that the

continual upgrading of our studies allows us to assume a position of authority in discussing turf problems as they arise.

Since more and more lawns (both sod and seed) are being installed in both urban and suburban areas for homes, public buildings, and schools, and with the increased use of our parks, playgrounds, and recreational areas, the need for effective turf management is becoming increasingly important. We feel that our customers are more readily impressed with the degree of skill of the turf man, if he is knowledgeable in all aspects of taking care of the lawn area. In talking to a prospective customer who is desirous of this service, we find that a careful explanation of how grass grows, the types of grasses which do best in various locations under certain conditions, their food needs, the diseases affecting them, and other factors affecting turf growth, is both necessary and important in promoting the customer's confidence in the turf management specialist.

We find that most homeowners, building supervisors, and others not directly involved with turf management are impressed by the appearance of a well-groomed, green, luxurious lawn area on golf courses, near factories, and around public buildings. Yet, they haven't realized the amount of education and training (both practical and theoretical) which is necessary to attain the degree of perfection they want.

It is for this reason that we take great pains to carefully explain that the requirements of proper turf care are not only mowing and trimming, but disease control, height of cut, timing, food and water needs, types and amounts of lawn food, soil conditions, and sun and shade conditions. Also to be considered are traffic problems and competition growth and how they can be controlled. Weed identification and control also play a role in determining proper turf management.

We find that in convincing the prospective maintenance customer of our thorough knowledge of these factors affecting turf growth and of our ability to provide competent personnel to take personal charge of any lawn area, the price factor doesn't seem to be of too much importance. We feel most people are only too willing to employ an experienced turf man not only to insure a well-groomed appearance for their turf area, but also to detect and correct any problems which might arise because of disease, lack of food, weed infestation, or any other problem which might detract from the appearance of the lawn area. If we can convince a prospective customer that we have a competent knowledge in these areas, he is most willing to allow us to shoulder this responsibility.

Some Common Lawn Weeds and How to Control Them

W. B. SIEFERT

Broadleaf weed control in lawns is still a double-barreled program. Eliminate the established broadleaf weeds with herbicides and prevent their re-establishment with good management.

Dandelions, plantain, shepherd's purse, and wild carrot are easily controlled with 2,4-D in spring or early fall. When these are the major pests, the fall application reduces the chances of injury to nearby gardens, home vineyards, and landscape plants. Fall weed control also permits unrestricted growth of bluegrass during the fall and spring while most weeds are dormant.

Clover, black medic, ground ivy, and henbit are effectively controlled with 2,4,5-TP (silvex) applied in late spring or early summer. Silvex has replaced 2,4-D in many spray programs because of its effective control of the above weed plants as well as dandelions, plantain, shepherd's purse, and wild carrot.

Chickweed, prostrate knotweed, and red sorrel were difficult to control until dicamba and MCPP became available. Both herbicides are very effective when properly used. Mouse-eared chickweed and red sorrel are perennials, smooth chickweed is an annual or winter annual, and prostrate knotweed is an annual. Timing of control is important. Early spring is best for smooth chickweed, while early summer is best for prostrate knotweed, red sorrel, and mouse-eared chickweed. Mixtures of dicamba or MCPP and 2,4-D produce a broad spectrum herbicide capable of effective control of all broadleaf weeds mentioned above. In large

turf areas the economy and effectiveness of dicamba or MCPP in combination with 2,4-D is difficult to surpass.

The drift problem with 2,4-D and silvex must always be a consideration. The amine form is less volatile than the ester form of 2,4-D. Whenever we can select the low-volatile amine form and apply it during the fall we can avoid most of the problems of drift and unfavorable public image. Regardless of the season, both 2,4-D and 2,4,5-TP will cause injury to nearby plants during windy weather. Select calm days and adjust the sprayer to maintain relatively low pressure.

Root uptake of dicamba can cause injury to trees and shrubs, especially pin oak, redbud, and other sensitive plants, when the herbicide is translocated to the growing branches. Exceeding the recommended rate of this herbicide and heavy watering or rains after a normal application appear to be the main causes of injury.

Management is important for effective broadleaf weed control. Once broadleaf weeds are eliminated, proper management will prevent re-establishment. Fall application of herbicides, tall cutting, and adequate fertilizer are the main ingredients for a dense turf and the prevention of weed invasion.

MATERIALS: Combinations of herbicides and fertilizers and the granular herbicides are very convenient in some instances and may warrant the relatively high cost. They minimize the drift problem and provide a tool for precise placement along beds and property margins. Overlapping is a hazard during the touch-up phase and may cause plant injury by increasing the rates of herbicide applied.

Aqueous solutions are more economical but require proper equipment and judgment. New equipment, such as the Amchem low-pressure applicator, provide accurate delivery of large droplets, good placement, and extremely low pressure to minimize drift. All of you should look over these ultra-low-pressure hooded pieces of equipment at the trade shows or the next turf field day.

Weed grasses such as crabgrass, foxtail, fall panicum, and goosegrass will appear in home lawns whenever an opportunity occurs. Effective control requires good management and occasional assistance from herbicides.

Management involves adequate fertilizer and tall cutting to produce a dense turf and maximum competition. Extra water may be necessary to maintain a high level of competition during drouth periods.

Preemergence herbicides such as Dacthal, Balan, Betasan, Azak, Tupersan, and calcium arsenate offer excellent preemergence control when accurately applied early in the season. These must be on the turf before saucer magnolias begin to drop their petals. Workmanship is the key to good control. Borders and along sidewalks may warrant an increased rate to insure better control of goosegrass. Management alone will provide reasonable control when you have a dense turf. It probably will not provide perfect control. Thin spots must be treated with a preemergence herbicide to restrict competition while reseeding so a dense turf can be re-established.

Late spring or early summer (post-emergence) control of weed grasses requires two or more applications of DSMA or AMA and often causes slight browning of resident bluegrass.

Tall fescue is a weed grass when it contaminates bluegrass. Deep cutting with a sod cutter or hand digging to remove the entire crown is effective.

Creeping bentgrass cannot be eliminated from bluegrass with 2,4-D or by a long drouth. Stripping with a sod cutter is our only choice, but requires careful workmanship.

Quackgrass can gradually be eliminated by good management. Regular mowing and dense turf provide severe conditions for quackgrass and gradually eliminate it as a lawn weed.

Zoysia can be eliminated by double cutting with a sod cutter and promptly resodding to restrict underground stems which may escape.

Wild onions and garlic can be gradually eliminated with repeated treatments with 2,4-D ester. Where large clumps occur, pulling often succeeds as a control measure.

Athletic Turf Session

Golf Course Design Principles

E. L. PACKARD

I want to thank you for asking me to be with you today to discuss golf course design principles. The members of the American Society of Golf Course Architects, at our annual meeting this year in Hollywood Beach, Florida, expressed the desire to cooperate with all golf-oriented groups, and I wish to extend greetings from our society.

Today, I want to talk about the subject of golf course design, but first I want to discuss briefly some of the broad aspects of the state of the game today, and make an assessment of the role of the various individuals and groups whose business is golf. As individuals, we have the golf professional, the golf course architect, and the golf course superintendent. The groups comprise the P.G.A. or Professional Golfers of America, the ASGCA or American Society of Golf Course Architects, and the GCSAA or the Golf Course Superintendents Association of America.

The special function of each of these individuals and the group to which each belongs is well known to you. In addition, we have the U.S.G.A. or United States Golf Association and the N.G.F. or National Golf Foundation, the former being for years the rule-making body of the game of golf, and the latter the association of companies manufacturing or dealing in golf course supplies and equipment of all kinds. Important also are numerous specialists in turf, fertilizers, irrigation, and so on.

Obviously, with so many and such varied interests directly or indirectly involved, it is essential that a sense of mutual cooperation, and helpfulness pervade the basic philosophy of all.

Each individual, the golf professional, the golf superintendent, and the golf course architect, should understand and respect the special services which the others perform.

Today the designing of new golf courses or the redesign of older ones has become a very highly specialized profession. Just as in the field of golf course maintenance or in operating the pro shop, today's people must know more than yesterday's and have command of a greater array of knowledge and skill, so today's new breed of golf course architect must be better educated than ever before. Today licensing laws are beginning to require the application of higher standards of education in golf course architecture. Through the screening of applicants, our society makes a determination, as carefully as possible, if those practicing as golf course architects can meet the standards of our group as far as competency of design and good business practices are concerned.

Today's golf course architect, then must be proficient in the following fields:

1. A knowledge of the game of golf.
2. Civil engineering - how to read a contour map and operate an engineer's transit for setting or checking grades.
3. Hydraulic engineering - how to design a water sprinkling system, pumps, motor, the piping system, and so on.
4. Landscape architecture - how to contour the ground and plant grass, trees, and so on, for eye-pleasing effect.
5. Agronomy - soil fertility and drainability.
6. Agrostology - turf culture.
7. Chemistry - fertilizers, fungicides, and weed killers.
8. A knowledge of heavy construction equipment for actual earth moving, trenching, grading, seeding, and so on.
9. Cost estimating - detailed figures for itemizing costs so that realistic budgets and adequate financing can be obtained, a necessity for insuring the success of any golf course project.

So let's get to the principles of golf course design. It has been said that the three basic components of a first-class golf course are woods, wind, and water. Of course, these elements together with the land, turf, and so on comprise the physical aspects of the golf course. But we also have the ability, particularly on new work, to design our golf holes in whatever arrangement of lengths we choose, and we can modify the landscape to create interesting golf problems. What we are seeking, is to create a playing field which will furnish the greatest pleasure possible to the average club golfer, who comprises 90 percent of our customers, but still will be a great challenge to the low handicap golfer. This is a tall order, but it can be done.

It has been written that there are three basic golf course design concepts: the heroic, the strategic, and the penal.

The heroic golf hole, so-called, is one which causes the golfer to extend himself to the utmost to hit the shot that will avoid the trouble and place his ball in a playable position for his next shot. The famous Ocean Carry Hole of Pebble Beach is an example.

The strategic golf hole is one in which natural or man-made hazards are placed diagonally across the line of play or in some manner that gives the golfer the chance to "bite off as much as he can chew," so to speak. Examples of this type of hole are numerous. From the design viewpoint, this type of hole is most interesting and challenging.

The penal type of hole is out of style at present. Designers used to build mounds and sand bunkers directly across the entire fairway in the most unlikely places, such as 100 yards off the tee. This would only hurt the poor player, who was having a bad enough time anyhow, and created many maintenance problems. Of course, it also slowed up play. As a result, no one does this anymore.

Factors that affect the design of a new golf course include:

1. Number of acres available.
2. Type of ground--flat, hilly, stoney, and swampy, as well as the fertility.
3. Tree cover.
4. Water available for strategy on the course, or for water supply.
5. Amount of financing available.
6. Whether the course is to be basically private or public.

The great majority of golf course superintendents or professionals will never be involved in the establishment of a new club. Most will be employed at established private clubs. You are most likely to become acquainted with golf course design when some dedicated group of golfers in the club gets the ball rolling for remodeling or improving their course.

Although the improvement or modernizing of an older course is to be desired, unless the program is carefully handled from its inception, such an undertaking can be a cause for dissension and divided opinion in a club, with possible unhappy or hurt feelings resulting. Indeed, poorly handled course renovation programs, in some cases, have resulted in the club member being dissatisfied with the golf course superintendent or the golf pro and sometimes in loss of revenue to the club or to the golf pro. These results have developed in situations where the course superintendent or the golf professional has not been astute enough to avoid being caught in the middle, between the diverse opinions of power groups in the club.

Can such a result be avoided, and if so, how? I am convinced that it is possible to promote a golf course improvement program successfully, although those who wish to initiate such a program should be aware that the chances for success in promoting such a program are about one-half as good as promoting a successful clubhouse improvement program. The reasons for this are not obvious, but are none the less, very real indeed.

The average established private country club or golf club will be composed of a relatively high percentage of men and women who will have only mild interest in bringing an outmoded course layout up to par. These people include the older members who have played the course for years, who realize that their playing days are numbered, and feel no compelling urge to spend their money to improve something for the younger members. "If it's good enough for me, it's good enough for my son," is this basic thinking, and regardless of what these members say, when the chips are down, many will vote against the improvements.

A second group, usually smaller, in the private clubs, comprises the younger members who have just enough money to belong to the club and do not relish an increase in dues or an assessment necessary to pay for course improvements.

A third deterrent to obtaining a favorable membership vote is the uncertainty over how long, and to what extent the golf course will be torn up; in other words, how much disruption to golf play will there be? This is a very tough nut to solve, indeed, and the manner in which this problem is proposed to be solved is often the key to the success or failure of the course improvement program.

There are two different approaches to the actual timing of a reconstruction program. One is to close the course for the better part of a year, have all the work completed, and be back in business the following year on the newly remodeled course. The second method is to spread the reconstruction over a period of two to five years, allowing play to continue uninterruptedly on a more or less restricted basis depending on the amount of work undertaken each year. Sometimes additional land is available adjoining the existing course, and it is possible to redesign the course and build in this new area without in any way affecting play on the old course. Sooner, or later, however, some transition work will be required to tie in the new holes with the old. Now, the sixty-four dollar question--which is the better way?

For the golf pro, the answer is pretty obvious, isn't it? With the golf course completely shut down for a year, what will the pro's income be that year? Will the club be willing to pay the pro the difference between what his regular pro-shop sales and so on will be in an ordinary year, and in the construction period year? Some will and some will not. Most pros, therefore, will probably be against doing all the reconstruction work in one year, even though the club may desire to get the work over with as rapidly as possible.

In actual practice, most clubs will spread the course remodeling over two or more years, keeping the course in play. It is possible to begin work on a limited number of greens, tees, and sand bunkers after Labor Day, complete the desired work, and be back in play the following spring. Complications in construction, often brought about by bad weather, can result in delays in completing work on time, and this will cause some player dissatisfaction.

As I have said, most clubs will elect to remodel their courses over a period of two or more years. This is the program which I recommend and call the "Long-Range Improvement Program."

You can begin to see, now, how the matter of improving or remodeling an old golf course can vitally affect not only the club membership, but should either the golf pro or course superintendent happen to align himself with what turns out to be the minority group, the final voting on the course of action can also affect the security of the position of the pro or superintendent.

For this reason, the golf pro or course superintendent who puts a little thought into this matter will be the first to recommend outside professional help in making these decisions. He will try to avoid being placed "in the middle" between opposing club factions, shifting these almost inevitably controversial recommendations to the golf course architect, whose job includes the responsibility of outlining the recommended construction methods for the particular club involved.

Now, having covered the elements of a golf course renovation program not often considered, let's get into the business of the actual redesign of the golf course itself, and the role of the golf professional in this program.

This brings us then to the question, what items are generally included in an improvement program on an existing golf course? Following an examination of these items, we will consider a tested method for obtaining a master improvement plan for any golf course, and will follow this by an evaluation of the factors which influence the adoption of such a master improvement plan.

High on the list of golf course improvements are maintenance items. These include the size, shape, and elevation of tees; the size, shape, and contour of greens, including the surface and under-drainage; the size, shape, and contour of sandtraps; the location and condition of the edges of any ponds, creeks, or streams on the golf course; the existing condition of the water system; and finally the placement and condition of plant material on the golf course. Let us consider each of these items briefly.

In regard to tees, these should be as large as possible, keeping in mind the fact that it is probably not advisable to recommend the cutting of fine old trees to any great extent in order to extend the tee surfaces. Sometimes moving a tee 50 or 100 feet in one direc-

tion or another will make it possible to build a new tee of adequate size. Where possible, tees should be at least 7,000 square feet in area, but should not be smaller than 5,000 square feet. This will enable the green superintendent to maintain his tees in good condition, even under heavy playing conditions, with a minimum of cost.

The correct relocation and enlargement of existing tees is one of the easiest and cheapest things which can be done on an existing golf course to improve it.

In regard to greens, all too frequently even brand new greens are constructed with bumps and back slopes which are entirely unmowable except by hand maintenance methods. A good average size for greens is 6,500 square feet. In my opinion, it is possible to have greens built that are too large. Of course, there are thousands of greens which have been built too small. It is not an easy thing to revise or remodel a green to enlarge it, because it means in many cases reconstructing a good part, if not all, of the old green. Nevertheless, it is possible to so add to an old green as to keep the existing surface intact, and to add to this existing surface sufficiently to obtain a green of the proper size. The best way, of course, is to reconstruct the whole green.

It goes without saying that the surface of all greens should be made to drain, and in more than one direction. All undulations of the green and contours of the shoulders should be mild enough so that there is no danger whatever of scalping the grass with the mowers. This means that the back slopes and side slopes must be carried out sufficiently far to permit machine mowing, whether it be by means of fairway units, or the more precise mowing of the three unit riding type mower. In the matter of under-drainage of greens, it is much less of a task to install additional drainage under a poor green than is commonly supposed. With all materials on hand, there is no reason why a particular green cannot be re-tiled in critical areas or have new tile placed, the backfilling firmly tamped and settled, and the sod replaced all within one day.

In the matter of easy maintenance of sandtraps, the trend has been toward milder convolutions of the edges of the traps, and more gentle rise from the bottom of the trap to the top edge. For easy maintenance, it is obvious that the convolutions, or serrations, of the edge of the sandtraps should be mild enough so that a power mowing unit can follow them without leaving areas which must be mowed by hand. It is also perfectly obvious that to be able to maintain sandtraps with power mowing units, the back slopes and the side slopes of the traps must be gently contoured so scalping does not occur.

Now, let us consider the use of water as hazards on the golf course. In connection with the location of ponds and creeks, not too much change can be done economically. However, the edges of these natural features are often so steep that a ball going over the edge cannot be played, and sometimes is difficult to retrieve. In addition, areas of this kind are frequently very difficult to mow properly and to keep maintained in an orderly fashion. If it is possible to gently slope these areas down toward the edge of the normal water level, a more easily maintained area will result. This will improve the play, as well as the appearance and also reduce the maintenance cost.

In regard to the water system of the golf course, this should be as fine a system as the owner can afford. The importance of this item cannot be over-emphasized. Where existing water systems are inadequate, and this means either from the standpoint of the water source or from the standpoint of the size or condition of the piping, or from the standpoint of the capacity or pressure of the pumping unit, recommendations are definitely in order on the long range improvement plan for rectifying these deficiencies. The trend today is toward completely automated sprinkling systems. This is a complete subject in itself, however.

In the matter of the use of trees on the golf course, there is frequently inadequate planting, either from the standpoint of safety or from the standpoint of beauty. Where such a condition exists, or where existing trees have reached maturity, or where they consist of elm trees that are very susceptible to Dutch elm disease, it is advisable to furnish a detailed planting plan for the replacement of these mature trees and for the supplementing of existing plantings by additional new long-lived trees, small flowering trees, and conifers.

The foregoing items, therefore, are some of the considerations of the master improvement plan viewed from the perspective of better maintenance.

From the standpoint of better <u>architectural quality</u> in a particular golf course, the following items should be given careful consideration. These items are, of course, of prime

concern to the golf course architect. His experience in solving many of the problems of a similar nature on other golf courses must be drawn upon in considering the particular problems of a particular course. While it is true that many superintendents and golf professionals have sufficient experience to be knowledgeable in connection with what is good or bad design, in general, these are the items on which a superintendent or golf professional and the owner should rely upon the experience and good judgment of the golf course architect. These items include first the general playability of the golf course. This is a rather broad term which encompasses the following items: safety, acreage, length, and placement.

First, safety. Safety on the golf course requires not only as full and complete visibility as possible from the tee through the fairway to the green, but also a sensible relationship of one fairway to another and of one tee to an adjoining green or to another tee.

Although there are hundreds of blind golf holes in the country in play today, none of these can be characterized as safe. Any time you hit a golf ball over a hill out of sight, you are in danger of striking a person hidden from view. Of course, golfers are under a legal responsibility for their acts if they strike another player with a ball. With this in mind, and knowing that the cost of moving dirt today has been reduced to such economical figures, there is really no longer any excuse whatever for not removing a blind hole from a golf course. New construction, in particular, should never have a blind hole deliberately laid out. Existing blind holes should by all means be scheduled for elimination in the master plan.

Many times the relationship of one tee to an adjoining green is very dangerous. You all are well acquainted with tight places on some golf courses. Here again the master plan should take all of these into account, and eliminate all conditions of this kind insofar as may be possible. As long as we have inexpert golfers, we will have balls which will not go down the fairway in the proper direction. This cannot be helped completely, but every effort should be made to minimize the possible dangers of a bad shot.

This brings us to a consideration of acreage. A fine golf course should be laid out on not less than 160 acres of usable ground, exclusive of deep ravines, water, or other obstacles which cannot be used for the playing field. The number of acres on which an existing golf course is constructed has a direct bearing on the maintenance of the golf course. Where the acreage is too low, the same number of players will be walking across a fewer number of square feet of grass and turf. This means heavier traffic patterns in all areas, and more difficult and costly maintenance. Reducing the acreage of the golf course greatly reduces the safety of the course. Inadequate buffer strips between fairways result. This also results in uninteresting back and forth parallel holes, and the consequent loss of interesting or challenging features for the golfer. Therefore, where an existing course can be improved by the acquisition of additional land and where additional land is available, the master plan will recommend acquiring a sufficient number of acres to spread out the course. Sufficient acreage will allow ample room for a practice tee, fairway, and chipping green.

Closely related to the acreage of any given golf course is the length of the course. As we all know, there is great variation in the length of various courses. Some very fine courses are very carefully groomed, and very carefully maintained even though the yardage is short. Most players agree that a middle-yardage course of 6,500 yards will furnish a challenging round of golf. If tees are large enough, a course of this kind can be shortened or lengthened by 500 yards. This permits the use of red, white, and blue tee markers, thus evening out the wear on tees, and providing for the short hitters as well as the scratch players. The May 1968 Golf Digest ran an article by Richard Tufts of the U.S.G.A. in which he said that players of differing abilities should tee off from different points on the tee in order to equalize the fairway and green hazards.

The location or placement of the fairway sandtraps and the green sandtraps on a golf course is a matter of prime importance to the golf course architect. Fairway sandtraps should be placed far enough from the tee so that tee shots by the average golfer will not reach the sandtrap, while at the same time, the shot by the expert player will have to be carefully placed in order to avoid or to carry the trap. This takes very precise location. In addition to the location of the fairway traps, the number of traps to be used also affects the playability of the golf course. We will take this point up in just a moment. Going back to placement of sandtraps, around the greens, these should be situated so as to pose a greater or lesser problem in regard to the approach shot to the particular green. Careful

consideration is given to proper length of each approach shot, and the traps placed accordingly. The green should be trapped more or less closely depending upon the length of the approach shot.

Many times a golf course architect is asked to retrap an existing course so as to make it more interesting, but at the same time not to make it tougher. This is a problem requiring a great deal of skill. Certainly, the number of sandtraps has a direct bearing on this point, as well as on maintenance cost. However, it can be fairly said that when sandtraps are correctly constructed according to modern concepts, they can be maintained with a minimum of expense. This is one area in the golf course master plan for improvement where the most substantial showing can be made, and for a reasonable cost.

We have now considered how a golf course can be improved not only from the standpoint of maintenance, but also from the standpoint of architectural quality and safety. Let us now consider briefly a system by which a golf course master improvement plan can be achieved and the specific items needed to accomplish it. I would like to say that the system which I will now describe has been time tested, and is being successfully utilized on several existing private golf courses.

The first step in obtaining the information necessary for preparing a master improvement plan is to obtain a topographic map of the existing golf course. This map should be drawn to the scale of 1 inch equals 100 feet. The photography for the topographic map should be ordered new. It will then show all of the latest work which has been done on the course and any and all existing conditions. This topographic map will also show the contours, or hills and valleys, and is utilized to produce a base plan of the existing condition of the golf course. In other words, a black line print is prepared, showing the exact location of the clubhouse, entrance drive and parking space, features such as swimming pool and bath house, and the golf course including tees, fairways, sandtraps, greens, and all existing plant material.

This base plan is then brought to the golf course, and the entire golf course is carefully inspected by walking from each tee through each fairway to each green. Careful notes are made in regard to the topography, drainage, size and condition of tees, sandtraps, greens, and size, condition, and location of trees. Notes are especially important in regard to the visibility of all fairways, sandtraps, and greens. In addition to the physical inspection of the golf course, the golf course architect will confer with the owners and with the golf course committee, with the golf pro, and with the golf course superintendent in regard to desired changes and revisions.

From the information so obtained, a <u>preliminary</u> existing condition plan is prepared. This plan will incorporate all of the notations made during the inspection of the course and by conferring with the interested parties.

Not until all of this basic existing condition information has been obtained can a proper evaluation of the existing course be made and improvement suggested. We now have factual information upon which to base our decisions and our proposals.

Therefore, from the information thus compiled, we will prepare a <u>preliminary</u> master improvement plan incorporating as many of the improvement features as it is possible to make, while trying to preserve valued existing features. This preliminary master improvement plan is then brought to the club for evaluation by the golf course committee.

From this conference will emerge the final drawing of the master improvement plan. This plan shows on one sheet in light lines the existing location of tees, fairways, greens, and sandtraps, and in heavy lines, the proposed changes and improvements. A colored rendering of the master improvement plan should be used in presenting the improvement program to the membership. We have now arrived at a point where all the improvement can be tabulated, and a cost estimate made for each item. These can then be assigned priority numbers so that certain items can be selected to be done first and others at subsequent times.

We have now created the general master improvement plan. However, if a specific change calls for the construction of one or more new greens, provision must be made for the design of these greens. These may be handled one or more at a time as required, and here again if the skills of the golf course architect are to be utilized to their fullest extent, the design for specific greens can now be made based upon the corrected yardages for the proposed new holes according to the master plan. This means that some greens may be larger than those now in use. The specific blueprints for each green can now be drawn

for any particular hole with the full knowledge that this green will be the proper size and shape, and located in the proper position in relation to the master improvement plan. By working from a master improvement plan the golf course features that are improved in one year will not have to be reworked some other year.

The master plan will prove of great value in other areas also. Design and location of additional sandtraps, addition of a new pond or enlargement of an existing pond, and changes in size or location of tees, can all be specifically provided for, all in accord with the long-range master plan. If a new water system is needed, the new system can be designed in accordance with the proposed master plan. The same is true of any additional trees which need to be planted on the golf course.

I would now like to say just a few words in regard to how best to obtain a master plan and how to convince your greens chairman, your greens committee, and the general membership that money should be spent for this purpose. In other words, where does one start and who initiates the idea for a master improvement plan? About half of the work which I have done has originated with forward-looking golf course superintendents who realize that something can be done on their particular course to improve maintenance, and who wanted to sell their greens chairman, greens committee, and the general membership on the idea. The other half comes generally from a greens chairman. Either one or the other of these gentlemen will have reached a point where he feels that something must be done.

When I am contacted at this point, it is necessary for me to inspect the golf course so I can have a first-hand knowledge of the problems. I can assure you that the golf courses which have instituted a successful long-range master improvement program have done so as a result of careful planning on the part of the golf course superintendent involved, his greens chairman and committee, and the golf pro, all working with the golf course architect, and finally the effective presentation of the program to the membership.

Getting a program of this kind accepted in your club is not a simple or easy procedure. Careful groundwork must be laid. However, based upon the carefully drawn plans as outlined in the foregoing steps for production of the master improvement plan, your greens chairman and committee will be armed and thoroughly prepared with all of the information necessary to furnish answers to all members who are concerned with the improvements proposed. There is absolutely no substitute for complete preparation such as I have outlined.

I hope that I have been able to provide a clear outline of the basics of golf course design or re-design.

Maintenance of Football Fields

W. H. DANIEL

Athletic turf, its proper grooming, and good playability have always been problems. It is true that in some very limited budgets anything beats nothing, but today more often the question is--What is best?

We do have much better control of weedy grasses. We have vertical machines for thinning patches of bent and creeping weeds that are not killed otherwise. We have aerifiers, the calcined clays for topdressing, plus numerous sources of peat that can improve resiliency, moisture retention, and water penetration.

VERTICAL DRAINAGE

The principle of vertical drainage is as follows. As water begins to accumulate on the surface it can easily move through porous holes, strips, trenches. When this excess surface water is gone then the soil can rather readily absorb additional water. By this technique soils that formerly were impervious can be bypassed so that ample drainage is secured.

Vertical trenching five yards apart that intercepts the flow of water and lets it go below ground into narrow trenches offers much promise. Vertical slitting, where the soil is

pushed aside by a knife and the slit is filled immediately with porous media, such as calcined aggregates or sand, can also be useful.

Vertical grooving, which encourages water to penetrate two to three inches, often is done with the slope so that it intersects the slits and trenches, and further upgrades the prompt removal of the water from the surface.

CALCINED AGGREGATES

Calcined aggregates, including Turface, Terra-green, LuSoil, Dialoam, and some others, can absorb water readily, may have 60 to 80 percent pore space and can encourage rapid infiltration. Adding these to topdressing, or adding them alone, with aerifying and vertical slicing has greatly improved many golf greens and athletic areas.

In freeze and thaw tests, the current labeled materials on the market appear quite stable. They do permit surface modification toward correcting the problem. In tests at Purdue by repeated topdressing we accumulated one inch in one year without affecting playability.

SODDING

Certainly there has been much progress in producing sod and in developing techniques for cutting and handling, hauling and placing. Numerous machines now on the market do make it possible for the manager to secure ample supplies of materials as needed and in sufficient quantity.

ST. LOUIS STADIUM

The St. Louis Stadium was a major attempt to provide improved technology in building and maintaining the playing area. Initially the plans called for six inches of soil over a very elaborate tile system, which had many junctions, then planting mixed grass seed or sod with common bluegrass.

It was possible to put in a modern tile system (as long laterals), a soil-warming system (5 watts per square foot), and an automatic soil-sensing, pop-up sprinkler system (including 11 zones). A porous root zone with only 10 percent soil was placed above a sand bed. Also dark sand was used in the base lines to achieve contrast and better playability.

In review, the field was quite thin the first year. The zoysia was quite good in 1967; the Bermuda was good in 1968 and again in 1969.

There was a major error in that the subsoil was allowed to settle and fill in overwinter above the pea gravel above the tile lines. Then when the sand and topsoil were placed, the pea gravel was not uniformly exposed by the contractor as all know it should be.

Now in 1970 the field will have artificial turf.

We were able to produce turf for 120 events each year of 1968 and 1969, including baseball, football, and soccer. We were not able to produce turf for the entire Cardinal team to practice from September 10 to December 15 day after day.

It is beyond comprehension what problems have occurred. Nevertheless, the sprinkling system worked, the soil-warming worked, the porous root zone finally worked, and the Bermuda worked. Eventually there was enough equipment to do the maintenance job, and it is with reluctance that the management is shifting to artificial turf. Now they will have a different set of problems.

Certainly we have better equipment and techniques than ever before to maintain turf. Certainly the demands for performance have never been higher either.

THREE ATHLETIC TURF-CARE PROGRAMS

Economy

Before players suit up and fall practice starts:

A. Fertilize to force grass growth and recovery. Consider using 50 - 100 lb. N inside track oval = Urea 45% at 100 - 200 lb. or 16-4-8 at 300 - 500 lb.

B. Start watering if at all possible when needed. Consider traveling equipment with an automatic cutoff. Turf equipment is preferable, but lawn types can be used.
C. Mow often at the 2-inch height. Keep grass as high as practical, rather than as low as possible. Keep more leaf for more wear and cushion.
D. In early football season spread the wear on the field by warming up on the sidelines. Save the center of the field. Keep moving around.
E. Overseed lightly before each home game--5 pounds per 1,000 square feet from a knapsack seeder on thin areas. Use a blend of bluegrasses.
F. Fertilize again by mid-season to force growth as the soil cools.
G. Mulch worn areas with 2,000 pounds of crushed corncobs per acre immediately after the last use of the field in the fall. Corncobs improve structure and infiltration.
H. Fertilize in early spring to hasten recovery.
I. Kill knotweed and other weeds before they compete with grass, as soon as school is out (June 1).
J. Mow often, but HIGH all summer. Build reserves of energy.

Medium

Use all the practices listed above, plus these:

A. Fertilize in early fall.
B. Water to keep turf from wilting.
C. Mow 2 inches high until second home game, than 1.5 inches as the weather cools.
D. Spread the wear and use practice fields fully.
E. Overseed before each home game, and put 3-inch-deep plugs into divot areas.
F. Fertilize again by mid-season, and roll lightly after each game as needed.
G. Fertilize to force early spring growth, and prevent crabgrass and foxtail in the center half of the field.
H. Kill knotweed and other weeds as needed.
I. Keep grass cut 2 inches or higher all summer, and water only when wilt shows. If in doubt, don't water. Aerify once in mid-summer--four or five times over in one day to thoroughly loosen soil, then roll if needed.

Best

Use all of the practices listed above, plus these:

A. Assure adequate drainage:
   1. Vertical trenches, 5 yards apart, above tile lines first, then between as needed.
   2. Vertical slits by machine or shovel through wet spots.
   3. Vertical grooves from sideline to sideline annually. With topdressing of calcined aggregates, 5 tons annually over the field by early summer.
B. Prevent crabgrass, etc., with preemergence material (April 10 - May 10). Mow grass twice in spring before applying preemerge.
C. Protect from disease. Spray about four times a year to reduce leaf diseases.
D. Topdress in early fall to bury the crown of the plant to reduce divots. Encourage short cleats on shoes of players.
E. Keep the turf growing and knitting.

Effects of Soil and Soil Mixtures on Plants

T. R. PECK

In discussing this subject there are two important points to consider:

1. Soils are a three-phase system comprised of solids, air, and water.

2. Plants depend on soils for space, anchorage, nutrients, water, and air.

With these things in mind let us consider the need for soil mixtures. The necessity for making a soil mixture arises because the natural soil in the place of interest or use is unsatisfactory. The purpose of the mixture is to modify the soil so it becomes more

suitable. Within this session we are concerned with athletics, thus we can become more definitive about the use.

Soils used for athletic purposes first must have good water relations, and second must have good fertility status. In allocating a piece of ground for athletic purposes, we necessarily dictate that its condition be conducive and attractive for people-traffic. This means it should be reasonably firm and clean, and must have a beautiful, lush growth of plants. It turns out the properties that make a soil best suited for people-traffic are different from those that are best for plant growth. Thus, the soil mixture needs to be a compromise.

Since soil-water relationships are important, let us briefly consider these. Rainfall or irrigation water falling on a soil can do one of four things: 1) run off, 2) infiltrate and be stored for plant use, 3) infiltrate and percolate through, or 4) stand on the soil surface until it runs off slowly, infiltrates slowly, or evaporates. Soils behaving in the last manner are undesirable for athletic use. The purposes of soil mixtures are to guard against the latter possibility happening. Standing water is usually in a depressional location in conjunction with a saturated soil or a tight soil surface that retards infiltration. Of course, depressional areas may be remedied by reshaping the surface contours.

Problems of wet soils caused by restricted internal drainage are related to tilth. This term refers to a soil having a favorable balance among its components--solids, air, and water. For building putting greens there seems to be considerable agreement on the subject of proper mixtures namely, 7 parts sand, 2 parts peat, and 1 part silt loam (i.e., soil). This mixture is by no means a prerequisite to a good turf, but it is a satisfactory compromise to the demands of an athletic turf.

A larger proportion of sand will be conducive to more rapid infiltration, but the requirements for watering and the fertility specifications of the turf will be more exacting and demanding. During the spring and fall seasons when rainfall is greatest the management would be easier, while summer management would be more complex. Higher proportions of soil and peat will reverse the management problem.

Layering of soil materials influences water movement. Water movement from areas of fine-textured soil material to coarse-textured material is inhibited. This may result in a situation described as a "perched" watertable, a condition of a very wet soil of fine material setting over dry, coarse soil materials.

New Golf Course Management Practices

W. M. BLAINE

With a topic such as this, a person could talk about many different things. For example, we could talk about the many new chemicals that have been introduced during the past few years, or about new advances in automatic irrigation, or about equipment, and so on. Any one of these would be a good topic for this talk. However, only equipment will be considered here, not just ordinary, everyday, run-of-the-mill equipment, but labor-saving equipment.

You all know the problems with labor. Good, reliable labor is difficult to locate and once located is expensive. Note please that we are talking about good, reliable labor. Our problem then, is to make the most of the labor that we are able to hire. It seems the most feasible means of accomplishing this is to take advantage of labor-saving machinery, or in other words we must put the man on wheels. The remarks which follow will be restricted to roughly the past ten years.

Stop and think of everyday jobs on the golf course that involve fairly large inputs of labor. For example, sand trap raking, spraying greens, aerifying, and mowing greens. All of these require reasonably large amounts of labor to get the job done. Within the past ten years we have seen some rather drastic changes in these jobs, since they have been mechanized by improving existing equipment, or creating totally new machines for the job.

SAND TRAPS

Let us first consider sand traps. You all know what a time-consuming job sand trap maintenance is and that it is possibly one of the most hated jobs on a golf course, particularly when you are dealing with 60, 70, or more traps per eighteen holes. Those of you who attended the National in Miami saw a piece of new equipment that looked exceptionally good. This was a three-section sand trap rake which was attached to a lawn and garden tractor by means of a three-point hitch. This past season has indicated either feast or famine with this piece of equipment. About 50 percent of those courses trying the rake found they could use it effectively. The best results were obtained when coupling the rake with a 12-horsepower tractor with hydrostatic drive and dual high-flotation tires. It is nearly impossible to rake 100 percent of all traps, particularly those with steep banks, but if this equipment is able to rake only the flat portions of a trap it still will account for considerable labor savings.

AERIFICATION

Greens aerification has long been a problem so far as large amounts of labor are concerned. It is slow, messy, and requires at least three or four men to get the job done. Without question the punch type aerifiers are still the most popular. Improvements have been made on some of these machines. One company has increased the width of swath from 16 inches to 24 inches, they have also developed windrowers for the machine, and even a semi-automatic oiler for the machine. This tends to decrease the time needed to aerify a green, but does little to speed clean up of the plug mess. Another company has a core-catcher kit available for their machine that will speed up the aerifying process on the green.

A relatively new concept in aerification was introduced a few years ago. This system is called "shatter aerification." There are no plugs to clean up after aerification. One man can aerify greens by himself rather than needing the usual three or four men. When using this type of aerification we do not rely upon the removal of plugs to accomplish the aerifying action. Here aerification is done by some star-shaped blades which hit the soil surface with such speed and force that the soil is actually shattered up to a depth of 12 inches. This action is much like hitting a block of ice with a sledge hammer. There have been some problems with this system or rather there are some requirements before it can be successful. First, topdressing is a must. If you do not topdress then your greens will not heal properly. Second, you must water intelligently after aerifying and topdressing. Superintendents using shatter aerification along with topdressing and intelligent watering seem to be very happy with this system. Above all they have playable, non-compacted greens while reducing labor expenditures at the same time.

A new concept of aerification was used this past year on golf courses. It is being called "sub-aerification." Some of you are familiar with the chisel plows which farmers use. This involves the use of a relatively long shaft or shafts which are pulled along at some distance below the plow sole layer of the soil. Sub-aerification is similar to this. With this machine we use three blades which go approximately seven inches into the soil and vibrate back and forth. This action supposedly breaks up any compacted areas that would occur in the sub-soil. As of now this machine hasn't been on the market long enough to warrant any type of judgment regarding the effects of this type of aerification, although on paper it looks good. Here again only one man is involved in the actual aerifying.

TOPDRESSING

Many of you have spent considerable time with a shovel in your hands attempting to topdress all of your greens. This is slow and involves the use of too much manpower. There are, at the present, two power topdressers on the market. Both of these do a very acceptable job and do not damage the turf. Some superintendents use this machine not only for topdressing but also for spreading sand on icy walks and drives.

UTILITY VEHICLES

The use of vehicles on the course for routine and specialized tasks has increased fantastically during the past few years. There are many of these vehicles on the market today and all of them have some value. There seems to be agreement between most superintendents that having a small versatile vehicle is much like having an additional man on the payroll. There are many attachments available for these machines; for example, the mounted sprayer.

Spraying by hand is at best half accurate. The accuracy of the mounted sprayer on an adapted vehicle is just short of phenomenal. Spray applications of 5.3 gallons per thousand square feet down to 0.3 gallon per thousand square feet are not only possible, but are being made every day of the growing season. It is not possible for a person with hand equipment to come close to the accuracy possible with a mounted sprayer. There are few problems created by using this machine for spraying greens. There have been few reports of any significant compaction when using this equipment. Naturally, the question of wheel-tracking arises. In general there is very little wheel-tracking problem. Most of the visible tracks disappear within an hour. If tracks last longer than this then the greens were probably too wet and should not have been driven on with a full sprayer load. The immediate benefit of the mounted sprayer is, in most cases, a 50-percent reduction in labor costs by reducing spraying time. There are other attachments available such as fertilizer spreaders, three-gang green spikers, and small aerifiers for use with utility vehicles.

MOWERS

Naturally when talking about labor savings on golf courses the talk gets around to mowers. In the last five years or so there have been two or three significant achievements in mowers.

The advent of the five-gang riding tee or collar or trim mower has been a boon to superintendents. At the present time there are two of these mowers on the market. One of them is strictly a five-gang mower and is largely unproven at this stage. The other one is convertible from a three-gang unit to a five-gang unit. The success of this machine is unquestioned. It seems to be a very versatile unit. One of the major selling points of this mower is its ability to climb steep hills and stick there without any problems. If hill climbing is a problem, duals on this machine will greatly improve the hill-climbing ability. Compaction, wheel-tracking, and so on do not seem to be any problem with this machine.

Last comes the riding greens mower. Many adjectives have been used to describe this machine. All seem to apply. It is unquestionably a labor-saving piece of equipment. There have been savings of up to 75 percent over hand mowing, but a more realistic figure would be roughly 66 percent. Such savings will pay for this unit in a relatively short time. Problems? Yes! However, the advantages have, so far, outweighed the disadvantages. Cutting quality seems to be comparable with any hand greens mower on the market, but it does take some extra time and care when making height and bedknife-to-reel adjustments. During the past season there has been some thatch build up, but this was primarily because brushes were unavailable for the unit until late in the summer, too late to take care of the problem. There were some hydraulic problems with the early machines, but in the later production runs most of these problems were solved.

There are other pieces of equipment that could be mentioned such as several different types of sweepers and blowers which have a place on golf courses, but neither time nor space will allow discussing them.

A New Concept in *Poa Annua* Control

W. E. SERBOUSEK

"Turf Enemy No. 1"..."Major unsolved turf problem"..."Poa annua--Friend and Foe"..."Most serious turf care problem"..."increasingly serious weed problem throughout the United States"..."Number one weed problem"...these are some quotations from current journals and turfgrass conference papers. No matter what the topic discussed at turf meetings, the subject matter usually winds up to be Poa annua. Be it bane or blessing, the problems of managing an annual turf species for perennial cover presents a real challenge to the most astute turf manager. Whether it be by fault, default, or design, Poa annua is now the major species in many golf course fairways.

Conceding that Poa annua is abundant, untrustworthy, and undesired by most superintendents, where can we go to improve our lot?

Recent improvements in preemergent and postemergent herbicides have been made, and for some the best route may be to prevent development of Poa annua stands by timely application of these types of chemicals. One important decision must be reached--can you afford to be without Poa annua? Will sufficient perennial turf be present to carry the traffic load and fill in thinned areas during peak use periods? If the answers are yes, your problems are relatively simple. On cool season turf species you can go the preemergent route to prevent germination of annual bluegrass and use postemergents to eliminate established plants. On warm season species, which go dormant in winter, you can allow the Poa to provide winter color and then, with determined courage, some early spring day wipe it out with a dessicant like Paraquat.

If the answer to both of the previous questions is "no", then you have lots of company and your route to Poa-free turf is hazardous. Many turf management specialists have improved their turf by following the narrow path between arsenate toxicity and phosphate nutrition. Other managers have used judicious applications of sodium arsenite as a means of selectively controlling Poa foliar growth and seed formation. As with arsenate dosage, the arsenite rate is critical in that it is dependent upon ambient conditions. Consequently, the results obtained with arsenite have varied from insignificant to dramatic.

For some time our research department has been confronted with the objective to develop a postemergent control for Poa annua that will result in gradual elimination of the weed with no loss of ground cover. Several years of experimentation with new chemicals has led to what we believe is a new concept for postemergence control of Poa annua.

We have found that application of a synergistic combination of two unique growth regulators will effectively prevent the formation of Poa seed heads. Application of the chemicals must be made in early spring just after Poa annua growth begins and before any significant amount of seedhead formation can be seen. In addition to eliminating the troublesome seedheads, the growth regulating agents reduce foliar growth of Poa which lessens the competition against the more desirable species. The treated Poa turf is more open since there is no mat build up and has a darker green color. The net result of treatment is destruction of next year's Poa crop while upsetting the Poa-versus-desirable-turf competitive balance in favor of the preferred species. Furthermore, the Poa annua appears to remain as a stable plant which is less susceptible to summer stress conditions.

Utilization of this method of Poa control is another step toward more desirable turf since control results from foliar absorption and no phytotoxic soil residues are built up. Therefore, treated turf areas can be reseeded at any time without fear of loss of germination. This phenomenon can further be utilized in fall seeding programs. For example, the turf may be treated one week prior to seeding so that competition and shading of the new seedling will be reduced until it is well established.

The overall result of a selective growth retardant program can be summarized simply by stating that it is a tool which aids in maintenance of fine turf through lessening of the competition from Poa. The final realization of this is a reversal of the trend toward increased Poa populations and initiation of competitive replacement by desirable species. This reversal ultimately leads to the point at which a very low population of Poa can be kept in check or done away with entirely using a preemergent program without the risk of bare earth.

For some managers, the control of Poa annua seedhead formation can be a worthwhile objective in itself, especially if the Poa maintains vigorous growth under stress.

Some side benefits in weed control should also be realized from this program since control of dandelion, chickweed, veronica and other broadleaf weeds results from treatment. Also, since Poa seed is reduced, the amount available for transport from fairway onto the greens is substantially less and weed control in the greens is made easier.

The program involves no radically new application techniques. Power spray equipment capable of uniformly applying 30 to 50 gallons per acre of diluted solution in the manner of herbicides treatment is satisfactory. However, it is important to note that, since these chemicals disrupt the chemistry within the Poa plant, it is essential to uniformly distribute the chemical without skipping (cover all foliage) and with a minimum of spray pattern overlap.

Introduction of a product under the tradename Po-San is contemplated for early 1970, but only a limited amount of material will be available to turf managers to incorporate in their own programs.

The Nature of Soil-Borne Diseases

W. A. MEYER

The soil is a very dynamic system with great numbers of microorganisms populating it at all times. According to Burges (2) an average population of microorganisms present in a gram (1/3 teaspoon) of fertile agricultural soil contains:

Bacteria	15,000,000
Actinomycetes	700,000
Fungi	400,000
Algae	50,000
Protozoa	30,000

In a soil uniform in texture and composition the number of organisms falls off very markedly within a few centimeters of the surface. The number of fungi isolated from a bentgrass green at 1 cm. was five times greater than the number isolated at 3 to 4 cm. (6).

The organisms present in the soil play an important role in the decomposition of thatch layers in turfgrasses. They are also partly responsible for the degradation of chemicals applied to the soil, such as fungicides. Many of the bacteria, actinomycetes, and fungi can compete and interact with plant pathogens and by this affect the amount of inoculum present in the soil.

Fungi have been shown to be the major plant pathogens of turfgrasses. They are unable to utilize sunlight as a major source of energy and must depend on dead and living plant materials for their existence. Those fungi that can live only on dead plant materials are called saprophytes. Those which can live only on living plants, such as the fungus causing stripe smut, are called obligate parasites. Many of the serious plant pathogens of turfgrasses fall under a third grouping which includes fungi that can adapt to either dead or living plant tissues. These fungi are called facultative parasites and include such organisms as Rhizoctonia solani, which causes brown patch, Sclerotinia homeocarpa, the cause of dollar spot, and the Helminthosporium species that cause leaf and crown infections. Both obligate and facultative parasites are able to attack healthy plants and cause disease when conditions are favorable (1).

How do the fungal pathogens of turfgrasses persist in the soil when conditions are unfavorable for them to cause disease? Each of the turf pathogens has some type of resting phase that enables it to persist under conditions unfavorable for its growth. Some have a resting structure called a sclerotium which consists of a hard compact mass of mycelium with a specialized outer coat. Others may persist in the soil as spores (seeds) which are produced by fungi or as mycelium within decaying plant parts. The following discussion will illustrate how some of the important pathogens of turfgrasses survive in the soil during adverse environmental conditions.

Rhizoctonia solani and S. homeocarpa are able to survive conditions unfavorable for growth as sclerotia in the thatch or upper layers of soil. The sclerotia are black and occur as flakes approximately 1/10 inch in diameter. The sclerotia germinate by resuming mycelial growth in the soil. The mycelium grow radially in the soil to form a colony in the upper portion of the soil or thatch, which then may attack healthy plants when disease-producing conditions exist.

The pathogen Typhula itoana, which causes gray snow mold, also forms sclerotia. This is a cold-weather disease and is usually associated with snow accumulations that melt slowly in the spring. The fungus survives through warm summer periods as sclerotia. The sclerotia germinate in late fall under cool, moist conditions by producing small club-shaped fruiting bodies which are less than one inch long. Small spores (basidiospores) are produced on these which then fuse to produce mycelial colonies in the thatch and form infection centers (1).

Another cold-weather disease is pink snow mold caused by Fusarium nivale. This fungus damages the grass under the snow or at the edge of a snowbank. It persists in the soil as

mycellium or spores in dead plant materials and by perithecia, which are spherical fruiting bodies containing many spores. When the fungus becomes actively parasitic, the mycelium grows out of the thatch and onto the leaves to penetrate the tissue (3). After the tissue is dead many spores are produced on the leaf surface by the masses of mycelium on the leaf surface.

The Helminthosporium species causing leaf and crown infections survive periods unfavorable for infection as spores and mycelium in the leaf tissue that was killed by the disease. These fungi are very aggressive saprophytes living on decaying plant parts and sporulate heavily in the thatch layer. If spores are splashed onto surfaces of healthy tissue when favorable conditions exist, infection will take place. Many spores are produced in the necrotic areas of infected plant tissues. These spores may produce new infections or remain dormant in association with the plant debris.

The Pythium species which cause Pythium blights survive as soil saprophytes in the thatch and as root parasites of turfgrasses (4). Both mycelium and spores are produced in the thatch layer. Spores of these fungi can germinate either to penetrate the plant directly or produce motile zoospores. The zoospores are capable of moving short distances in the soil when free water is present. When a zoospore comes in contact with a root it can encyst and penetrate to cause infection.

Stripe smut caused by Ustilago striiformis survives periods of unfavorable weather as mycelium in the crowns of infected plants and as spores in the thatch and soil (1). Infections take place when the soil-borne spores penetrate the coleoptile of young seedlings and the lateral buds of rhizomes and crowns (5). Once the fungus is within a plant all new growth will be infected. The fungus produces large numbers of spores in gray linear lesions within grass leaves. These spores remain in the soil and thatch layers until new infections take place.

The pathogens of turfgrasses are well adapted to survive within the soil and thatch layers. By the different resting phases fungi maintain high inoculum levels in plant populations which are then capable of causing disease when conditions are favorable. An understanding of the life cycles of the different turf pathogens can aid greatly in our quest to control them effectively.

REFERENCES

1. Britton, M. P. (in manuscript). Chapter on Turfgrass Diseases in the Monograph on Turfgrass Science, American Society of Agronomy.
2. Burges, Alan. 1967. Microorganisms in the Soil. Hutchinson and Co., London.
3. Dahl, A. S. 1934. Snow Mold of Turfgrasses Caused by Fusarium nivale. Phytopathology 24:197-214.
4. Endo, R. M. 1961. Turfgrass Diseases in Southern California. Plant Dis. Reptr. 45:869-873.
5. Hodges, C. F. 1967. Etiology of Stripesmut, Ustilago striiformis (West.) Niessl, on Merion bluegrass, Poa pratensis. Ph.D. thesis, Univ. Ill.
6. Meyer, W. A. 1969. The Microfungi Isolated From Creeping Bentgrass Turf Plots Subjected to Different Fungicide Treatments. M.S. thesis, Univ. Ill.

Institutional, Industrial, and Highway Turf Session

Use of Mulches for Turf Establishment

DON FOLEY

The following discussion of mulches is not intended as a technical report as to what and how mulches should be used, but rather an indication of what we are currently using for mulches and some personal observations as to their effectiveness. I look primarily at the effectiveness of a mulch from the standpoints of how effective it is in moisture retention and in breaking up impact erosion, how well it stands up under runoff erosion, longevity, and how it effects plant establishment which, of course, cannot be totally divorced from the other items.

In highway work I am sure you understand that we are working with far from ideal soil conditions, and we are obligated to seed outside the normal seeding dates--which makes the soil retention capacity and longevity of a mulch critical.

In our District, which is in east-central Illinois, we are currently working or have worked with the following mulches: asphalt coated straw, green excelsior mulch, dry excelsior mulch (erosion control blanket), jute mat, wood cellulose fiber, and hardwood bark mulch.

ASPHALT-COATED STRAW

Our primary mulch is the asphalt-coated straw which is applied at the rate of two tons of straw to the acre. Each ton of straw is coated with one hundred gallons of asphalt. This mulch seems to be effective from the standpoint of breaking up impact erosion and for moisture retention, but does not hold up under heavy runoff erosion. Mr. Wack has made plant counts on highway seeding in various parts of the state, and in some instances in our District it was observed that germination had been retarded because of too heavy a mulch. This leads us to believe that uniform distribution is essential when using this mulch. For the most part the longevity of the asphalt-coated straw mulch is adequate if we get a decent cover during the first year, but if the first year's cover is inadequate this mulch does not seem to hold through an additional year.

Although the asphalt-coated straw mulch seems to be an effective mulch for highway purposes, I would hesitate to use it on a fine lawn seeding for fear of contamination with seed from the coarse perennial grasses such as tall fescue, brome, or orchard grass. But if you want to accept this risk, it would probably serve as an effective mulch.

EXCELSIOR MATERIALS

Another mulch product that is used in highway seedings in a relatively large volume is the green (wet) excelsior mulch, which is used at the rate of 80 five-cubic-foot bales (compression ratio of 6 to 1) to the acre. My experience with this product is limited, but it has a definite advantage over straw in being much cleaner from the standpoint of weed seed contamination. It is apparently effective.

Also in the excelsior line we use what we call an erosion control blanket. This blanket consists of cured excelsior in a mat that weighs a minimum of 0.8 pound per square yard and is covered by a twisted paper netting of one-inch by three-inch squares. We use this very effective mulch primarily in locations where runoff erosion is a problem. It is held in place by wire staples, so as you can imagine, there is a high labor requirement for its placement. I feel this product would have a place in the development of fine lawns particularly in areas of concentrated runoff or areas with very steep slopes. It seems to satisfy all of the requirements of a good mulch, possibly leaving a little to be desired in regard to moisture.

WOOD CELLULOSE FIBER

Another mulch material that we use primarily for maintenance work is the wood cellulose fiber mulch. This product can be applied with the hydroseeder and used at high rates. It has proven an effective mulch, but it does not seem to hold up well for runoff erosion control; rainfall immediately after installation sometimes results in a total loss. The ease of application in difficult-to-reach areas is a major plus, but I feel its application is limited as far as highway work is concerned.

JUTE MATTING

Although jute matting is not what I would consider a mulch, I feel it should be included in this discussion because it is a useful tool in erosion control. By itself it will stand a great deal of runoff and will hold the soil in place but it affords little or none of the other mulching qualities. It also has a high labor requirement for its placement. We have had some excellent results using this product over sod in very high runoff areas and have been able to establish a cover on these critical areas. In most of these cases this practice was actually a substitute for a concrete structure, and I am sure you realize the dollar savings both in the initial cost and in the maintenance of a paved ditch or similar structure.

HARDWOOD BARK

Another product we have been looking at for mulching purposes is a hardwood bark mulch. With the very limited experience we have had with this product it appears that it has a good deal of promise. We have found that it can be handled with the conventional mulch blower and that it does a good job in preventing impact erosion. We have not observed this material under conditions where moisture retention has been critical, but it should prove to have this quality. Although my information is limited, I feel that this product shows enough promise that it might be of interest. It would be applicable for fine lawn seeding since it apparently does not have any weed seed contamination.

Managing Grass to Reduce Care

VINCE CASTRONOVO

Grass mowing represents a larger proportion of our total maintenance costs than any other grounds maintenance activity. Our maintenance crew cuts grass on about 1,400 acres of grounds. About 600 acres of this is high maintenance ground area; the remainder is semi-improved ground such as the airfield and field areas adjacent to perimeter and highway roads. In addition we have 500 acres of woodland which includes a 5-acre lake. There are 1,256 housing units and an additional 300 proposed for 1972. The base operates a variety of recreational activities including an 18-hole golf course, firearm ranges, stable, ball diamonds, football fields, and a running track. There are 4 miles of fencing and 6 miles of drainage ditch and natural waterways to maintain. These statistics are mentioned to give you an idea of the varied grounds maintenance activities carried on at a typical Air Force installation. Such a complex presents at one time or another every conceivable grounds maintenance problem.

The government, like any large enterprise, is always interested in saving money as long as it improves methods and doesn't affect the mission. This is evidenced by the fact that an incentive awards system is operated throughout the government in an effort to reduce costs as much as possible and reward personnel for their ideas. The grounds maintenance function is an area in which great cost reductions can be achieved by using better methods and equipment. In managing grass to reduce care we have several tools available.

MOWING HEIGHT

This one factor can be the most economical in reducing grass care and costs because it requires no investment yet results in better turfgrass appearance, reduces both weed infesta-

tion and cutting frequency, and indirectly affects other costly turf maintenance factors. At the beginning of the 1968 growing season all improved grounds mowing equipment was set to cut turf (basically bluegrass and fescue) at 2½ inches and mowers on semi-improved grounds at 5 inches. The next year we observed a 40-percent reduction in grassy weeds. This was accomplished without the use of herbicides. Mowing frequency in 1969 as compared to the same period in 1967 was reduced by 1/3. We found that close mowing at 1 to 1½ inches did not, as many believe, reduce mowing frequency but increased it due to an increase in grassy and broadleaved weeds. We were actually cutting seedheads of weeds rather than turfgrass. Close mowing resulted in shallow root systems, high soil-water loss through evaporation, loss of turf vigor, increased weed populations, and more wear on mowing equipment. Cutting turf at an actual 2 to 2½ inches improved turf in several ways. Tall cut allows more grass blade area to produce more plant food and a deeper root system. Tall cut provides a microshade which prevents weed seed germination, keeps plant roots cool, and reduces soil-water loss through evaporation. The total result is a vigorous plant, capable of competing against weeds, and having the ability to persist through periods of drouth. A side benefit to tall cut is less mower maintenance problems because turf is cut rather than soil.

FERTILIZATION

Fertilization is necessary for good turf growth. There is more to fertilizing than buying what you've always used and putting it on at 40-50 pounds of nitrogen (N) per acre. Applying fertilizer in early spring seems best because it becomes available to the plant and is in the root zone at about the time it starts to grow. Sandy and irrigated soils require late summer fertilization due to leaching of N. Fall fertilization promotes cool season grass growth to fill in areas previously occupied by summer weeds. Going back to school a bit, we know that N makes grass green, P and K are for good roots and cellular structures, and pH determines availability of the plant nutrients. If you have taken soil tests on established turf areas you probably found adequate to high levels of P and K. However, managers continue to apply a complete fertilizer at each fertilizer application. Since green grass is what we want, let's give it the element that makes it green--nitrogen. Why pay for P and K if they're not needed? Apply complete fertilizers only if needed, not because you've always done it that way. We've gone to a program of straight N to give us the green we need. We buy inexpensive N of a high analysis (33-0-0). This means less labor in application due to a reduction in bulk and time to apply it. Due to increasing labor costs we are investigating purchase of fertilizer "in place." Custom applicators can put it down in bulk cheaper than we can buy it in 50 lb. bags, unload, store, load, open bags, and spread. This method also frees manpower for other fall and spring work.

IRRIGATION

Irrigation is needed for turf growth and movement of nutrients to the root zone. The amount of water needed for optimum turf seems to be about 1 inch per week during peak growing periods. This is so variable, however, that it is impossible to make any concrete recommendation. The need to water depends on daily weather conditions, soil type, terrain, level of maintenance, and type of grass. The main thing is, water only when needed, not just to see water fly. In average rainfall areas, tall cut can mean the difference between watering once per week or none at all. This practice can save money on purchased water, electricity, wear on pumps, and manpower to set up irrigation pipe.

SUPPLEMENTAL AIDS

Other management practices can also reduce care when used wisely and as supplemental tools. Grass roots require air to grow. If you've ever plugged a turfed area that has recently been aerified you will find roots growing around and in aerifier holes. Aerification where practical can greatly increase plant vigor, especially on heavy soils. Using new mowing equipment to greatly reduce labor time can cut costs. New varieties such as the dwarf bermudas, more disease-resistant fine-leaved fescues, bluegrass which can tolerate close mowing, and fine-leaved ryegrasses are available from turf breeders. Disease-resistant grasses of every turf type are being developed. Use these to reduce care and save money. Herbicides are developed each year by the score: We can stop weeds before they germinate, after they come up, and without harming the turf. All of these supplemental tools, however, cannot compensate for poor overall management of the three basic factors: mowing height,

fertilization, and irrigation. You may get by temporarily but poor management will eventually cause you to lose turf and possibly your job.

SUMMARY

Management of grass can be done effectively with less care and cost by following these basic principles. Proper mowing heights must be determined in relation to turf species and the use to be made of the grounds area. Set mower blades to cut at the proper height when the mower is actually cutting grass. This may mean setting the blade at 3 inches to actually cut at 2 inches in the field. Keep mower blades sharpened to avoid damaging grass blades. Fertilize for turf needs, not because of tradition. Water to grow grass only, not just to see water flowing. Use new developments in machinery, turf breeding, and weed control as supplemental tools to good management but not as a panacea for poor management.

What to Look For in Seed

JOHN LONG

INTRODUCTION

The use of high-purity and viable seed for turf planting is much like using quality materials for a road base or a building foundation. In each case the foundation determines the success or failure of the end product.

Since seed is such a basic ingredient in turf programs it is of importance for the turf manager to have a general knowledge of the quality of seeds he plants. In the discussion to follow we will discuss where responsibilities apply in seed moving in commerce, the place of seed testing, seed regulatory functions, definition of seed quality factors, and indirect forces influencing seed quality. From this discussion it is hoped that you will be able to select better turfgrass seeds.

The responsibility of providing information relating to seed quality in the seed that you purchase is placed upon the seed merchant in order to properly label the seed sold. State and Federal Seed Control Agencies are charged with the responsibility of determining if requirements on labeling seed sold is carried out according to State and Federal Seed Laws.

SEED TESTING RULES

The major objectives in seed testing are to develop accurate information about (1) the physical purity of seed; (2) the viability of seeds; and (3) in some cases, varietal purity of seeds. The results of the seed test generally are considered a measure of the seeds' quality - both from a physical purity standpoint and viability standpoint. The seed test is not entirely accurate in providing information on varietal purity for a number of turf species.

The rules that laboratories (both public and private) follow in seed testing provide a basis for uniformity of results in seed analysis. Such rules are adopted generally after a considerable amount of testing has been carried out. Today we operate under rules for testing developed jointly by the U. S. Department of Agriculture and the Association of Official Seed Analysts.

The rules for seed testing must be practical and workable. They cover sampling, analysis of the seed, examinations, germination tests, and tolerances. The information developed by the seed test under the testing rules is provided with the seed purchased.

FEDERAL AND STATE SEED LAWS

The Federal Seed Act applies to imported seed and seed moving in interstate commerce. Seed of turfgrasses moving in interstate commerce is required to be truthfully labeled to show (1) the name of each kind, kind and variety, or kind and type of agricultural seed present in excess of 5 percent; (2) the percentage of pure seed, other crop seed, weed seed, inert

matter, germination, and hard seed when present; (3) the name and rate of occurrence for each secondary or permissible noxious-weed seed and otherwise to comply with the noxious-weed seed requirements of the state into which the seed is shipped; (4) the date the test was made to determine the percentages of germination and hard seeds shown on the label (the test is required to have been made within a five-month period prior to shipment); (5) lot designation; and (6) name and address of shipper or name and address of consignee together with the shippers' code designation.

The interstate section of the Federal Seed Act is frequently referred to as a Truth-in-Labeling Law. State seed laws differ most in their noxious-weed seed requirements. Some vary in the germination test period and listing of variety names for agricultural seeds.

As reviewed above, state and federal seed control agencies are charged with determining if the seed merchant is labeling his seed in accordance with seed laws. Periodic inspection is carried out on seed moving in commerce.

ASSESSING SEED QUALITY

Physical seed purity or purity composition is one of the key factors of seed quality that appears to be of most concern to the turf manager, assuming that the seed in question has a good level of germination. Purity analysis determines the identity of the important kinds of seed present and the percentage by weight of each component such as pure seed, other crop seed, weed seed, and inert matter. The germination test is based on the pure-seed component; thus the purity analysis and the germination test are complementary.

Weed seed and other crop seed are not necessarily given on the seed analysis label with the seed you purchase. Only noxious weed seed as indicated by state or federal laws would be listed. Otherwise the label will only show a total figure for weed seed with no indication of what weeds are present. The same holds for other crop seed. Only a total percentage would be required to meet regulations. You can see that seed laws will not necessarily insure that you would receive a highly desirable seed. As most of you know, some seed testing laboratories will provide a special analysis detailing what weed seed is present in addition to itemizing what crop seed is present. A number of seed merchants will supply this information on seed on request.

GERMINATION TESTS

Seed germination is an indicator of seed viability. The seed analyst defines germination in the seed test as the emergence and development from the seed embryo of those essential structures which for the kind of seed in question are indicative of the ability to produce a normal plant under favorable conditions. Germination then would be expressed as the percentage of pure seed which produces normal seedlings of the kind that is supposed to be in the package.

In the laboratory test for germination the environmental conditions must be specific enough to initiate growth in seed and further provide for favorable development of the seedling to a stage where normal or abnormal types can be determined.

VARIETAL SEED PURITY

Varietal seed purity refers to the purity of the seed as to the variety that is indicated. For example, if the seed being sold is labeled a Merion Kentucky bluegrass, then an analysis which shows the content of Merion Kentucky bluegrass in the seed sample would refer to varietal purity. Seed laboratories normally do not carry out varietal purity analysis. Special procedures are required which involve growing tests to provide plants upon which a check can be made as to meeting the description of the variety as labeled.

Varietal purity is one of the most difficult aspects facing the seedsman for certain turfgrass species. Kentucky bluegrass is classified as an apomict, which to many would indicate that it should be very simple to maintain high varietal purity. Because of the variation in level of apomixis in bluegrasses, rather precise control must be practiced over the number of generations for which most bluegrass can be multiplied for commercial seed production. In some cases the apomixis level will run so low that varietal purity can only be maintained through vegetative planting.

Synthetic varieties of fine fescues, ryegrasses, and bentgrasses also must be handled in precise ways in commercial production to insure that wide deviations in the synthesis of the synthetic will not occur. Penncross bentgrass represents a very good example of close generation control to provide high varietal purity. Commercial seed fields are planted vegetatively with three clones of bentgrass. Seed produced from such fields represents the commercial seed of Penncross that you purchase. Seed from such production fields should not be used to plant additional seed production fields because of the potential for drift to one of the more vigorous seeding clones.

Synthetic varieties of fine fescue such as Pennlawn and C-26 do not require as critical a level of generation control as the case for Penncross bent. Usually synthetic third or fourth generation seed is used for commercial seed. In some cases it is essential to go to later generations to obtain maximum synthesis for the given synthetic variety.

OTHER SEED QUALITY CONSIDERATIONS

Seed dormancy level is normally evaluated in the seed germination test and can have a marked effect on turf planting success. Varieties of Kentucky bluegrass may be affected by an after-ripening dormancy - particularly shortly after harvest. For this reason most Kentucky bluegrass seed is not used extensively for planting during the same season that it is harvested. If it is used, blending will be done with older seed to insure that a more uniform turf stand is obtained. Attempts to overcome the after-ripening dormancy through the use of chemical agents, cold treatments, high frequency sound waves, ionizing radiation, etc., have not been highly successful. Moreover, findings indicate that stage of maturity when harvested has little effect on breaking dormancy.

Seed moisture plays an important role in the maintenance of high seed viability. This is particularly critical when seed of high moisture content is stored under high temperature and high relative humidity levels. Storage conditions can be negated to some degree by using moisture barrier packaging for seed; however, high seed-moisture levels will result in rapid seed deterioration regardless of the kind of packaging used. Recent research has demonstrated that a combination of low seed moisture plus the use of seed containers that prevent moisture penetration into the seed container will hold seed viability at a high level.

Grass seed is quite sensitive to heat used in drying. The effect of hot air drying may not be observed when germination is carried out soon after the drying phase, but where drying temperatures are too high, rather rapid seed deterioration can occur. The trend now is to employ conditioned air drying, which uses desiccants plus temperature control.

SUMMARY

The selection of seed of high physical purity and high viability (as indicated by germination) should be considered an essential step in turf management programs. Varietal seed purity will influence turfgrass performance and turfgrass uniformity; thus, it should be given consideration in seed selection. Seed merchants are responsible for providing information on the important factors of seed purity and viability, while federal and state control agencies are responsible for determining whether seed is properly labeled. Varietal maintenance in production and the processing of seed after harvest play key roles in insuring that the quality level of seed is maintained.

Soil Testing and Fertilizing Large Areas

TOM HUGHES

Adequate soil fertility levels are essential for establishment and maintenance of quality turf. Turf grasses grown with adequate fertility do a better job of competing with weedy undesirable species. The concept that increased use of fertilizers necessitates increased mowing is often false. Under low fertility, the presence of weedy species can cause differences in color and height on turf areas, which will necessitate frequent mowing to pro-

duce the desired appearance. Although fertile soils may not be productive turf soils due to some physical limitation, the more productive soils are always fertile.

A distinction needs to be made between turf grown on large areas for institutional, industrial, and highway purposes and that grown in the home lawn. On the large areas irrigation is often not available and frequent mowing may not be feasible due to equipment and labor costs. Management practices such as these determine the quality of the turf that can be produced and therefore also affect the fertility practices. Extensive use of fertilizers to produce extremely high-quality turf when other management practices are not correspondingly intensive is needlessly expensive and may bring about other problems.

Soil testing is only a tool. Soil test information is useful in determining appropriate fertility practices since it describes the fertility status of soil. However, final determination of the fertilizer recommendations requires information about how the area is to be used, the desired quality of turf, and management practices as well as the soil test results.

SAMPLING THE AREA

The process of soil testing and fertilization may be divided into several steps. The first step and probably the most important is sampling the soil of the area. The importance of this step cannot be overemphasized. The soil sample must be representative of the area if the fertilizer recommendation is to be appropriate. Obtaining a representative sample is difficult even on areas that have not been disturbed by earthmoving equipment. Removal of topsoil in some places and not in others can present an especially difficult problem. A sample that represents only one core or boring can seldom be used to represent an area. The proper approach is to make each sample a composite of several cores or borings.

All the cores or borings used to form a sample should be from an area or portion of the area that is thought to be fairly uniform. If there is an established stand of grass on the area, it can serve as a useful guide in determining the uniformity or heterogeneity of the area. Differences in rates of growth that have been observed and differences in the relative proportions of the various plant species present can sometimes provide a clue. Soil properties such as color and texture may also be helpful. On areas thought to be fairly uniform, the sampling sites may be selected according to some definite pattern. The University of Illinois (2) recommends a grid system of eleven samples, each of which is a composite of five cores of borings, for a forty-acre field. In this system, each of the eleven composite samples represents an area of approximately four acres and therefore may not represent the area in enough detail if it is not fairly uniform. Problem areas must be sampled separately so that separate recommendations can be obtained. It should be emphasized at this point that dividing the area into sections for separate recommendations is senseless unless separate fertility practices can be employed on the various sections.

It should be evident that turf growing situations differ considerably with respect to sampling procedures. The determination of what is an appropriate procedure has to be made by the person doing the sampling. This person needs to be able to formulate some ideas about the area either through previous experience or by visual observations at the time of sampling.

HANDLING THE SAMPLES

The second step is transporting the samples to the laboratory for chemical analysis. Small cardboard containers are appropriate. The samples should not be exposed to extreme temperature conditions while being transported, as freezing or heating can change the chemical determinations. Keeping the time interval between sampling and analysis to a minimum improves the accuracy of the analysis.

CHEMICAL ANALYSIS

The third step is the chemical analysis of the soil samples. Soil pH, available phosphorus, and available potassium are the routine determinations. There is no field soil test prescribed by the University of Illinois for nitrogen.

FERTILIZER RECOMMENDATIONS

The fourth step is to determine the fertilizer recommendations by using the results of the chemical analysis as well as information about management practices. For phosphorus and potassium, levelsof soil nutrients are related mathematically to a measure of plant growth. The mathematical equations are the basis for a soil test correlation. The development of an accurate soil test correlation requires a tremendous amount of research information. Since only a small amount of research information is available concerning turfgrass production, soil test correlations have not been established for turf. A rule of thumb approach is still being used, although it produces fertilizer recommendations that are less accurate than the soil test correlation approach.

The rules of thumb are developed by using visual observations from fertility experiments and therefore may vary somewhat depending on the individual research worker's opinion. It may seem, therefore, that there is no need to test soil for phosphorus and potassium if the fertilizer recommendation is going to be someone's opinion. This is definitely not the case. Such designations as deficient, satisfactory for maintenance, or ample; or low, medium, or high may be applied to soil test values and used to develop a more accurate set of rules of thumb.

For nitrogen recommendations, the lack of a satisfactory laboratory analysis necessitates a rule of thumb approach. Table 1 reports a set of fertilizer recommendations that have been established by Daniel (1) using the rule of thumb approach. Note that soil test information is needed before the table can be used.

In Table 1, the rates for establishment are double those for maintenance. Nitrogen recommendations for maintenance are about one pound of nitrogen per 1,000 square feet. This rate can be doubled if irrigation water is used. Approximately ½ pound of P_2O_5 and ½ pound of K_2O per 1,000 square feet is the usual recommendation. For establishment, the amounts of phosphorus should be slightly greater than amounts of K_2O. For maintenance, slightly more K_2O is recommended than P_2O_5. Fertilizers that contain no P_2O_5 or K_2O are recommended when soil tests indicate that there are ample amounts of available phosphorus and potassium. Fertilizers that contain only nitrogen are not recommended for establishment. Slow-release nitrogen sources such as ureaform and activated sludge must be applied at much higher rates.

If the pH determination indicates lime is needed, a separate procedure is used to determine the amounts of lime needed to raise an acid pH to the desired level. This determination, as well as the resulting recommendation, is considered to be accurate. Where turf production is concerned, the recommendations for lime application are much more accurate than the recommendations for nitrogen, phosphorus, and potassium.

FERTILIZER APPLICATION

The final step is the application of needed fertilizer nutrients according to the recommendations. As can be seen in Table 1, fertilizers containing many different N, P_2O_5, and K_2O ratios are available. Therefore it is usually not difficult to obtain a material that will supply the recommended amounts of the various plant nutrients. Care should be exercised in the application to obtain a uniform distribution of the fertilizer on the area. Excessive rates in spots can cause burning of the turf, and skips may cause the grass to suffer from nutrient deficiencies. Also a nonuniform distribution of fertilizer can cause difficulties in soil sampling at a later date.

To summarize, soil testing is a useful tool in determining fertilizer recommendations for large turf areas. However, the usefulness of soil test information depends on how representative the soil samples are of the area. Soil tests do not provide all the answers. Information about management practices is also needed. Much more research information is needed to develop accurate soil test correlations for turfgrass production.

REFERENCES

1. Daniel, W. H. 1968. Fertilizing Lawns and Turf Areas in the Midwest. Plant Food Review 14:2-4.
2. Peck, T. R., and S. W. Melsted. 1967. Field Sampling for Soil Testing. Soil Testing and Plant Analysis, SSSA Special Pub. No. 2, part I, pp. 25-35.

Table 1. Representative Turf Fertilizers and Recommendations

Sample analysis	Ratio comments	Lb./1000 sq. ft. To start	To maintain	Conditions for which recommended
15-15-15	1-1-1	12	6	Seldom used, only if all major nutrients are deficient.
12-12-12	1-1-1	16	8	
20-5-5	4-1-1	10	5	Useful for starting turf; also widely used for maintenance.
23-7-7	3-1-1	10	7	
15-5-5	3-1-1	15	8	
16-8-8	2-1-1	15	6	
12-6-6	2-1-1	16	10	
20-10-5	4-2-1	10	6	
10-6-4		20	10	
30-8-14	Variable	--[a]	3	Useful for maintaining turf by repeated applications.
30-5-10	ratios of	--	3	
28-7-14	high N, low	8	4	
25-5-10	P_2O_5, medium	10	6	
22-5-9	K_2O	10	5	
22-4-6		10	5	
18-4-6		12	6	
16-4-8		12	9	
12-4-8		15	10	
10-3-7		15	12	
45-0-0	Urea	--	2	Useful where phosphorus and potassium are ample.
38-0-0	Ureaform	--	8	
33-0-0	Am-Nitrate	--	3	
16-0-0	Nitrate of soda	--		
6-4-0	Activated sludge	--	30	
Other fertilizers and materials as required to supply N and K_2O in a ratio of 2 to 1.				Useful where P_2O_5 is high from repeated fertilization.

a/ Dashes indicate that no specific amounts are listed due to variability of results under different conditions.

Large Area Turf Weed Control

PAUL CRAIG

Consider for a moment the problems of managing a 135,000-acre turf farm approximately 16,000 miles long and 100 feet wide. The complexities of any phase of turf management on this long ribbon of landscape are at times awesome. Roadside management practices are constantly subjected to extremes in climate, topography, soil type, drainage, and fertility. In addition to the natural occurrence of these extremes, we frequently intensify many of them. When we construct a highway, we disturb the soil, change the ecology of the area

through which the highway passes, and alter the drainage. Weed control practices are affected by the natural variations occurring along highways, as well as by the environmental manipulations caused by the construction of a highway.

We have found few absolutes which apply to weed control practices. Therefore, to be effective, our weed control efforts must be carefully planned and efficiently executed.

For the Illinois Division of Highways, three basic areas exist for which weed control programs are planned: general highway right-of-way, highway rest areas, and scattered areas of illegal weeds. Each of these three areas contains a different community of weed types. As the categories would indicate, weed control procedures within a category would be similar in approach and efficiency.

GENERAL HIGHWAY RIGHT-OF-WAY

These areas are generally characterized by poor soils and constantly changing topography. Whenever erosion control becomes a prime objective in a turf program, all perennial grasses are welcome. On some expressways in northern Illinois, quack grass represents a large percentage of the grassy cover. An intolerable nuisance in most turf situations, in this instance it is looked upon as an effective and dependable plant to prevent erosion.

On this large volume of land which comprises the general highway right-of-way, turf maintenance is extensive only as related to the volume of land. Maintenance practices are necessarily of a minimum nature. Due to the large scale and the speed of modern traffic, weed definement is minimal, and at the normal height of cut on these areas, some of the more common lawn weeds are not objectionable.

We are concerned with a few weeds in both the broadleaf and annual grass groups. The frequency of occurrence of these troublesome weeds is largely determined by the maintenance practice in a given area--mowed vs. unmowed. Eight or ten broadleaf weeds are significant in our weed-control programs; many of these are more frequent and most troublesome in unmowed grassy areas. Plants like Queen Anne's lace, wild parsnips, and goatsbeard are frequent invaders of unmowed areas, while dandelion, plantain, red sorrel, and so on, are most troublesome in mowed situations.

Annual grasses are of concern since they leave an area unprotected for a period of time. Such areas are then vulnerable to erosion during the winter and early spring months. Of this group, both species of crabgrass and the foxtails are growing on our right-of-way.

HIGHWAY REST AREAS

These facilities are people-sized and park-like. Since they are subjected to individual close-up inspection, they are more demanding in their maintenance requirements. Usually we have relatively undisturbed soil in these areas so that better turf is possible. With the grass cut shorter, the weeds which invade our rest areas are more prominent.

Weed problems in rest area turf would resemble those found in parks, cemeteries, or home lawns. In selecting locations for rest area facilities, wooded sites are frequently chosen. This naturally imposes some rigid limitations on both the method and chemicals which can be used to solve weed problems.

SCATTERED AREAS OF ILLEGAL WEEDS

Infestations of illegal weeds, such as Johnson grass, hemp, and Canada thistle, range from spotty to extensive. Frequently they are difficult to locate. The geographic ranges overlap, so we may find extensive infestations of one and spotty infestations of another within the same region or area of the state.

Fortunately, we do have good selective and non-selective chemicals for controlling these noxious weeds. In central and southern Illinois, both Dowpon and MSMA have been effective in controlling Johnson grass. The DSMA-MSMA materials have received widespread use because of their lower cost; however, observations over the past four seasons would lead us to believe that Dowpon is slightly more efficient in terms of lowering the regrowth potential.

In the past, Canada thistle has been extremely difficult to eliminate. Soil sterilants like sodium chlorate were often used. However, we have found a potent selective killer in Tordon. This material is usually applied in granular or bead form, with care being taken to limit its use to areas that do not contain desirable woody plants.

HERBICIDE PROCEDURES

Weed-control programs along Illinois highways have been primarily associated with 2,4-D and 2,4-D-related materials. The most extensive work has been done by contract, with supplementary spraying by state personnel.

During the last decade we have experienced a trend away from the ester materials to the amine formulations. However, as Illinois progresses toward a more contemporary approach to roadside turf maintenance, the unmowed acreage of grass will expand. The increased pressure of broadleaf weed invasions in unmowed grass may tend to reverse this trend somewhat, making the esters with their extra killing power more attractive.

Today the problem of drift has more significance than does volatility. Windswept highways always present a problem in the safe application of herbicides. New formulations of ester 2,4-D have reduced the probability of volatility; however, drift problems are virtually unaffected. Future success with postemergent herbicides on a broader scale will rest with closer supervision of work projects, better material specifications, new methods or materials, and reduction of drift.

The Illinois Division of Highways is considering the use of thickening agents to reduce drift, extend the safe spray zone, and improve the efficiency of our work. After only the briefest encounter with one of the thickeners, Vistick, we are convinced that these materials have merit. We were able to use Vistick at 5 pounds per 100 gallons of water, with only minimum alterations of our existing equipment. Mixing is critical, but if done properly, we find we can spray this material in our conventional equipment, operated by roller pumps and without mechanical agitation. Hose and valve sizes were increased to accommodate thickened materials, and the resulting performance was very satisfactory.

THE FUTURE

The future holds many new challenges in the area of weed control in large turf areas. Land management responsibilities are increasing with the construction of new highways on wider right of way. These responsibilities are also expanding with the implementation of selective mowing concepts and the construction of highway rest areas.

Future efforts will emphasize preventive aspects. I do not mean preemergent herbicides although they will be increasing in importance. By preventive aspects, I am referring to applications of new technology--prevention of weed problems through better stands of grass, improved fertility practices, and more suitable mowing, and quick efficient chemical control through proper chemical selection and improved application techniques.

The challenge will be exciting. It will be met by a growing group of alert men whose thinking is always plastic and developing with the changing technology of this field.

Equipment to Reduce Maintenance Costs

J. R. WATSON and E. A. HUNNICUTT

Today a rapidly increasing population, coupled with more leisure time than at any period in history, is placing heavy demands on all types of recreational facilities and services. No doubt, increasing economic and production efficiencies will result in even more leisure time in the future. From the standpoint of usage, this will exert even more pressure on existing turfgrass areas as well as necessitate the construction of new facilities. In the face of rising labor costs and with user demands for higher quality turfgrass, it seems mandatory that the organization charged with maintaining recreational areas whether golf course, park, school, highway, or airport must either increase its budget or increase efficiency in its operations. Growing resistance to higher budgets seems to indicate that rising costs must be offset by more efficient operations. Efficiency, in this case, implies the development and maintenance of the highest possible degree of turfgrass quality and user acceptance commensurate with a given expenditure of time, energy, and money.

Grass cutting is the most time consuming part of the maintenance program. It is also a most important factor contributing to overall appearance of the turfgrass area. For these reasons, selection of grass cutting equipment is an important part of the well-run maintenance program.

Selection of mowing equipment to meet the requirements for modern turfgrass culture and management depends on the available labor force, the level of maintenance, the size of the area, landscaping, kind of grass, and the use for which the area is designed. These considerations are basic when selecting the size, number, and types of mowing equipment needed for economical operation on turfgrass areas.

MOWERS

The proper type and size of mower are important in maintaining any turf area. Mowers are available in varying widths and with numerous features. Requirements of a good mower are maneuverability, easy adjustment, durability, sturdiness, and adequate horsepower for the size of the mower and the usage expected.

Most manufacturers build two lines of equipment--"consumer" and "industrial" or "institutional." Consumer equipment is designed and constructed for cutting home lawns. It operates satisfactorily when used for a few hours a day or a few days a week. Industrial equipment, on the other hand, is built to stand up under eight hours a day, five days a week usage for extended periods. It has a rugged construction and a functional design and is capable of performing under continuous use if cared for properly. Obviously, there is a considerable cost differential between the two lines, but as with most items, cost is a function of value received.

Four basic types of mowers are available--reel, rotary, sickle, and vertical. Choice of a given type will be governed by the particular duties the unit will be expected to perform, and by the size and landscaping of the lawn area. Each type has certain advantages and limitations which should be considered carefully before final selection of the mower.

Reel. Reel mowers are always recommended for the cutting of formal and semi-formal turf areas, including golf greens, tees, and fairways. Reel-type gang mowers are the most efficient and economical for mowing large open areas such as airfields and parks. The cutting action of the reel is like that of a pair of scissors. Reels, when sharp and properly adjusted, give a clean even cut which cannot be equalled by any other type of mower. Certain kinds of grass should always be cut with reel-type mowers. Bentgrasses and, in most cases, fine-leaf bermuda grasses are examples.

The use of reel-type mowers may be limited in some turf areas because they require relatively smooth ground upon which to operate, and they will not cut tall, rank growing weeds. In addition, their maintenance costs are somewhat higher than other types of mowers.

Rotary. Rotary mowers are more versatile than reels. In addition to mowing grass, rotaries may be used to (1) collect clippings, leaves, and other debris; (2) pulverize or grind up leaves; (3) cut tall-stemmed weeds, tall grass, and other unruly vegetation; and (4) trim (for this, a small rotary would be used).

The rotary cuts by impact, similar to the cutting action of a scythe. For this reason a sharp, properly balanced blade is necessary to avoid ragged tearing of the grass blade. Cutting with a dull blade generally results in a graying and subsequent browning of the leaf tip. When selecting a rotary mower, particular attention should be given to the safety features, the type of blade and method of blade mounting, ease of adjustment, and the horsepower of the unit.

Power requirements--the highest of any type of mower--and scalping on uneven or rough terrain, along with poor quality of cut when blades are dull, are the major limitations of rotary mowers. The cost of maintenance is low on the rotary unit although the cost of engine maintenance may be much higher than on reel units, particularly if the unit is underpowered.

Sickle. Sickle mowers have no place under normal turfgrass conditions. They may be used to advantage in rank, weedy growth where only an occasional mowing is required. Sickles have a very high cost of maintenance and relatively slow ground speed; consequently, they are an expensive method of mowing.

Vertical. Vertical mowers are made with fixed blades or with free-swinging blades (hammerknife). They cut by impact similar to the rotary mower except that the blades travel in a vertical plane rather than in a horizontal plane. Hammerknife mowers can be used on a rough terrain more satisfactorily than rotary mowers because their short wheel base lessens the possibility of scalping. They have a relatively high cost of maintenance.

Vertical mowers with fixed blades are used primarily for controlling thatch and grain on golf greens and other highly specialized turf areas.

CONSERVATION OF LABOR

Adequate modern mowing equipment contributes to efficient operation and maintenance of turfgrass areas. Since labor is the biggest expense item in a yearly budget (estimates vary from 65 percent to 75 percent), this means that operations must be keyed to the use of mowers that will produce a greater number of work units per man hour.

As an example, let us compare labor costs involved when using 30-inch and 76-inch mowers. These calculations were made with the TORO Grass Cutting Calculator.

1. A 30-inch mower (walk) at 3 mph will cut 6½ acres in 8 hours. Assuming $2.00 per hour for its operator ($16.00 per day), labor costs would be approximately $2.46 per acre.
2. A 76-inch professional-type mower (riding) at 3 mph will cut 17 acres in 8 hours, or at 3½ mph will cut 19 acres in 8 hours. Figuring one machine with one operator at $2.00 per hour ($16.00 per day labor cost) and using 18 acres, the per acre labor cost is approximately $.88.
3. Looking at these two units in another way, the 76-inch triplex machine at 3 mph would cut 6½ acres in 3½ hours. The 30-inch mower would cut 6½ acres in 8 hours. Use of the 76-inch professional-type mower would free the operator for 4½ hours to perform work in other areas.
4. From a cost standpoint, the 76-inch machine would run approximately $750.00 more than the 30-inch unit. At $16.00 per day labor savings for one operator working 5 days a week would equal the additional cost of the larger unit in 9 to 10 weeks.

Obviously, not all areas lend themselves to this type of analysis but such comparisons should always be made whenever possible. Landscaping, for example, must be taken into account when choosing between different size mowers.

LANDSCAPING

Many of our turfgrass areas were designed and constructed during an era when labor costs were negligible and mechanization was of little importance. This created many time-consuming operations which today require the use of low-capacity, high-cost equipment. Landscaping may not have been planned but rather grew haphazardly over the years with little thought to the maintenance demands being created (often according to the whims and fancies of some particular individual).

As a result, delays encountered in maneuvering larger equipment around mowing obstacles--tying up more expensive equipment and possibly higher paid workers--plus the time required to "clean up" inaccessible areas, may often consume more man hours than would be required to operate smaller equipment. On such areas mowers which will trim along borders, around trees, and especially cut under low hanging branches without damage will save additional clean up and trimming time. Combinations of large and small units working in teams may be the most efficient method for handling such sites.

From a long-range standpoint, remodeling of the landscape to permit the use of larger capacity mowers may be the preferred approach on many such areas. Ability to use large capacity mowers should be taken into account when new sites are being landscaped.

OTHER CONSIDERATIONS

Other factors to consider when selecting mowers include these:

1. Equipment purchases, for the most part, are capital expenditures and should be treated as such--amortized and depreciated.
2. The manufacturer or his representative should be consulted on the type of mower needed. Information on new equipment and improved features as well as the suitability of their equipment for the job at hand is readily available from the reliable manufacturer.

3. The availability of parts and service facilities is of prime importance when selecting mowers. If repair parts are not available when needed and a machine is inoperable for extended periods, it is of questionable value and certainly will contribute little to correct mowing procedures.

SUMMARY

Adequate mowing equipment for a particular golf course, cemetery, park, highway, or school system may be inadequate for another and excessive for a third; therefore, equipment must be selected on the basis of the individual requirements for a particular organization. Terrain, landscape, and available labor are some of the factors that will dictate the various kinds, sizes, and types of equipment required for efficient operation. In addition, treating equipment purchases as capital expenditures and consulting the manufacturer or his local representative should be considered when selecting equipment. The importance of selecting proper mowing equipment is evident when it is recognized that grass cutting is the most time-consuming of all turfgrass maintenance practices and that mowing techniques contribute to the well-groomed appearance desirable in all lawns.

Herbicides to Cut Upkeep

F. W. SLIFE

The cost of maintaining our large turf areas has increased so rapidly in recent years that it is necessary to reevaluate many of our maintenance programs. There are at least three major areas where herbicides can be used to substitute for high labor costs: (1) Shrub beds and individual trees; (2) Vegetation control along guard rails, fences, and other permanent structures; and (3) The turf area.

Weed control in shrub beds is needed for a number of years, until the shrubs produce enough shade to discourage weed growth. Using a mulching material will frequently reduce the weed problem enough so that no chemicals are needed. Although corncobs are one of the most common mulching materials, they decompose relatively quickly, and form good seedbeds for weeds unless more mulch is added. Newer materials such as bark probably give better weed control because they decompose much slower and hence discourage weed growth longer.

Both simazine and casaron have wide adaptability to shrub beds, and most of the common shrubs have tolerance to these materials. These tend to be much more effective when applied to bare soil without mulching material, but they are of some benefit on top of mulching material when and if annual weeds begin to appear. The rates for application on top of mulching material are higher than when applying to bare soil. Even so, these materials can effectively reduce hand labor in shrub beds.

Individual trees in large turf areas require additional labor in the form of hand mowing; moreover, such trees are frequently injured with mowing equipment. Treating the areas around these trees with a contact chemical such as paraquat will control the grass, and if simazine or casaron is added, enough residue is obtained to eliminate the hand mowing operation.

There is no one herbicide or herbicide combination that satisfies all requirements for vegetation control around permanent structures in large turf areas. Although a long residue soil sterilant is desirable, it is frequently hazardous because of movement with heavy rain. In many areas a more acceptable program uses a contact material like paraquat combined with a soil sterilant at lighter rates; with this program, control can be achieved for several months. Using these kinds of materials wisely will eliminate most of the high mowing costs around guard rails, fences, and other permanent structures.

In the future, we can look to some of the newer growth inhibitors that are now appearing on the market. It may be that one of these materials or a combination of these materials will discourage growth around permanent structures without killing and achieve the same purpose as an herbicide treatment.

As a general rule, herbicides have not replaced much of the labor used to mow grass in the large turf areas but rather have been used to improve the appearance and quality of the turf. As the cost of mowing increases, it seems probable that we will try to eliminate mowing in many areas, and it is in these areas that herbicides can be particularly effective. Compounds like 2,4-D can be used to control many of the broadleaf plants in these areas without harming the grass. Unmowed areas should then be relatively attractive to most people because they will contain either planted grasses or native grasses that may invade these areas. In unmowed turf areas, most of the species that exist even without spraying are considered wild plants. Most of these species pose little or no threat to cultivated areas adjacent to the highways. We believe that many people would find these plants attractive; and rather than detracting from the landscape, they may become a very desirable feature.

Retailers' and Garden Suppliers' Session

Current Fertilizer Recommendations

P. E. RIEKE

Fertilization of turfgrasses is only one of several important management practices which must be followed for maintenance of quality turf. This discussion will be approached from the standpoint of providing information which should be helpful in answering lawn fertilization questions asked of fertilizer retailers.

Answering homeowners' questions about lawn fertilization presents a special problem because of the wide range of interest in and understanding of a good fertilization program. Some people will be quite knowledgeable on the subject and may have already decided what fertilizer they plan to purchase. Others will know only that they should fertilize their lawn. Suggestions can best be provided by asking a series of pointed questions.

1. Is the fertilizer to be applied on established turf? For turf already established a fertilizer with a higher ratio of nitrogen to phosphoric acid and potash is suggested. Ratio refers to the lowest common ratio of the analysis of the fertilizer. For example, a 20-5-10 fertilizer would have a ratio of 4-1-2, while an analysis of 25-5-5 would have a ratio of 5-1-1. At establishment time the ratio can be closer to 1-1-1. Based on some of our greenhouse and field tests, no more than 2 to 3 pounds per 1,000 square feet of any one nutrient should be applied to the seedbed.

Soil tests are helpful in making lime, phosphoric acid, and potash recommendations. At establishment time these materials should be mixed into the soil to a depth of 3 to 4 inches at least. This is not possible on established turf, so the fertilizer is applied on the turf. A dependable soil test is dependent on a representative soil sample. On established turf the sample can be obtained by sampling the soil to a depth of about 2 inches in at least six to eight locations over the turf area. These samples should be mixed, air-dried at room temperature, packaged in a suitable container, and about ½ pint sent to a soil-testing laboratory for analysis. Be sure to include information as to whether the sample represents a new or an established lawn, if there is a special problem observed, your name, address, and where the sample was obtained in the turf area (backyard, etc.).

2. What kind of grass is being grown? Nitrogen is the key element in fertilizing home lawns, although adequate levels of other nutrients must also be present. Merion Kentucky bluegrass and the bentgrasses respond to higher levels of nitrogen than most other grasses (6 to 8 pounds of nitrogen per 1,000 square feet per year for high-quality turf). Common, Park, and Delta Kentucky bluegrasses perform best at 3 to 4 pounds of nitrogen while some of the newer Kentucky bluegrass varieties have somewhat intermediate nitrogen needs. The red fescues should not normally receive more than 1 to 3 pounds nitrogen per 1,000 square feet per year. Mixtures and blends of grasses should receive nitrogen rates at levels intermediate to the optimum rates for the specific grasses in question.

These rates of nitrogen should result in good quality turf throughout the growing season and will help form a dense turf which can compete with weeds.

3. Are clippings returned? Returning clippings may reduce annual nitrogen requirements by about 25 percent.

4. What is the soil texture and how much water is being applied? Very sandy soils have limited capacity to hold water for turf. This necessitates more frequent watering for quality turf and can lead to increased leaching of nutrients. If sandy soils are not watered, nitrogen applications normally should be reduced because there is less potential for turf growth.

5. What is the condition of the turf at the present time? The season of the year plays a significant role in answering this question. If the turf is weak with open spots caused

by weeds, disease, insects, high or low temperature injury, or moisture stress, the use of a fertilizer containing more soluble fast-acting nitrogen may be encouraged, especially during cooler periods. Early spring response is important in forming a dense turf so there is not a good place for weed seeds to germinate. If the turf is dense in the spring, lower rates of nitrogen may be used to "green-up" the turf. This results in moderate growth and less frequent mowing. During the warmer periods it is safer to use a slow-release nitrogen fertilizer so burn possibilities are reduced and harmful excessive growth is not forced.

6. What quality of turf is desired? The individual must determine what quality turf he would like. For an attractive lawn throughout the year he must be either knowledgeable in the use of turf fertilizers or willing to invest in the more costly, but safer-to-use slow-release fertilizers.

7. What is the cost of the fertilizer? Much of the fertilizer sold for home lawn use is determined by the price on the fertilizer bag. The water-soluble nitrogen sources (ammonium, nitrate, urea) will usually be cheaper in cost per pound of nitrogen, will give a quick response, but may cause burning, and may need to be applied more frequently. On the other hand, the organic sources (natural organic materials or urea-formaldehyde) will be more expensive but will give slow, long-lasting effects without burning. The organic fertilizers will be especially slow in giving a response in the spring of the year. On the fertilizer bag, information is often given referring to the type of nitrogen included, particularly if organic nitrogen is present. Look especially for the percentage of water-insoluble nitrogen (WIN). Usually the higher this percentage, the higher the cost of the fertilizer. All of these comparisons should be weighed before a decision is made.

8. Which fertilizer should be purchased? This is the typical question to be answered. In some cases the person may be knowledgeable enough to answer the questions posed and follow his own fertilization program, perhaps even using a combination of products. In many other cases, the simplest answer is to suggest using one company's product and applying it at the recommended rates and frequencies.

Other questions are often raised as well. Should a micronutrient (such as iron) be included? What about lime? What about fertilizing under shade conditions? Should a fertilizer-pesticide product be used? How should it be applied to be safe from burning? Answers to these questions can be provided through knowledge of local soil and environmental conditions. Your Cooperative Extension Service representative should be able to provide this information for you.

Current Herbicide Recommendations

J. A. TWEEDY

The best preventive measures for controlling weeds in lawns are to use adapted grasses and to fertilize adequately to maintain a dense turf that provides good cover and competition for weeds.

Weeds can be separated into different categories for specific herbicide recommendations. One category includes the easy-to-kill broadleaf weeds controlled with 2,4-D amine. Included in this category are weeds such as dandelion, plantain, pigweed, shepherd's purse, and curled dock. Wild onion and wild garlic are more difficult to control and the 2,4-D ester is recommended. Always caution homeowners about 2,4-D ester and the danger of volitalization to nearby shrubs and garden plants. The addition of a tablespoon of surfactant or dishwashing detergent may increase the effectiveness of this herbicide on onions and garlic.

Several broadleaf weeds are not adequately controlled with 2,4-D amine and require the use of 2,4,5-TP (silvex). Included in this list are such weeds as black medic, common and mouse-ear chickweed, ground ivy, henbit, prostrate knotweed, red sorrel, round-leaved mallow, white clover, and others. MCPP or dicamba may give better control of the chickweed, ground ivy, prostrate knotweed, and white clover. Be especially careful to follow instructions with dicamba because shrub and tree injury may result if too much material is applied to the soil surface.

There are several good preemergence grass killers for controlling grasses such as crabgrass, fall panicum, and yellow foxtail in established Kentucky bluegrass. Included in this list are Dacthal, Balan, Bandane, Betasan, Azak, Tupersan, and calcium arsenate. Of this group, only Tupersan is recommended for use at the time of seeding or immediately after seeding Kentucky bluegrass.

The organic arsenicals DSMA and AMA give fair to good postemergence control of grasses such as crabgrass, fall panicum, goosegrass, and yellow foxtail. These materials may give some control of nutgrass, but one usually can expect poor control. These materials should be applied in two to three applications at seven- to ten-day intervals.

There are no selective herbicides for the control of quackgrass or tall fescue in a Kentucky bluegrass lawn. If these weeds are not too dense, one may spot treat with dalapon, however this herbicide is not selective and will kill Kentucky bluegrass.

One problem often encountered by personnel at lawn and garden centers involves the mixtures of fertilizer, herbicide, insecticide, and fungicide or combinations of the above materials. These mixtures are sold under a trade name. The problem encountered is that the specific chemicals, for example the herbicide, may be changed without a change in the trade name. Check the label for ingredients to be certain that the materials recommended in the past are the same. A good reference book which may be helpful is "Pesticide Handbook--Entoma" from Pennsylvania State University at State College, Pennsylvania. This book is revised each year and gives a complete listing of pesticide products by trade name and the active ingredients.

Seed—the Thread of Life

R. C. NEWMAN

A seed is essentially a young plant (embryo) arrested in its development. It consists of a young root, a young shoot, one or more seed leaves, and a source of stored food surrounded by a seed coat. The seed coat protects the rudimentary plant against drying, mechanical injury and, to some degree, against insects, bacteria, and fungi.

Seed formation begins with formation of stamens and pistils in the flower bud of the parent plant or plants. Special cells of the ovule develop into embryo-sac mother cells, and special cells of the anther develop into pollen mother cells. These mother cells divide by a process known as meiosis, and the resulting daughter cells receive one-half the number of chromosomes characteristic of the species. The opening of the flower signals sexual maturity, and pollination occurs at this time. Pollen from the anthers is transferred by various means to the pistil, where a pollen grain germinates and forms a pollen tube that grows down the pistil.

Fertilization of the egg and polar nuclei by the sperm nuclei restores the double or diploid chromosome number in the new embryo. The embryo grows by cell division and differentiation into a rudimentary plant. Fusion of the polar nuclei and sperm nuclei results in the development of endosperm (stored food) in grasses. When seed is mature, enlargement of the embryo ceases, seed structures become dry, and the seed becomes a dormant, living organism prepared to withstand adverse conditions. Seed is the end product of flowering, a resting embryo that started as a single cell, with a supply of stored food and surrounded by a seed coat.

Most grass seeds are of similar structure with a relatively small embryo and large endosperm surrounded by the seed coat. The embryo lies on one side of the seed, often in an oval depression. The endosperm, or stored food, consists mainly of carbohydrates and proteins. The protein is primarily found in a narrow single layer of cells around the outside of the endosperm, called the aleurone layer. Most of the endosperm is made up of starch. The embryo of grasses consists of the rudimentary plant and various protective structures. The young root lies within a sheath known as the coleorhiza, and the first foliage leaf is protected by a modified leaf known as the coleoptile. A seed leaf, known as the scutellum, lies in contact with the endosperm. When germination begins, enzymes secreted by the scutellum digest the stored food of the endosperm, and these foods are transferred to the developing seedling.

Seed germination is the resumption of growth and development of the embryo or seedling. Water, oxygen, and a favorable temperature are necessary for germination to begin. Water is absorbed by the seed coat, embryo, and endosperm. Water softens the seedcoat, and the swelling embryo and endosperm burst it. Oxygen dissolved in water enters the seed. Water dilutes the protoplasm and life processes such as digestion, respiration, assimilation and growth are ready to begin. The digested stored food of the endosperm moves to the actively growing parts of the embryo, the roots, and shoot.

The root is the first organ to visibly grow. It grows down through the protective coleorhiza, sends out branches and root hairs, and attaches the seedling plant to the soil. The coleoptile grows upward to the soil surface, where its tip splits open and allows the first foliage leaf to expand.

The developing seedling is entirely dependent on food stored within the seed for some while after germinating. As roots and leaves develop, it becomes a self-sufficient plant, no longer dependent upon stored food in the seed. Upon reaching a certain size and age, and meeting other requirements, the plant flowers and, in turn, produces seed--the thread of life.

The viability or capacity of seeds to germinate and produce vigorous seedlings that will grow into adult plants depends on several factors, which include:

1. Vigor of the parent plant
2. Environmental conditions during seed development
3. Maturity of seeds
4. Storage temperature and humidity
5. Age of the seed

Highest quality seed is produced by vigorous parent plants. Relatively dry, cool conditions favor seed development. Mature seeds have larger embryos and endosperms than immature seed. Cool, low-humidity storage conditions favor seed viability. Old seed generally lacks the vigor of young seed, as there is a general loss of vitality with time.

It is impossible to tell the germination of seed by its size, weight, or external appearance. Standard germination tests have been developed to accurately measure seed viability, and the germination appears on the seed label.

The seed label or tag is one of the most important sources of seed information. The tag states the kind of seed, the variety, purity, and germination. Multiplying purity percentage by germination percentages gives the percentage of pure live seeds within the container. Certification is the guarantee of genetic purity.

Current Fungicide Recommendations

M. C. SHURTLEFF and J. D. BUTLER

Disease	RPD No.[a]	Fungicide	Ounces per 1,000 sq. ft.	Timing and remarks
Snow molds (typhula blight, snow scald, or gray snow mold; pink snow mold or fusarium patch)	404	Tersan OM	6-8	Apply dry, as sprays, or mixed with a granular fertilizer to problem lawn or fine turf areas just before first heavy snow or cold, drizzly weather is forecast in late fall. Reapply 1 to 3 times during winter or early spring as snow melts. Follow manufacturer's directions carefully. Follow recommended fertilizer program for your area and type of grass. Keep phosphate levels up. Do not apply fertilizers high in nitrogen after about September 15. Use lime only when needed. Mow frequently and at recommended height. Keep down thatch. Increase air cirulation by pruning or removing dense trees and shrubs. Under severe conditions mercury compounds have given good control.
		Ortho Lawn and Turf Fungicide	4-6	
		Phenyl mercury[b]	See label	
		Panogen Turf Fungicide	3	
		Mercury chlorides[c]	2-4	
		Calo-Clor, Calo-Gran	See label	
		Cadmium compounds[d]	See label	
		Phenyl mercury + cadmium	See label	
		Acti-dione-Thiram	6-8	
Helminthosporium (leaf, crown, and root disease complex), Melting-out	405	Dyrene	6-8	Fungicides are best applied on regular, protective schedule. For cool weather group, begin in early spring when first leaves are formed. Continue at 1- to 2-week intervals until warm, dry weather. For warm to hot weather group, begin in mid-May (So. Ill.) to mid-June (No. Ill.). Continue weekly or more often during moist weather. Disease is usually checked in home lawns by mowing at recommended maximum height, collecting clippings, keeping down thatch, avoiding over-watering and frequent sprinkling, fertilizing according to recommended program, watering seldom but deeply, increasing air circulation, growing resistant grasses, etc. See RPD No. 405. Fungicides are not generally recommended to control these diseases in home lawns.
		Ortho Lawn and Turf Fungicide	4-6	
		Acti-dione-Thiram	2-4	
		Zineb[e] or Maneb[f]	2-4	
		Daconil 2787	4	
		Panogen Turf Fungicide	1½-3	

Disease	RPD No.[a]	Fungicide	Ounces per 1,000 sq. ft.	Timing and remarks
Sclerotinia dollar spot, small brown patch	407	Cadmium compound	See label	Apply in spring, early summer, and fall when temperatures average between 60° and 85° F. Cadmium materials last longest, but cadmium-resistant strains of the dollar spot fungus are now appearing. Switch to a different type of fungicide. Use same cultural practices as for Helminthosporium and brown patch. Follow manufacturer's directions.
		Kromad, Kroma-Clor, Ultra-Clor	3-4	
		Dyrene	4-6	
		Phenyl mercury	See label	
		Ortho Lawn and Turf Fungicide	4-6	
		Acti-dione-Thiram	2-4	
		Mercury chlorides	See label	
		Panogen Turf Fungicide	1½-3	
		Tersan OM	4-6	
		Thiram[g]	2-4	
		Daconil 2787	2-4	
		Benlate[h]	1-4	
Brown patch, rhizoctonia disease (mostly bentgrass and overwatered turf)		Mercury chlorides	See label	Apply weekly in hot, moist weather. Avoid overwatering--especially in the evening--frequent sprinkling, and over-fertilizing with quickly available, high-nitrogen fertilizer. Increase air movement by pruning dense trees and shrubs. Reduce shade. Remove dew from golf greens early in morning. Disease is most severe when evening temperatures remain above 70° F.
		Ortho Lawn and Turf Fungicide	4-6	
		Panogen Turf Fungicide	1½-3	
		Dyrene	4-6	
		Thiram or Maneb	3-5	
		Tersan OM	4-6	
		Mercury chlorides + Thiram	See label	
		Daconil 2787	2-4	
		Benlate	1-4	
Powdery mildew (primarily bluegrass)	406	Karathane WD	½-½	Several applications are needed, 7 to 10 days apart, in spring and fall when days are warm and nights cool. Most serious in shady, damp locations. Affected turf may winter-kill. Reduce shading and improve air movement, or grow shade-tolerant grass or ground cover. Bluegrass varieties differ greatly in resistance.
		Acti-dione-Thiram	2-4	
		Benlate	1-3	
Rusts (primarily bluegrass, especially Merion, and ryegrass)		Acti-dione-Thiram	2-4	Make 3 weekly applications when grass is growing slowly. Water and fertilize enough during late summer to keep grass growing steadily and to keep rust from becoming a serious problem. Follow manufacturer's directions carefully. Collect clippings. Bluegrass varieties differ greatly in resistance.
		Zineb, Maneb, or Thiram	2-4	
		Dyrene	4-6	
		Daconil 2787	2-4	
		Ortho Lawn and Turf Fungicide	4-6	
Fusarium blight (mostly bluegrasses, especially Merion; red fescues, bentgrasses, and ryegrass)		Maneb (Fore)	4-6	Fusarium is most prevalent during hot, humid weather in full sun on thick turf grown under high nitrogen or deficient calcium levels. Avoid thatch. Water thoroughly during drouths. Fungicides have given erratic control, but they are ineffective without good management.
		Tersan OM	6-8	
		Dyrene	6-8	

Disease	RPD No.[a/]	Fungicide	Ounces per 1,000 sq. ft.	Timing and remarks
Pythium blight, grease spot, spot blight (primarily bentgrass)		Koban Dexon	See label 4-6	Follow manufacturer's recommendations carefully. Alternate with regular fungicide program in hot, wet weather. Same cultural practices as for brown patch and helminthosporium (both above). When pythium is active, do not mow, water, or walk on affected turf before spraying. Keep turf surface as dry as possible.
Stripe and flag smuts		Benlate	6-12	Apply several soil drenches (50 gallons of water per 1,000 sq. ft.) at 2- to 4-week intervals in spring or fall. Carefully follow manufacturer's directions. Certain varieties of Kentucky bluegrass and creeping bentgrass are highly resistant or immune; other varieties are very susceptible.
Seed rot, damping-off, seedling blights		Zineb, Thiram, Captan, Difolatan, Kroma-Clor or Daconil 2787 Ortho Lawn and Turf Fungicide (add 2 ounces of Koban or Demosan to control water molds)	2-4 4	Apply as seedbed spray (in 5 to 10 gallons of water) after planting. Repeat if damping-off starts. Avoid over-watering, poor soil drainage, and low spots. Sow top-quality seed of permanent grasses (treated with Captan or Thiram) in well-prepared, fertile seedbed. Special turf areas are sometimes fumigated before planting. See University of Illinois Circular 893, Revised, "Soil Disinfestation Methods and Materials," for details. Methyl bromide, SMDC (Vapam, VPM), MIT (Vorlex), Chloropicrin, etc., are often used.
Fairy rings	403	(Lifting sod and fumigating soil underneath with methyl bromide or formaldehyde gives the only lasting chemical control)		Fungicides are not generally recommended. Usually best to suppress symptoms by pumping large quantities of water 10 to 24 inches deep into the soil, at 1-foot intervals just inside ring of dead grass. Use tree-feeding lance or root feeder attached to garden hose. Keep turf well watered and fertilized. See RPD No. 403 for treatment details.
Nematodes	1100	DBCP (Nemagon or Fumazone) (available as granules, dusts, wettable powders, emulsions, and mixed with fertilizers)	See label	First determine whether you have a nematode problem. Read RPD No. 1100, "Instructions for Collecting and Shipping Soil Samples for Nematode Determination." Identification and counting should be done by a competent nematologist in a well-equipped laboratory. Test chemical first on a small area.

Disease	RPD No.[a/]	Fungicide	Ounces per 1,000 sq. ft.	Timing and remarks
Slime molds	401	Same fungicides as for Helminthosporium where practical		These molds are non-parasitic and will soon disappear, often before fungicide can be applied. Mow, wash, brush, or rake away. They follow rainy periods or heavy watering and do no harm.
Algae or green scum		Maneb, Thiram, Zineb	2-4	Aerify, fertilize, provide for good soil drainage. Reduce shade and compaction where possible. Keep turf growing vigorously. Same cultural practices as for brown patch.

a/ RPD = Report on Plant Diseases. General reference: NC Regional Extension Pub. No. 12, "Lawn Diseases in the Midwest." For copies of 1969 edition, write to Department of Plant Pathology, 218 Mumford Hall, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801.

b/ Phenyl mercury is sold as PMAS, Tag Fungicide, Linck's 10% PMA Turf Fungicide, Metasol 10, Liquiphene Turf Fungicide, Puraturf 10, Phenmad Turf Fungicide, etc.

c/ Mercury chlorides mixtures are sold as Calo-clor, Calocure, Woodridge Mixture "21," Fungchex, Calo-Gran, Turf Tox MC, etc.

d/ Cadmium compounds are sold as Cadminate, Caddy, Vi-Cad, Puraturf 177, Cad-trete, etc.

e/ Zineb is sold as Dithane Z-78, Parzate C Zineb Fungicide, Pearson's Super-Fungicide Wettable Powder, etc.

f/ Maneb is sold as Manzate D Maneb Fungicide, Dithane M-45 and M-22 Special, Fore, Manzate 200, Pratt Lawn and Garden Fungicide, etc.

g/ Thiram is sold as Tersan 75, Thiban, Spotrete, Thiramad, Thiramad Plus, Thiuram-75, Turf Tox, etc.

h/ Benlate will be recommended when cleared by federal agencies.

Handling Sod for Maximum Returns

LEROY MUELLER

I wonder whether I am the "right" or the "wrong" man to speak on the subject of "handling sod for maximum returns in the field of retailers and garden centers." If I were addressing people in the turf-growing industry, this presentation could have been stimulating and might have made a few faces grimace in pain. But one cannot always have things fall into place as one would want them, so I will do my best to point out some of the observations I have made in this area.

I think we ought to begin with quality control--it plays such a very important part and is a difficult problem in any field. Generally, retailers will agree that it is imperative to handle the best possible product available. One can always command a better price with top-quality goods because of their appeal to the consumer. Because of the advertising of major seed and grass companies in the area the consumer has become more sophisticated and intelligent in these purchases. This alone would dictate that the retailer carry greater selections of quality turf at his place of business. Again I would stress quality because so many sales and repeat sales depend upon customer satisfaction. I would suggest a sample display of four or five varieties of turf that would be well manicured at all times and with signs designating each species. A picture or display can speak thousands of words, saving your breath and your valuable time.

Part of the success formula in retailing sod is the ability to maintain a fresh supply of turf at all times.

You, no doubt, have seen a customer come into a place of business where a trailer load of sod is on display and immediately unroll one of the pieces; he looks at it and expresses a desire to purchase if the color is dark green and the roll is not warm or hot to the touch of the hand. And you have also seen a customer walk away from a warm load of sod or a discolored two- or three-day-old delivery.

Quality control is difficult to maintain unless sales are in such volume that new supplies can be brought in at close intervals. One big factor in helping the retailer maintain freshness and quality is to have a supplier as close as possible. The less distance between supplier and retailer, the less risk of any damage to the turf. Purchasing your product from people dedicated to the industry and people of integrity and unquestionable character will help you maintain quality control.

Also demand that the sod you purchase be cut the same day it is delivered and take a good look at the equipment that is bringing in your product. Ask yourself, "What are the chances of a breakdown or a delay in delivery?" In the summer, delays in deliveries can play havoc with quality control and customer patience. I would also inspect the fields of the supplier with a critical eye to determine the quality of the product he produces and the mode of operation.

The location of one's garden center is of prime importance; being situated in a prime growing area easily accessible to the public is very beneficial. If you are situated near vital expressways your sales opportunities multiply greatly. I know of one garden center with all of the desirable assets just mentioned that grew from minimal volume to sales of four and five trailer loads of sod per day. Of course, these people also had the drive, desire, and sales ability to succeed. They also had a motto "we try a little harder" and lived up to it. We all know that desire is a motivating force in any line of endeavor and to succeed it is essential that desire and the acceptance of responsibility be undertaken.

Another great factor in the success of making a business prosper is advertising. We have been told again and again by advertising experts that we have a "strong built-in appeal" in turf: its color, its beauty, its cooling effect around the home in summer, its effectiveness as a sound absorber (so apparent in parks and forests), and the added value it lends to the premises not only in beauty but in an economical sense. But what do some of the people selling this merchandise do? They advertise the price of a yard of sod, letting

the customer figure out, if he can, when and how to use it. Sometimes the customer spends money to put in his lawn wondering if he is doing the right thing. But when that same person runs across an advertisement of a power tool or lawn mower he is told in great detail what it will do for him and how easily. The customer pays for this purchase feeling totally assured the sale was warranted.

We generally look at our competitors and say if it wasn't for that so and so I'd be sitting pretty, but that just isn't the truth. It's the fellow down the street selling well-advertised, well-known merchandise (power tools, furniture, etc.) who is your biggest competitor; he is getting your customers' dollars that could have been spent on turf.

Knowing your product, what it will do, how it performs under all conditions is very important in sales. A knowledgeable man in turf can answer nearly all questions put to him by the homeowner, thereby building confidence and prestige. You, as a knowledgeable man in turf, will build your own image as time goes on.

There are many facts about turf that can be passed along to the customer. Let's tell the homeowner about the difference in high-maintenance grasses and low-maintenance grasses. It may well be that the customer is the lazy type and will only water his lawn when it rains and fertilize only once in the spring. Well, to sell him a high-maintenance lawn or grass would be a disaster. Or your customer might be the green-thumb type who wants the best looking lawn in the neighborhood; so you naturally would want him to have one of the high-maintenance types.

We can only pass along the information we have, so why don't we take a look at four or five good varieties of grass and make comparisons.

Merion is considered to be a high-maintenance grass, beautiful in color when properly fertilized; much more resistant to helminthosporium leaf spot or melting out. When properly managed Merion forms an attractive, dense, vigorous turf highly resistant to weed invasion and capable of withstanding moderate wear. A major weakness of Merion is its susceptibility to stripe smut. Since it is highly susceptible to powdery mildew, it should not be used in heavily shaded areas. It is susceptible to stem rust and is associated with turf weakness caused by high temperatures. It also has a thatch problem. Merion requires high fertilization and should have at least 3/4 to 1 inch of water per week.

Fylking, developed in Sweden, is showing considerable promise. It develops an attractive, dense, low-growing turf of moderately fine leaves. It maintains a leafy, high-quality turf during seedhead setting in late spring when other varieties become very stemmy. It tolerates close mowing to 3/4 inch. It develops an attractive, rich, dark green color in early spring, and keeps its color well into late fall and under moderately adverse growing conditions such as low fertility and incipient drouth. It also is moderately susceptible to stem rust and powdery mildew. Fylking is the only commercially available variety that has demonstrated good resistance to stripe smut and leaf spot.

Windsor is a moderately low-growing, dark green bluegrass which can produce a rather attractive turf under favorable conditions. It has moderate susceptibility to leaf spot, powdery mildew, and rust and is reported to be susceptible to stripe smut. Color during late fall is often poor because of orange leaf tips. On the plus side, Windsor forms a dense heavy carpet (even more so than Merion) with less fertilization. It also responds readily to treatment for leaf spot with a fungicide.

Delta or common Kentucky bluegrass is fairly resistant to stem rust and powdery mildew; it has shown moderately good survival and recovery from drouth compared with the high-maintenance varieties. It is highly susceptible to helminthosporium leaf spot. It does not have the density of most other types.

Warrens A-10 is a dark green variety with moderately fine leaves. It does quite well in high temperatures. A-20 appears to have good resistance to leaf spot. A-10 is moderately susceptible to helminthosporium leaf spot.

There are other varieties, as you well know, but they are not commonly used in the Chicago area.

While you are giving your customer all this information you might add that it is much easier to get a lawn started by sodding than it is by seeding and, of course, it is much faster.

Handling sod for maximum returns could be explained in one short sentence. Handle it in volume with low overhead.

In closing, I would like to quote Senator Ingalis of Kansas:

"Grass is the forgiveness of nature. . .her constant benediction. Fields trampled with battle, saturated with blood, torn with ruts of cannon, grow green again with grass, and carnage is forgotten. Streets abandoned by traffic become grass grown, like rural lanes, and are obliterated. It bears no blazonry of bloom to charm the senses with fragrance or splendor, but its homely hue is more enchanting than the lily or the rose. Forests decay, harvests perish, flowers vanish, but grass is immortal."

General Session

A Turf Supplier's Problems

AL LINKOGLE SR.

Back in the early 1930's I was asked to take over as superintendent of a private golf course in the St. Louis area. I knew very little about golf course turf, but was raised on a farm and had worked a little with a landscape architect. I took this job with the agreement that I could attend every turf conference to learn what I could about turf. I also worked very closely with the greens section of which Dr. John Montieth was then in charge, and O. J. Noer of the Milwaukee Sewerage Commission.

One of the first things I did was lay out a turf experiment area at the suggestion of Dr. Montieth. I was then able to experiment with some of the newer grasses that Dr. Montieth thought might have possibilities in the St. Louis area. Back in the early 1930's we had very few chemical weed controllers and did not know too much about fertilizers. So some of the first grasses he sent were some of the zoysias and bermudas along with some fescues and bluegrasses. Some testing was done on the golf course and I had some property next to the golf course of my own, where I did most of the testing.

In the early 1950's I decided to go into the supply business. Many small town clubs contacted me. They wanted a golf course or had sand greens and wanted to change over to grass, but could not raise much money. We would have them see how much money they could raise and then show them what type of course they could expect. We would also provide supervision of the course if they could not afford a superintendent; to date we have designed or redesigned over 80 golf courses.

After several years of testing we lost most of our bermudas, except the U-3 strain, so to continue our test we planted a U-3 bermuda tee on a course. After having this tee in play several years, we planted about 1 acre into one of the fairways. Our club members and members from other clubs were so enthused about this turf that I was asked how to introduce it into our present bluegrass fairways without interrupting play. We started testing different methods of introducing it into fairways. Finally we came up with a sprigging machine that I had made that seemed to be the best method. This caused very little interference with golfing. All of the private country clubs in the area changed to U-3 bermuda on fairway and tees. This worked out very well, but after 3 or 4 years we ran into spring dead spot problems. Every spring we had more and more dead spots with Poa annua. The superintendents and golfers were a little disgusted with bermuda, but we were still working with the zoysias. We found that on some of the tees that were partially shaded, bermuda did not do too well, but zoysia did a lot better.

More recently we started to think of zoysias for fairways, and tried the same methods of planting. Here we ran into a little trouble. We found that sprigging zoysia was quite a bit different from sprigging bermuda. With bermuda we could sprig a whole fairway, and then apply water. With zoysia, unless we sprigged small areas, and then applied water, it did not work. By not getting water to the zoysia stolons within 1 hour after sprigging we lost most of our sprigs, so we discarded this method.

Plugs worked out much better, but there was the labor cost and with the shortage in labor, this was prohibitive. A check of different plugging machines proved them to be too slow. I revamped our sprigging machine so that we could plant plugs. This has worked out very well.

We have tried out different methods of cutting plugs. The best machine we came up with was a West Point VC-20 from which we removed the basket. We then cut part of the shield in the rear so the clippings could get out. Then we removed the 6 hp. motor, put on an 8 hp. motor and spaced the blades 2 1/4 inches apart. We have sold thousands of West Point pluggers which cut 2 3/8-inch round plugs. So by cutting out plugs 2 1/4 inches square, they squeeze into a 2 3/8-inch round hole very well. This pretty well solved our problem

of cost of cutting plugs. We would take this machine and precut our plugs both ways several weeks ahead and as orders came in we would take our sod cutter and cut under the plugs. On large orders we shovel them into trucks for delivery. For small retail orders we made collapsible cardboard cartons that hold 100 plugs. This has solved our labor problem, with one man cutting and packing 10,000 plugs per day.

Another problem we ran into, especially with the country clubs that have bermuda, was whether zoysia would take over the bermuda. It will under proper maintenance.

Zoysia, as you may know, has a longer growing season than bermuda and starts growth earlier in the season. If you are going to plant zoysia plugs into bermuda then you should feed zoysia extra early with a complete fertilizer. In St. Louis this would be the first part of April. Do not feed during July and August when bermuda is making its best growth. I have plugged zoysia into heavy bermuda turf, planting plugs 3 feet apart, and in 5 years zoysia has taken over completely. With 1-foot centers you can do the same in 3 years.

Producing Quality Sod

B. O. WARREN

The subject of producing quality sod has been discussed before, and I believe most of us are aware of the various practices that enter into such production. However, I would like to call attention to some of the situations that are departures from normal that have arisen over the years at our various locations.

We have encountered a wide variety of soil types and, excepting rocky and gravelly soil, have managed to produce a satisfactory crop on most of them. Extremes in the pH level have been encountered which require special treatment. We have small areas with soil reactions as low pH 3. These are quickly corrected with limestone, although amounts needed can be large. Our experiences at the other end of the pH scale are much more complicated and difficult to control. In California, we have localized areas of saline-alkaline soils that require applications of 18 to 20 tons of gypsum per acre and up to 100 inches of leaching water to correct.

More serious than these soil conditions are the presence of certain plant and animal contaminants existing in the soil. Such plants as quack, creeping bent, Poa annua, nimblewill, bermuda, and under some conditions bluegrass can require special and sometimes expensive treatment to enable one to produce quality grass.

There are pests that do no appreciable damage to the sod we raise, but it is necessary for freedom of shipment to control them. In New York, Ohio, and Indiana we must use controlling chemicals for Japanese beetles and cereal leaf beetles, although neither do any recognizable damage to grass.

In this respect, California presents some conditions that we find in no other places. To have freedom of shipment in all parts of the state, we must satisfy the authorities that we are free of certain noxious nematodes. To date these have not been found by lab examination. If these are ever introduced, we will be forced to undertake expensive treatments. These are not grass parasites, but can be translocated by sod.

A major contributing factor to the quality of sod is the strain of grass used in producing it. For some time deciding what varieties to grow has been relatively easy. In most of our market areas Merion has been the number one seller, and a large percentage of our acreage has been planted to this grass. This situation is rapidly changing.

Ten years ago the weaknesses in Merion had become very apparent and it seemed highly unlikely that it would go on forever unchallenged in its superiority. At that time our company made the decision to undertake an extensive varietal selection and evaluation program. Out of this work have come A-20, A-34, and A-10 which we believe to be superior to other strains available. We are rapidly shifting our production to these varieties. An innovation of the last several years has been the vegetative planting of bluegrasses. This has become necessary because some of our new selections are not reproduced true to type from seed. We are finding several other advantages in this method.

Our mowing, fertilizing, irrigation, and weed control practices are more or less conventional. Most of our mowing is done by either Roseman or Ransome gang units ranging from 3 to 13 units per gang. Fertilizing is based on soil tests and accomplished by broadcast spreaders using granulated or pelletized material. Irrigation is a combination of 2-inch by 3-inch solid set and 4-inch hand- and wheel-moved laterals. Weed control is accomplished with 2,4-D and dicamba with attendant complications of avoiding injury to neighboring soybean fields.

Producing quality sod includes getting it to its final destination without any reduction in quality. Heating and pathogen incubation in loads of sod is an ever-present potential hazard except in very cool weather. The system of vacuum cooling that we use at two of our nurseries has eliminated this cause of downgraded quality.

Our aim is to produce top-quality sod, to get it to the customer in that shape, and to have it consist of the strain or strains of grass that have the best chance of being superior turf for years with a minimum of effort on the owner's part.

Selecting and Purchasing Trees for Turf Areas

M. C. CARBONNEAU

Selection of trees depends on the purpose or use of the trees in the park, golf course, institution, or industrial grounds.

Trees are used for:
Beauty: to relieve monotony, soften the landscape, or bring scale into vast spaces.
Shade: to provide shelter from the sun for a golfer, a place to go during rest periods.
Screening: eliminating road confusion, near parking lots, and around undesirable buildings or other features in the landscape.
Soundproofing: eliminating highway noises.
Windbreaks: in Illinois this is important for the golfer as well as for a quiet atmosphere in a park or on industrial or institution grounds.

TREES FOR BEAUTY

Trees for beauty or ornamental purposes are usually selected for an outstanding feature such as foliage color, fall color, flower color, fruit, or habit of growth.

Summer color. Summer greens are spectacular in large lawn areas. Varying shades help make a soft, pleasing landscape. Foliage colors such as red, yellow, silver, or variegated may be very interesting, but also distracting and should be used sparingly. It takes expertise to blend these colors into a landscape without producing distractions. Examples of these are blue spruce, sunburst locust, purple beech, and many others.

Fall color. This is probably one of the most important features of beauty for trees in large turf areas. The colors of yellow, orange, red, and brown at varying degrees from late summer to early fall produce an effect unequaled in most parts of the world. Examples of trees with excellent fall colors are sugar maples, red maples, sweet gums, oaks, gingko, ash, and tulip trees.

Flower color. Most of the trees that are hardy in Illinois flower in early spring. The flower season is short, but very often spectacular. Flowering crabs, red bud, dogwood, hawthorn, and magnolias are our major flowering trees.

Habit of growth. Tall, medium, small, weeping, narrow, columnar, and globe shape are a few ways to describe growth habit. Weeping birch, globe, Norway maple, pyramidal evergreens, and clump birch are but a few ornamental habits of growth to consider.

TREES FOR SHADE

The shade of ornamental trees is usually classed as light, medium, or dense.

Light shade will usually not interfere or compete with the growth of turf. Good examples of this are the thornless honey locusts, birch, and most of the small flowering or ornamental trees.

Medium shade may interfere with some turfgrasses, but shade-tolerant varieties will persist. Examples of such trees would be silver maples, elms, ashes, or London planes.

Dense shade trees will usually keep the soil barren under the spread of their branches. The soil is usually very dry under the canopy throughout the summer. Good examples are Norway maples, oaks, sweet gums, and hawthorns.

The changes in the landscape caused by shade can be interesting and dramatic. On a golf course this can cause blind spots or interfere with play.

TREES FOR SCREENING

Large trees with dense foliage are often used for screening or softening backgrounds. Pines and spruces are very effective for screening. Large or small deciduous trees can be used for screening, but remember that during fall, winter, and spring a complete screen will not be present.

TREES FOR SOUNDPROOFING

Various sizes, shapes, and textures of trees are effective in cutting down sounds. Vary the planting to absorb noises. Trees and shrubs in landscape plantings do this effectively.

TREES FOR WINDBREAKS

Windbreaks are important in large turf areas in Illinois. One often sees the use of Lombardy poplars for this purpose. This particular tree is a poor choice because it is susceptible to disease and is short-lived. Spruces and pines are useful for this purpose and will be useful throughout the year. It is also interesting to use some smaller trees in the foreground to add interest to the green wall.

Selection of individual trees for Illinois growing conditions:

Ash--White, green, black, red, and blue are most commonly used in Illinois. They are relatively fast growing and are not subject to major insect or disease problems.

Birch--European, yellow, river, and canoe birch are used in Illinois. They grow fast, are subject to borers, and have interesting bark.

Cork tree--(Phellodendron amurense). This tree can grow to 40 feet high and 30 feet wide. It is free of insects and diseases, and has yellow fall color.

Flowering crab--Asiatic species. Flower colors are white, pink, and red. Fruit colors are yellow, orange, and red. Spring effect is spectacular.

Flowering dogwood--Central and southern Illinois. Grow in an acid soil. Partial shade, white flowers.

Elm--Chinese (U. parvifolia), Siberian (U. panuta). Light shade, fast growth.

Ginkgo--Very slow growing, height 80 to 90 feet, exceptionally free of pests.

Goldenrain tree--Southern two-thirds of state, free of insects and diseases, 30 feet high, summer flowers.

Hackberry--Height 90 feet. Relatively free of insects, but are susceptible to witches'-broom after several years.

Hawthorn--Washington, Cockspur, or Lavell, not English. 15 to 20 feet high, 15 feet wide, white flowers, red or orange fruit in fall.

Honey locust--Thornless and podless, 60 to 70 feet high, light shade, Mimosa webworms and mites are major problems.

Junipers--Canaert and Keteleer. 30 to 40 feet high, useful as screens and windbreaks, dense growth, bagworm and spruce mites are a problem.

Linden--American, Little-leaf, Crimean. 80 to 90 feet high, 30 to 40 feet wide, relatively fast growing, excellent foliage color in summer.

Magnolias--Saucer. 30 to 40 feet high, pink flowers in spring, free of disease. Plant in well-drained soil.

Sweet bay--Southern two-thirds of state, white flowers in spring and summer, loose well-drained soil needed for good growth.

Maples--Sugar, Black, Silver, and Red. 80 to 90 feet high, fall color, rapid growth, easily established.

European mountain ash--25 to 35 feet high, white flowers in spring; orange, red, and yellow fruit in fall, good specimen.

Oak--Pin, Red, White, and Bur. Do not grow well near excavations, buildings, or heavy equipment. Good fall color.

Pine--White, Red, Austrian, and Scotch. 40 to 60 feet high, used as a windbreak or sound barrier, good screen when young, relatively free of pests.

Red bud--Rose, White. 20 feet high, 15 feet wide, southern two-thirds of Illinois, flowers spectacular in spring, susceptible to verticillium wilt and 2,4-D sprays or drifts.

Spruce--Colorado, Norway, Black Hill. 50 to 75 feet high, 25 feet wide. Dense branches, good screen or windbreak, and fast growth. Watch for spruce mite and spruce gall aphid problems.

Sweet gum--40 to 60 feet high, 30 feet wide, southern two-thirds of Illinois, good fall color, interesting habit of growth.

London plane--70 to 80 feet high, 50 feet wide, used as specimen plants, rapid growth, subject to trunk splitting in severe winters.

Tulip tree--Yellow poplar. 60 to 80 feet high, 30 to 40 feet wide, rapid growth, yellow fall color. Subject to wind damage, especially the leader growth.

Tupelo--Black Gum. 50 to 70 feet high, 30 to 40 feet wide, dense branches as specimen, excellent red fall color, good in southern two-thirds of the state, difficult to move.

Trees not recommended:

Arborvitae
Buckeye
Catalpa
Mulberry
Osage orange
Poplar
Tree of heaven
Willow

PURCHASING TREES

The size of trees and the cost of the trees will naturally determine the actual purchase. Many "bargain" collected trees are offered for sale. These are usually a poor choice because of the way in which they are handled. The top and root growth on collected trees are usually inferior to those grown in a nursery.

Purchasers very often buy on price only. When purchasing trees this is a poor bargain. Nursery plants are selections of better growing cultivars. The plants are sprayed regularly, pruned when needed, inspected for severe defects, and root-pruned prior to digging. It is better to purchase fewer good trees than a truckload of inferior ones. Planting and care the first few years is an expensive operation and should not be wasted on junk.

SIZES OF TREES AVAILABLE

Bare-root. Many trees can be moved in late fall and early spring in a bare-root condition. These are usually smaller trees of 2- to 3-inch trunk diameter. Consult the nurseryman on the advisability of moving those trees you selected "bare-root."

Balled and burlapped (B and B). Most larger trees and evergreens are moved B and B. This makes it possible to extend the planting season and also to move many plants that are difficult to move.

Peat-balled. Some nurserymen offer trees that are dug bare-root, but which have peat or other organic materials compressed about the root systems. These are usually smaller trees, 1 to 1½ inches in diameter. They are satisfactory, especially when you are doing your own planting. Peat-balled plants can be stored for several months prior to planting.

Container grown. On the west coast most trees are grown in containers. In this part of the country plants of smaller sizes are usually offered for sale in containers. As land prices increase and labor becomes more of a problem, many plants of larger sizes will be available in larger containers. It is easy to select and plant trees grown in containers. The planting season is extended throughout the year. Many of the plants that are difficult to move can be easily used when grown in containers.

PLANTING TIMES

Many trees can be planted in both spring and fall. Some survive more readily if planted in the spring. The following indicates when it is best to plant various types of trees:

Spring planting

Beech	Goldenrain	Tulip tree
Birch	Magnolia	Willow
Dogwood	Oak	Yellowwood
Fir	Sweet gum	

Spring or fall planting

Ash	Hackberry	Maple
Flowering crab	Hawthorn	Pine
Elm	Honey locust	Spruce
Ginkgo	Linden	Sycamore
		Red bud

Grass in the Landscape

W. R. NELSON JR.

The grasses in all of our little gardens, large parks, and golf courses are part and parcel of the continuum of earth. Grasses are basic to the natural landscape--the meadow, the woodland glade, the prairie, and the seashore. From this natural landscape we have carefully selected and rejected the many varieties with which nature has so abundantly blessed this earth.

As a result of this process of selection, it became apparent that one grass differs from another in vigor, texture, and color. One is vulgar and another patrician. Some varieties are useful. Some are beautiful. Others combine utility and ornament. For example, swamp grass is the low born. Timothy is a valuable servant, redtop and clover are a degree higher in the social scale. But in the final analysis in the northern United States the bluegrasses, bents, and fescues hold the greatest potential for utility and beauty in the man-made landscape.

Grass is just one of the materials used to create useful space for people to live and play in, yet the role of grass is more than just a ground cover. Grasses produce a unity by tying together a number of diverse objects and masses. Grass can be a satisfactory part of the landscape as long as the proportions and forms of the space are good.

There is a further dichotomy in the way grasses are used. They may be used merely for utility, that is, in the simplest and most obvious manner; or they may be used entirely for beauty so as to produce a maximum esthetic effect. Between these two distinct uses, there are a number of varying combinations of the two that result from the intended function and use of the area. For example, grass selection for use in protecting the soil, in covering our playing fields, in enhancing our highways, and in beautifying our home grounds will be combinations of these two divisions.

Although our concern in landscape design is primarily for grasses with strong esthetic qualities like bluegrasses, bents, and fescues, the serviceability of the grass for its intended use cannot be ignored. Each of these groups of grasses have varying degrees of utility, so let us first consider the major landscape developments in which they might be used.

In parks and on playgrounds comfort, health, and beauty are the basic requirements. Grass fills the bill. Long ago we discarded the possibility of bare soil, cinders, clay, and gravel. They do not meet the requirements. But even turf has its limitations. It cannot tolerate continuous traffic and rough play. Perhaps the solution is a combination of bluegrass or tall fescue field areas, combined with concrete areas for wet weather and special types of games suited to a hard surface.

Generally speaking, the larger the area, the less the grass will be abused, particularly if we rotate the areas of hardest play over the entire area. Grass selected for the playing field should have the following characteristics: (1) The ability to develop a good root system in spite of constant defoliation, (2) good color and medium texture, (3) resistance to insects and disease, and (4) a lateral spreading quality to produce a dense mat.

The basic requirements on a golf course are a turf-covered tee for a firm stance, a relatively smooth and medium- to fine-textured fairway, an ultra-fine-textured putting surface, and general beauty. The most satisfactory grass must then meet some very special specifications for the tee, the fairway, and the putting green. One grass alone will usually not meet the needs of three unlike areas of use. Before the design of the course can be a success the characteristics of the grass used on the tees, fairways, and greens must be spelled out in detail. Then the search is made for grass that can provide the utility as well as the beauty required.

Along the highway improving the appearance, economy of maintenance, reduction of erosion, and safety are prime considerations; hence, grasses are a prime item in the development of the highway. In this case, grass selection should be divided into the use and non-use areas of the roadway. The use areas are shoulders and drainage channels which require a grass that is low, dense, closely knit turf that can exist on stabilized soil, withstand reasonable wear, and withstand the force of drainage runoff. In non-use areas the primary purpose of the cover is to prevent erosion. In this case there is a wider variety of grasses from low-growing to taller types. In this area mowing should not be done. The natural sequence of growth is interesting and constantly changing, which gives much needed visual relief and can even reduce monotony to an extent. In my judgment it is not a good idea to attempt to keep our highways as well manicured as the front lawns of our homes.

On the home grounds nothing will ever take the place of green mowed turf. Here the requirements are fine texture, good color, and beauty, along with no weeds, insects, or diseases. One thing hasn't changed and probably never will. Even with new paving materials or other low-maintenance landscape schemes, nothing will divert the homeowner from having his lawn. The major problem is teaching the homeowner that he is not mowing the country club green or fertilizing 160 acres. In spite of the homeowner's mismanagement, grass usually survives.

Having considered the major developments in which our grasses are used and a few requirements the turf must meet, it is now logical to consider the three general principles which are basic to the use of any of these grasses for esthetic or creative purpose.

First, grasses must express their characteristics and possibilities. A grass plant is a single unit that is neither beautiful nor durable. Lawn effects are built up by repetition of a number of individual plants. This combination is really a very plastic element whose shape, line, and form are subject to control and direction. By modeling the earth's surface into earth mounds, gentle slopes, or flat planes the form of the grass is modified and changed. The shape of the grass will be controlled by the placement and outline of three-dimensional masses used to create the total space of which grass is only the floor. Finally, grasses form strong lines in design by definition of the edge outlining a planting bed or other surfaced areas.

The second principle basic to the esthetic use of grass is that grass has importance and character only in relation to other landscape materials and specific situations. It is the combination between the specific way in which grass is handled and the relations established between the other materials which determines the strength and clarity of expression of each material. It is obvious that planting a large area to the same green color, the same

texture, and with everything horizontal, is dull, static, and monotonous. But add trees, bordering shrubs, or other structures and we will add light and shadow to the surface. The lawn now becomes alive, active, and interesting. Combined with these other landscape materials, the lawn furnishes the human being with the ability to judge distance and depth by means of relative light and shade, as well as by variations in size, texture, and color. Any sunlit surface lacks in scale and interest. But the moment shadows are thrown over the surface, the interest quickens, the eye notes the space and depth relations, the pattern of shadow stimulates the imagination, and the scene benefits from the result.

Third, grasses are used, not for their own sake, but primarily to delineate space for people to use. The more subtle functions such as ground cover, erosion control, and so on, are portions of this over-all objective. Playgrounds, golf courses, highways, and home grounds are for people first and for grasses or plants second. The importance of this emphasis increases with the interest people have in the lawn. Nothing else is as soft, spongy, and resilient or so cool looking and so natural on this good earth's surface.

Therefore, grass in the landscape is something more than the broadcasting of some seed or the rolling out of some sod. It is an esthetic yet functional landscape element available to the landscape designer. The problem is to determine how to get the most out of the material--the most interesting form and shape, the most dramatic line, the greatest unifying effects, and the most pleasant human experience and satisfactions. Remember it is only one of an endless variety of materials available to create landscape space--but it is more important to the landscape and its design than we have ever given it credit.