UNIVERSITY OF ILLINOIS
DIVISION OF UNIVERSITY EXTENSION



# 5th

# ILLINOIS

# TURFGRASS CONFERENCE

# PROCEEDINGS

College of Law
Auditorium

**December 3-4,1964**





arranged and conducted by the

COLLEGE OF AGRICULTURE

with the cooperation of the

ILLINOIS TURFGRASS FOUNDATION

This conference is presented specifically for persons interested in turf management by the University of Illinois College of Agriculture. Abstracts in this manual bring to you up-to-date information required by those who wish to maintain high quality turf-grass area but do not constitute positive recommendations unless so stated. Statements made herein are the responsibility of either the speaker or the institution he represents. Reproduction and publication are permitted only with the approval of each author.

University of Illinois
Division of University Extension

# FIFTH ILLINOIS TURFGRASS CONFERENCE

December 3 and 4, 1964
Auditorium, Law Building
Urbana, Illinois

You are invited to attend the fifth educational program which is sponsored by the Illinois Turfgrass Foundation and the College of Agriculture of the University of Illinois. The purpose of this program is to provide up-to-date information for those in the turfgrass field.

Program committee

M. P. Britton
J. D. Butler
F. W. Slife

## PROGRAM

### Thursday, December 3--First Session

| | |
|---|---|
| 10:00 - 12:00 Noon | Registration |
| 11:00 - 11:30 a.m. | Illinois Turfgrass Foundation Business Meeting<br>Ted Woehrle, President |
| 11:30 - 1:15 p.m. | Lunch |

### Thursday, December 3--Second Session

Moderator - Roy Nelson, Homewood, Illinois

| | |
|---|---|
| 1:15 - 1:20 p.m. | Welcome - Dean K. E. Gardner |
| 1:20 - 1:40 p.m. | Important Turf Diseases<br>M. P. Britton<br>University of Illinois |
| 1:40 - 2:15 p.m. | Water Movement<br>T. D. Hinesly<br>University of Illinois |
| 2:15 - 2:35 p.m. | Use of Annual Plants<br>G. M. Fosler<br>University of Illinois |

Thursday, December 3--Second Session (continued)

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|---|---|
| 2:35 - 3:00 p.m. | Root Development<br>C. W. Lobenstein<br>Southern Illinois University |
| 3:00 - 3:15 p.m. | Break |

Moderator - Bob Johnson, Orland Park, Illinois

| | |
|---|---|
| 3:15 - 3:35 p.m. | Fungicides and Turf Disease Control<br>J. D. Butler<br>University of Illinois |
| 3:35 - 4:20 p.m. | Maintenance Calendar for Shrubs and Trees<br>J. B. Gartner<br>University of Illinois |
| 4:20 - 4:40 p.m. | The Golf Course of Tomorrow<br>W. R. Nelson<br>University of Illinois |
| 6:30 p.m. | Banquet--314 Illini Union |

Friday, December 4--Third Session

Moderator - John Vaughan, Chicago, Illinois

| | |
|---|---|
| 8:30 - 8:40 a.m. | Briefs<br>Ted Woehrle and others<br>Chicago, Illinois |
| 8:40 - 9:00 a.m. | Weed Control<br>Dr. F. W. Slife<br>University of Illinois |
| 9:00 - 9:25 a.m. | Plant Diseases--An Illustration<br>M. J. Healy<br>University of Illinois |
| 9:25 - 10:00 a.m. | Agricultural Chemical Use on the Golf Course<br>J. L. Holmes<br>Chicago, Illinois |
| 10:00 - 10:15 a.m. | Break |

Friday, December 4--Fourth Session

Moderator - Walt Breakman, Lafayette, Illinois

| | |
|---|---|
| 10:15 - 10:35 a.m. | Turfgrass Testing<br><br>T. Gaskin<br>Chicago, Illinois |
| 10:35 - 11:00 a.m. | How A Plant Grows<br><br>T. K. Hodges<br>University of Illinois |
| 11:00 - 11:45 a.m. | How to Recognize Quality Turfgrass Seed<br><br>Dr. Norman Goetze<br>Oregon State University |
| 11:45 a.m. | Adjourn |

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# Some Important Turf Diseases

M. P. Britton

## Fusarium Blight

Recent investigations by workers at Pennsylvania and elsewhere have shown that the fungus Fusarium roseum is capable of infecting Kentucky bluegrass, bentgrass and red fescue. Under favorable conditions of temperature, moisture and soil fertility, susceptible grasses may be rapidly killed. The killing out of entire stands of turfgrass within one week has been reported. In Illinois the disease has been observed only on Kentucky bluegrass.

Fusarium blight is reportedly most severe when the turf is grown under high nitrogen fertility or deficient calcium levels. Observations in Illinois tend to confirm that the disease appears to be most prevalent on well fertilized lawns. It usually occurs during hot, humid weather in July and August.

In Kentucky bluegrass lawns, the disease commonly occures in circular patches, rings or partial rings varying from a few inches to over two feet in diameter. Characteristically the grass leaves in these areas are light yellow-green at first but rapidly become light tan as they are killed. An examination of the crowns, roots and rhizomes during this period reveals an extensive rot of these structures.

Although a number of different fungi have been isolated from these diseased plants, Fusarium roseum was the one most frequently obtained. Inoculation studies have shown that F. roseum is capable of causing a severe blighting of the leaves of Kentucky bluegrass, bentgrass and red fescue. However, rotting of the crowns, roots, stolons and rhizomes has not been reproduced by artificial inoculation with this fungus. The research reports certainly show that Fusarium roseum is important in this disease and future research may show that is is the only pathogen involved.

Some control of the disease has been obtained with the fungicide Dithane M-45.

## Helminthosporium Leaf Spot Diseases of Bentgrass

Two species of fungi in the genus Helminthosporium commonly cause leaf spot diseases of bentgrasses in Illinois.

Helminthosporium erythrospilum Drechsler is the cause of "red leaf spot." The leaf spots caused by this fungus are straw colored in the center and are surrounded by a margin of reddish-brown. Occasionally the straw-colored centers are absent and only the reddish-brown discoloration is apparent. Individual spots are nearly circular but irregular shaped areas are formed when several spots run together. Infected leaves usually turn light green and then yellow before they wither and die. Infected areas can be readily seen by the yellowish cast these diseased leaves impart to the turf. Red leaf spot occurs most commonly in late April and May but may also be active in October and November. In the studies in Illinois this fungus has not been isolated from bentgrass during June, July, August or September. This disease has been adequately controlled with 2-3 applications of zineb at a rate of 2-4 ounces per 1000 sq. ft.

The second disease called "Helminthosporium leaf spot" is caused by the fungus Helminthosporium sorokinianum Sacc. ex Sorokin (Synonym H. sativum P.K. & B.). The leaf spots caused by this fungus first appear as minute water soaked areas that develop into a small, circular, brown spot surrounded by a yellowed zone of leaf tissue. This yellowed zone later turns dark brown and the central brown area becomes tan. Leaf spots may be so numerous that the leaves wilt and die causing a thinning of the turf. Under extremely hot wet conditions infections may result in a blighting of the leaves without the formation of typical leaf spots. This blighting involves the entire leaf and is first evident by a wilting of the leaves, even though abundant moisture is present in the soil. The wilted leaves die quickly and become straw colored. Infections of leaves of adjacent plants may produce areas of blighted turf varying from less than one inch to several inches in diameter. When these blighted areas coalesce large irregularly shaped areas are formed.

Helminthosporium sorokinianum has been isolated from bentgrass during every month from April through November. However, the disease usually does not become damaging until late May or early June when periods of hot, humid weather normally occur. Severe outbreaks are most prevalent in hot, humid weather, especially if rainfall has been abundant.

This disease has been adequately controlled on the turf plots at the University of Illinois with several fungicides applied once a week on a preventive schedule. The better materials, Dyrene, Difolitan 80W and Dithane M-45, should give adequate control on golf course putting greens. For further information on control see Mr. J. D. Butler's article on Fungicide Testing in 1964 in these proceedings.

# SOIL WATER AND ITS MOVEMENT

T. D. HINESLY

Soil water is nearly always moving. Most of this water movement is in a vertical direction. Water either moves into, down and out of the soil by drainage, or it moves upward to the soil surface where it is lost to the atmosphere by evaporation or by the transpiration of plants.

Water moves from one location in the soil to another because the forces acting on the water are different at the two points. The kind of forces causing water movement depends on whether the soil is saturated or not.

If all of the soil pore space is not filled with water the soil is unsaturated and liquid water movement is due mostly to a difference of adsorptive forces at the two points. Adsorptive forces include both adhesive and cohesive forces. The affinity for water at soil particle surfaces is an adhesive force, while the attraction between like molecules of water is a cohesive force.

If all of the soil pore space is filled with water the soil is water saturated and the movement of water is due to the difference in gravitational forces at various points within the soil. For example, water moves into drainage tiles or ditches because it is under a pressure head in the soil great enough to overcome the resistance, presented by the soil, to its movement.

Water movement in the vapor phase may be important especially where temperature variation exist within the soil but because of space limitation very little will be said about it.

To obtain a view of the forces producing liquid water movement in saturated and unsaturated soil, let us assume a water table at some depth in the soil. At the free surface of the water table the force per unit area is that of the air above it or atmospheric pressure, which is about 14.7 pounds per square inch. Any point <u>below</u> the water table bears this same atmospheric pressure plus added pressure from the weight of water above the point. On the other hand, any point above the free water surface is subject to atmospheric pressure less the pull resulting from the adsorptive forces. Since atmospheric pressure is the same above or below the free water surface, the free water surface (top of the water table) is generally taken as the reference level and called the zero pressure level. Then all points below this free water surface or reference level have a positive pressure (higher than atmospheric) while all points above it have a negative pressure (lower than atmospheric). However, to avoid the use of negative signs, the term tension or suction is used to describe the negative pressure of water above the free water surface reference level.

Water is held in capillary size pores by the adsorptive forces in soil above the free water surface. Thus, the capillary equation given as:

$$\frac{2\,T}{r} = dgh \qquad (1)$$

can be used to calculate the radius, r, of soil pores holding water h distance above the free water surface. In the equation, T is the surface tension of water, d is its density, and g is the accerleration of gravity. The right hand side of the above equation, dgh, is the negative pressure, tension, or suction value expressed in units of force per unit area such as $lbs/in^2$ or $dyne/cm^2$. At a given temperature all elements of the equation are constant except the capillary pore radius, r, and the height, h, above the free water surface. Points selected at greater distances above the free water surface have greater h values and water is held at a greater tension in smaller pores the further the point is chosen above the free water surface. Because the surface tension T remains constant as long as there is no temperature change, as h increases on the right hand side the left hand side of the above equation can only increase correspondingly by a reduction in the capillary pore size. Therefore, at a given water tension there is an upper limit to the size of pore spaces between soil particles that are holding water.

To express water tension, most workers have found it convenient to use centimeters of water or mercury for lower ranges and atmospheres for higher ranges of tension. A column of water 1035 centimeters or a column of mercury 76 centimeters high exerts an equivalent one atmosphere of pressure on a surface. Hence h centimeters of water or h centimeters of mercury tension head is equivalent to $\frac{h}{1035}$ or $\frac{h}{76}$ atmospheres respectively.

More than a century ago, Darcy, a hydraulic engineer, found that a quantity Q of water crossing a cross sectional area, A, in unit time, t, is directly proportional to the difference in hydraulic heads $(h_1 - h_2)$ at the ends of a column of water saturated porous media and inversely proportional to its length, L. The equation is most simple written as:

$$\frac{Q}{At} = k \frac{(h_1 - h_2)}{L} \qquad (2)$$

where k is a proportionality constant called the hydraulic conductivity. If the properties of the water are not changed by temperature variation the hydraulic conductive remains unchanged for a given medium regardless of how the driving force or hydraulic gradient, $\frac{(h_1 - h_2)}{L}$, is changed. At a given temperature the hydraulic conductivity varies as a function of the continuity and size of pores through which water is conducted in a saturated soil. The size of pores has more effect on water flow than the number of pores. A silty clay loam soil would have more total pore space than a sandy loam soil, but water can move more freely through the sandy soil because individual pores are larger. The larger the channel of flow the smaller is the resistance from the channel walls.

Consider equation (2) now from the standpoint of water movement in unsaturated soils. For unsaturated soils, instead of pressure heads, the driving force is now a difference between suction or tension heads. For water movement in unsaturated soils the k term is referred to as the capillary conductivity. The capillary conductivity does not remain constant as the driving force, $\frac{(h_1 - h_2)}{L}$,

is changed. The capillary conductivity varies as the moisture content and state of compaction of the soil changes. It is greatest near saturation and drops off rapidly as the moisture content decreases to near field capacity. (Field capacity is the final moisture content that will be established behind the wetting front in a well drained soil after the water supply at the surface has stopped and further downward movement of moisture is almost nil.) Below the field capacity, capillary conductivity changes very slowly and researchers believe that many of the water films, by which water moves from particle to particle of soil, become discontinuous as the soil dries. With these broken, adsorptive forces can no longer pull the water along and further movement is mostly through the mositure vapor phase. Because the tension head increases as the moisture content decreases, the value that would be obtained for the capillary conductivity in equation (2), depends upon what values of tension head h are chosen for the determination. If $h_1$ and $h_2$ are chosen at moisture contents appraching saturation the capillary conductivity would be large compared to its value when $h_1$ and $h_2$ are selected near field capacity.

As mentioned above the state of packing affects capillary conductivity. For fine textures soils, very loosely and very tightly compacted soils have lower conductivities than some intermediate degree of compaction. In loosely packed soils the small capillary pores apparently are not as continuous and water films cannot move as smoothly as they can in intermediately compacted soils. On the other extreme, the pores in severly compacted soils are so small as to present a considerable resistance to flow.

The condition of the soil surface with regard to packing may significantly alter the water infiltration process.

When water moves into the surface of a well drained soil, only those pores and cracks opening at the surface are completely filled with water. The saturated zone is usually only a few centimeters thick at the surface. Below the shallow saturated zone, water moves downward under tension as it is transmitted to the wetting front. How rapidly the wetting front advances into the soil depends on how rapidly water is conducted from the saturated zone at the surface down to the front. Gravity contributes very little to the driving force as compared to the adsorptive forces, at least in the early stages of the infiltration process. When the water supply at the surface has been removed less and less water moves down to the front and eventually, as the water tension behind the wetting front increases to field capacity tensions, (approximately 1/3 atmosphere) for all practical purposes the wetting front stops.

Now suppose the wetting front encounteres a zone of impermeable material or one of very low capillary conductivity while there is still a water supply or head of water at the soil surface. In this case the soil immediately behind the front increases in moisture content to saturation. As this soil is saturated behind the wetting front a water table is formed. Only when the water table has formed from the bottom to the extent that it reaches tile drains, located above the impermeable zone, will the drains begin to function.

A wetting front advancing in a fine textured material may also be temporarily retarded when it reaches a layer of coarse material. Water moving through the finer material finds breaks in its channels of flow as it meets the coarse material. Adsorptive forces tend to hold the water back in the small pores. Again water content increases behind the wetting front until pressure builds up enough in the fine material to force water into the coarse material.

The movement of water in unsaturated soils is important in considering water losses from the soil. After drainage has ceased the only water lost occurs at the soil surface by evaporation and by transpiration of plants. Both of these processes require energy from the sun to convert liquid water to water vapor and wind to carry the water vapor away.

So far, scientists have had little success in reducing plant transpirational water losses, but have made great strides in increasing the efficiency of water use by plants. Yields have been increased by adequate fertilization and by disease and insect control without increasing the need for more water.

When soil moisture contents are high, above field capacity, the rate of evaporation is almost dirctly proportional to the rate at which sunlight energy reaches the soil surface. Later as the soil dries and capillary conductivity decreases, the rate of evaporation is proportional to the rate at which water is conducted to the surface. Once a dry layer of soil develops at the surface moisture loss is very low because water movement is primarily as water vapor and vapor diffusion from within the soil is a slow process.

To summarize, thereare great differences in the way water moves depending on whether the soil is saturated or unsaturated. In the saturated state water moves by gravity and the rate of movement is determined by the driving force and channels of flow. However, in unsaturated soils water movement is the result of differences of adsorptive forces within the soil. The rate of water movement in unsaturated soils also depends on the strength of the driving force and size of channels of flow, but often the soil moisture content is a greater determining factor.

Water moves downward into an unsaturated soil under tension until the wetting front meets an impermeable layer, then the soil becomes saturated from the bottom upward. In unsaturated soils water moves upward under tension almost as readily as it moves downward as long as the surface does not become dry as a result of evaporation exceeding the rate at which water can be conducted to the surface.

# BEDDING ANNUALS--THEIR SELECTION AND CULTURE

G. M. Fosler

A vast majority of the flowering plants now used for massed color effects in public and private plantings are seed-grown annuals, or tender perennials handled as annuals. Many of the once familiar vegetatively propagated bedding plants, both flowering and foliage types, are now seldom offered for sale and infrequently seen in ornamental plantings. Although attractive and useful, they were relatively expensive to produce and cannot compete in today's market with items grown from seed. The geranium is a major exception; yet even with this important crop, seed lines are now coming into prominence. Other vegetatively propagated bedding plants which still merit attention, and have not been entirely replaced by seed varieties, include ageratum (where uniformity is needed), canna, coleus and lantana.

## What Bedding Annuals Give Us

Our most reliable and important bedding annuals provide us with a good display of color over a relatively long season--perhaps 4 or 5 months. It would be difficult to achieve comparable continuity of color with hardy perennials. Many perennials are spring-blooming, and individually, their main blooming seasons are usually only several weeks in duration. Because most annuals don't come into their own until late June or early July, it may be necessary to provide spring color in the flower beds with bulbs or pansies. It is then entirely feasible to make follow-up plantings with bedding annuals to complete the season.

Seed-grown annuals, which are short-term greenhouse crops, are now relatively inexpensive to produce and can be sold at reasonable prices. Add to this the advantages of an amazing array of different types from which to choose--almost every conceivable color, flower form, and plant height you could want. Our plant breeders the world over have outdone themselves since

World War II in expanding the list of available varieties. Great improvements have been seen in expanded color ranges, and in vigor, uniformity, growth habit, flower form and substance, and disease resistance. Even entirely new species have become important. And the future for bedding annuals also looks bright, considering the advanced breeding techniques now being employed.

Very prominent are the $F_1$ hybrids, particularly in petunias, snapdragons, zinnias, marigolds, impatiens and fibrous-rooted begonias. Certain tetraploid forms have also become quite important. Needless to say, the competition is so keen that inferior varieties have a way of dropping by the wayside rather quickly.

In addition to the above advantages, bedding annuals are quite undemanding in their cultural requirements, and disease and insect problems are seldom encountered. The fact that the plants must be replaced each year is more than offset by the real garden value we receive from them.

## Should We Buy Our Plants?

Generally speaking, you will be money ahead by buying started plants for the flower beds you have planned. And in many cases, it would be well to consider having them contract grown, with the particular varieties you have chosen to be delivered at the date(s) you specify. Plants received in prime conditions can then be set out immediately, and in only several weeks will begin providing real color.

Be sure to find out what the recommended planting-out time is in your area. Here in Champaign-Urbana we aim at May 15, although our average date of last frost is April 25. You can't afford to have the plants killed by a late frost: furthermore, their development is slow until the ground has warmed up. Once they are established, you can usually be assured of good performance with a minimum of maintenance and care until frost in the fall, or later. As you probably know, quite a number of our popular bedding annuals withstand hard freezes yet continue blooming, even well into November.

Considering the comparative costs of seed and plants, it is sometimes a temptation to economize by trying to direct-seed the flower beds. You may have fair success with some of the larger seeded, vigorous growing types. But with petunias and most other small-seeded items, the results will be spotty and your investment in seeds usually lost. Another point to keep in mind is that plants from direct-sown seed will often bloom considerably later than thrifty, well-started plants from a greenhouse.

If you have greenhouse space, and a grower who is competent to do the job, you might consider producing your own plants. But if only makeshift facilities are at your disposal, I hardly think it is worth the gamble. It is possible, however, to buy flats of started seedlings in the spring. These could be pricked off and spaced out in flats, packs or individual pots and finished in a heated coldframe.

## Demand Good Plants

Whether you have your bedding annuals contract grown, or whether you shop around at local greenhouses, always insist upon good quality plants. Be sure they are healthy and insect-free; but above all, look for low-branched specimens of uniform height--not stunted, yellowish, or hardened up.

Most customers will pass up flats or containers of plants that aren't in bloom. It's always good to know that you are getting the correct variety, as evidenced by the flowers. But it is far more important to get quality plants, even if it has been necessary to pinch out the stem tips (and flowers) to induce low branching.

It must be stressed that, whether you buy or gow your own plants, most bedding annuals should be "pinched" before setting out. That is, the stem tips are broken out to encourage the lower axillary buds to "break." With petunias and snapdragons, for example, this pinch should be such that only several inches of the stem remain. If left unpinched, you will inevitably have the spindly, straggly sort of plants that are all too familiar in plantings you see every summer.

While pinching is a "must" with most bedding annuals, there are several exceptions to the rule. Celosia (cockscomb) and balsam sometimes do not break well if the terminal growing points are removed.

Your florist uses various means to produce the quality of plants you seek. Proper greenhouse temperature levels for different crops are particularly important. But the progressive grower is now also manipulating daylengths. In addition, you may have heard about several new growth retardant chemicals (B-Nine is one of them) that are quite effective. When properly applied, they give us low compact growth and desirable base branching, yet flowering is not impaired. Lush, deep-green foliage color is an added advantage. Experiments indicate, too, that the effects of these retardants are rather temporary, thus in no way hindering the performance of the plants once established in the outdoor beds.

Also insist that the plants you buy have been properly "hardened off." By this we mean that they have been gradually subjected, during the last several weeks before sale, to cooler temperatures and more rigorous environmental conditions. This is often accomplished in coldframes. Certain physiological changes occur in the plants, making them better able to withstand the shock of being planted out. You can readily understand that a plant grown under ideal greenhouse conditions, without hardening off, would take considerable time to recover from being suddenly subjected to outdoor conditions in our changeable spring weather.

In what kind of container should you buy plants? Large flats will cost you the least per plant. The small packs, containing a dozen or so plants, are convenient to handle but were largely designed for cash-and-carry sales to home gardeners. With these flats or packs, it will be necessary to remove the plants by carefully cutting downward into the soil between them. Then lift out each plant with a block of soil surrounding its roots and set into the hole. Individually potted plants can be handled with the least root damage, yet will be the most costly. With peat or bagasse pots, there is virtually no damage to the roots since the pot is set with the soil ball into the planting hole. To remedy the difficulty that some people have encountered with peat pots, some brands are now being treated with a wetting agent.

What about plants being grown in artificial mixes, such as one-half peat and one-half vermiculite, or one-half peat and one-half perlite? High quality bedding annuals can be--and are being--precision grown in these non-soil mixtures. And once set out, the plants will perform fully as well as those grown by more conventional methods.

## Selecting Varieties

It is beyond the scope of this brief presentation to go into the landscape uses of bedding annuals. If you have the services of a landscape architect, by all means get his suggestions on types and varieties for the effect you want. But even without professional help, you can often do quite well by consulting experienced gardeners and by viewing plantings in parks or other public areas. Seed catalogs, magazines, and many books also provide helpful hints along with pictures of successful combinations.

When deciding upon varieties to buy or grow, there are a great many aids at your disposal. Above all, plan to visit one or more of the trial gardens. Geo. J. Ball, Inc., West Chicago, and Vaughan's Seed Company., Downers Grove, both maintain extensive trials in the Chicago area. By visiting these several times a season, you can note those varieties that perform best in our area and are suited to your particular needs. In addition, these gardens present a number of demonstration landscape settings utilizing some of our best bedding annuals.

We welcome you, also, to visit the University of Illinois Trial Garden of Annuals and Bedding Plants here on the campus, located near the intersection of Florida and Lincoln Avenues in Urbana. The Garden, maintained by the Division of Floriculture and Ornamental Horticulture, is open to the public every day of the week. This year it included over 1,475 varieties, secured from all of the major seedsmen in the United States. There were over 330 varieties of petunias--our No. 1 bedding annual--in the planting, most of them $F_1$ hybrids.

In addition to the trial gardens, recommendations from seed catalogs are generally good. Depend heavily on the advice of your florist as well (although he may be more concerned with how a variety looks at sale time than how it performs outside). Fieldmen or salesmen from the larger seed wholesalers can give you much helpful information. Your own experience from previous year's plantings is invaluable. And it might be well to run a few limited trials of your own on new items that you think may have potential in the ornamental plantings for which you are responsible.

You are all aware, I am sure, of the much-publicized All-America Selections. Our University of Illinois Trial Garden is now designated as an AAS Demonstration Garden, and we are hopeful that it may soon be give full Trial Garden status. All-America award-winning varieties have been entered in two-year competitive trials in many different parts of North America. If the official panel of judges grants a particular entry a sufficient point total, it rates either a bronze, silver or gold medal. The variety then receives extensive promotion and publicity. Generally speaking, AAS winners are excellent. But in some cases they turn out to be garden novelties rather than good bedding subjects. And a few have also not panned out too well in our rigorous Illinois summers.

For the past several years, I have been preparing a publication which lists varieties of bedding annuals that, in our opinion, give the best garden performance under our conditions. Although many growers reportedly have come to rely upon this listing quite heavily, we feel that it should be only <u>one</u> contributing source of information on which to base <u>your</u> choice of varieties. In other words, don't take our word for it completely--don't place all your weight on this one "crutch."

Copies of the publication, "Recommended Bedding Plant Varieties for 1965," will be off the presses in the near future. Those of you who would like free copies may send your request to: 100 Floriculture Building, University of Illinois, Urbana, Illinois 61803.

## Cultural Tips

Sun versus shade--Although we have a long list of reliable bedding annuals from which to choose, nearly all of them perform best in full sun. Fortunately, there are some items which require light to moderate shade in this area: impatiens, fibrous- and tuberous-rooted begonia, seed-grown coleus, lobelia, and exacum. Caladiums, although not seed-grown, also fit into this group of shade plants. Certain other annuals can be grown in light shade (although they ordinarily perform better in full sun): petunia, alyssum, annual phlox, salvia, snapdragon, verbena, aster, cleome, periwinkle, pansy, carnation, pinks, and balsam.

Soil preparation--The point has been stressed that bedding annuals are easy to grow. Yet, as with all other ornamentals, you should take no short-cuts as far as soil preparation is concerned. Plow or spade the area deeply, preferably the previous fall, working in generous amounts of organic matter, such as manure, compost, leafmold, peat moss, etc. Leave rough over winter. Then work up, level, and rake the bed smooth a week or so before planting date. At the same time, incorporate peat moss, fertilizer, and lime as needed.

Make certain, too, that the flower beds are well drained. If drainage is a problem, you should remedy the situation with drainage tiles or channels, or by elevating the beds a few inches above the surrounding area.

Your chances of success with flowering annuals are far greater if the soil has good physical structure--loose, friable, well aerated, and with good humus content. Over-pulverizing the soil, either by hand or with a rototiller-type implement, actually destroys soil structure.

Fertilization--There is a grain of truth in the old adage which says that any soil which grows a good crop of weeds will also grow good annuals. But you'll be more pleased with plants grown in soil which has been properly prepared and judiciously fertilized.

While adequate amounts of phosphorus (P) and potassium (K) in the soil are essential, "caution" is the word with nitrogen (N). If in doubt, have soil tests made, then base your fertilization program on the results. Many annuals bloom best with rather low amounts of N in the soil. With excessive N, they may produce lush foliage and rank stems, with all too few flowers. The soil pH should be near neutral (6.5 to 7.5); therefore, do not apply lime or limestone unless tests indicate that the soil is too acid.

When working up the flower beds in spring, I would recommend that a complete dry fertilizer (such as 5-10-5 or 6-10-4) be incorporated into the soil. Use 1½ to 2½ pounds per 100 square feet, depending upon soil test results. If the N level is extremely low, use the larger amount. Later on in the spring or early summer, more fertilizer can be applied as a light side-dressing if the nature of growth indicates the need for it. Or, it may be more convenient to inject a fertilizer stock solution into the water line, thus fertilizing as you water the beds.

Allowing fertilizer to be carelessly scattered over portions of the flower beds when adjacent turf areas are fertilized can lead to difficulties. Similarly, if N washes down into the beds in drainage water from a lawn area, you may also be disappointed in the performance of the affected plants.

Using a starter or booster solution is advised when setting the plants, in order to get them off to a quicker start. A soluble complete fertilizer high in P, such as 10-52-17 or 10-50-10, is often used. Mix the fertilizer in water (about 2 tablespoonsful per gallon of water), then put 1 cup of this solution around the roots of each plant. If you have a fertilizer injector, water in the newly set plants with a dilute fertilizer solution.

Watering--If there are any real secrets for success with bedding annuals, proper watering is one of them. Visitors to our Trial Garden often ask how many times a week we water. Actually, there are many weeks when we don't water at all. During this past very dry, hot season the sprinklers were turned on no more than 6 or 7 times.

It would be wonderful if we could depend on rainfall entirely. But if rain doesn't come at the right time and the soil has become moderately dry, it's time to water--and to water heavily. With our "Rainbird" irrigation system, we water continuously for periods of from 6 to 8 hours. Length of the watering period, however, is not the important point. Water should be applied slowly and long enough so that it can all penetrate the soil and soak down through the root zone, perhaps 8 to 12 inches deep. Once this has been achieved, do not rewater again until the soil is on the dry side. But don't wait so long that you see wilting. Wilting never benefited any plant.

Frequent light waterings result in shallow root formation. With this situation, plants wilt rather quickly on hot, dry days. And if you continue with insufficient applications of water, you needlessly get yourself into a vicious circle which is hard to break. Plants should have extensive root systems so they can tap the moisture reserves deeper down during periods of drouth.

One hears many arguments among gardeners about the proper time of day to water. Most of us have to consider convenience above most other factors. But it is true that water loss from evaporation will be greatest during the heat of the day. On the other hand, watering during the evening or night may encourage foliar disorders. It is my recommendation that watering be done when it can be accommodated into your daily work schedule--but shutting off the sprinklers early enough so that the foliage has a chance to dry before nightfall.

Keeping down weeds--The day of frequent and deep cultivation is past. Whether done with a hand hoe or a power implement, cultivation should be shallow--serving mainly to shave off weeds and to break up the surface crust. Working up the soil to any depth does great damage to the root systems, but also turns up countless weed seeds that will give you trouble later on. The old dust-mulch theory has been fairly well debunked by our scientists, and the age of minimum tillage is here. In our experience, weeding and cultivating at 10- to 14-day intervals is sufficient.

If feasible, use a mulch around your bedding annuals. In addition to holding down weeds and eliminating the need for cultivation, a good mulch conserves moisture, aids water penetration, prevents soil compaction and crusting, keeps the soil cooler, and may add organic matter to the soil. Many different mulch materials are being used: pet moss, ground corncobs, pecan shells, tobacco stems, cocoa bean hulls, compost, peanut hulls, etc. All of these are good, but each has its own advantages and disadvantages. If a rapidly decaying type of mulch is used, such as straw, sawdust or even finely ground corncobs, you may need to fertilize somewhat more heavily with N.

Soil fumigation is another way to destroy weed seeds and roots of perennial weeds. In addition, fumigants are variously employed to destroy certain disease organisms, insects and nematodes in the soil.

Insects and diseases--Even though we are dealing with a large and diversified group of plants, most of them are usually not plagued by insects or serious diseases. Quite a number are especially susceptible to damping-off in the seed flats, but once in the garden, seldom give us much trouble. Powdery mildew on zinnias is almost inevitable every summer. In some cases, we can take advantage of varieties which show resistance to certain diseases, e.g., rust-resistant snapdragons and wilt-resistant asters. This year we experienced a damaging infestation of spider mites on the tall-growing marigolds.

Soil fumigation has already been mentioned as a means of eradicating certain soil pests. Rotation of plantings, so the same types of plants don't grow in the same spot year after year, is another helpful way to circumvent certain disease difficulties. In the fall, rake off and burn all plant debris from the beds, rather than spading it under. This material often harbors insects and disease organisms. As protection against cutworms and other soil pests, we make a regular practice of applying dieldrin to our Trial Garden plot shortly before planting time. Appropriate sprays or dusts are usually called for to ward off or control insects or foliar diseases. However, systemic insecticides are coming into prominence for the control of insects on outdoor ornamental plantings.

If you need help with a specific insect or disease problem do not hesitate to call on your farm adviser or extension specialist for their recommendations.

Maintenance practices--Aside from the points already covered, bedding annuals require little other special care. The young plants should have been pinched back before, or shortly after, they were planted out. A second pinch is rarely necessary or advised. With a few items, careful shaping of the plants through the season will keep them in more presentable condition. It is generally not even necessary to remove the old flower heads, unless they are taken off because of unsightliness. There are a few types of bedding annuals, however, which may fail to rebloom satisfactorily unless the seed heads of spikes are removed; the snapdragon is a good example.

The finest bedding annual we have--the petunia--is one plant that may need extra attention. You have all noticed that some varieties tend to become open-centered, rangy and matted down in midsummer. When they reach this stage, pruning back will rejuvenate them for better performance in late summer and fall. The stems are cut back to 8 or 9 inches from the base. This can be done all at once, or a few at a time so that there is no drastic disruption in flowering. In a surprisingly short time new shoot growth will occur, along with a fine showing of blooms.

Few of our important bedding annuals need support or staking. The few exceptions would include the taller snapdragons and the tall African marigolds.

# GREEN GRASS AND GRASS ROOTS

C. W. Lobenstein

The growing of healthy green grass is the common goal of our respective jobs which brings us together at meetings such as this. The users of our product expect the production of an adequately thick ground cover at all times in spite of the many hurdles of disease, weather, and soils problems and at the same time desire the product to be green. Many times green is not green enough and we may find ourselves yielding to pressures to make it greener. This is fine--we all desire to produce a product that gains maximum customer satisfaction.

All who have examined critically the question of "How green is good?" recognize it as not a new problem. In any series of turfgrass literature this matter is discussed repeatedly. As recently as 1960 in these Proceedings, Dr. Eliot C. Roberts discussed the relationship between foliage and root production and again pointed out that yield, as foliage production, and dark green color were, in themselves, poor indicators of quality turfgrass.

Anyone seriously concerned with turfgrass management recognizes as obvious, the fact that grass, like most other plants, cannot be grown without an adequate root system. Examples of problems observed during the past season illustrate the point that many apparently do not yet recognize this point or overlook it in the pressures of the growing season. Thus some of the factors affecting foliage and root development are perhaps worthy of review and re-emphasis.

Mowing is necessary in production of good usable turf but may be a necessary evil as far as the grass is concerned. The fact that clipping practices, especially at the heights often required, reduces foliage and root growth is a cardinal principle in turfgrass growth. Maintainence of high nitrogen levels and optimum moisture conditions stimulate shoot growth much more rapidly than root growth especially when new leaves are removed as rapidly as they are produced. This is the second principle. If root development is further placed at a disadvantage by poor aeration through compacted or poorly drained rootzone structure, the effects of the two previous factors are aggravated. The poor growth of roots is transferred to poorer shoot growth. Additional nitrogen or additional water in an effort to get quick results only makes matters worse. With a good structured, well aerated rootzone, troubles may still arise from problems of pH or failure of the turf user to appreciate the limitations of air and soil temperatures beyond which the turfgrass cannot be forced without serious injury.

Development of slow release nitrogen fertilizer compounds in recent years have been a most useful and welcome addition to the tool kit of turfgrass management. The ability to provide a more continuous feeding in place of the very stimulative soluble materials should lead to better turf health. At the same time, many still must use moderate amounts of the quick solubles or even spray-on applications to get that "quick kick" to keep the color up and the user happy. Without full knowledge and awareness of the interacting factors regulating foliage and root growth, all three forms can still cause serious trouble.

As an example up to June, the greens on a small course in Southern Illinois started the season in excellent shape. Upon subsequent development of poor color, a urea-formaldehyde application was made, the only fertilizer application since early spring. The greens responded--colorwise! During the summer nearly all greens went out from 20 to 90 percent in spite of verticutting, spiking, daily watering, and more U-F. When the damage had been done it was discovered that the greens had received 16 pounds of calcium arsenate per 1,000 in a split application the preceding fall and spring, some potash but no phosphate of record. No soil test had been made but a fairly good guess could be made as the the trouble, expecially in view of the arsenical used on typically low phosphate soils of Southern Illinois.

The point of concern here is that even with the exclusive use of slow release nitrogen materials, trouble can surely arise if all factors are not considered. With the typical reduction of the working depth of the grass roots accompanying high temperatures, coupled with depletion or complexing of the phosphate reserves in the surface zones of soil, addition of even slow release nitrogen to get growth and color can backfire just as surely as the more quickly soluble forms.

Two home lawns in Carbondale illustrate a similar violation of the cardinal principles of growing a durable turf. They were established with the best of seed with adequate surface fertilization including limestone but no incorporation sufficiently deep into the rootzone of the slowly soluble limestone or phosphates. The result-- ? By following recommended applications of a complete fertilizer with a high ratio of slow release nitrogen including regular monthly applications, beautiful lawns were produced--as long as the rains came and before that section of the city ran out of water. Then, with the dry summer and an anti-watering ordinance, disaster struck. Other lawns in the neighborhood, with moderate to little fertilization and particularly lower nitrogen levels, survived. --Not as green of course, but they survived. The luxuriant foliage had been produced at the expense of a root system adequate to carry through; moreover, the thatch developed by this program had encourage the roots to develop even shallower in the tight soil. Small wonder the turf expired when the thatch dried out.

In a long-term fertility experiment on bluegrass at Dixon Springs in cooperation with the University of Illinois, Department of Horticulture, we again observed the breakdown of greenness of color as a measure of turf quality. This experiment was set up on low phosphate soils of very desirable structure but received supplemental irrigation only once during the summer. In the various combinations used, plots receiving high nitrogen rates in monthly increments always rated highest from the viewpoint of color regardless of whether P and K were high or at the minimum level. When drought stress took its toll the high nitrogen plots lost the most grass and by the end of the season were the lowest in measured shoot density.

In review, the basic principles of maintaining good foliage and root balance are summarized by many papers and talks in previous turfgrass meetings as follows: maintain clipping height as high as possible within the dictates of the grass and its use, diseased leaves cannot support adequate root growth nor use of the turf, phosphorus and slowly soluble nutrients must be adequate throughout the rootzones, other essential nutrients should be suppled in proper balance and quantities, pH and water factors should be regulated with common sense, roots cannot grow without air, and nitrogen levels should be as low as possible without causing the grass to completely lose its vigor to recover when climatic and disease factors become more favorable. Even though the slow release materials may provide a much more desirable means of supplying nitrogen to grow <u>green</u> grass, they do not provide a means of escaping the pitfalls of grass being permitted to grow <u>too green</u> for its own good.

# FUNGICIDES AND TURF DISEASE CONTROL--1964

J. D. Butler and M. P. Britton

During the last few seasons, rather severe injury from melting-out (Helminthosporium leaf spot) has occurred on Seaside creeping bentgrass on the University plots. Repeated testing is needed to determine the effectiveness of fungicides against this disease. Certainly not all of the available materials were tested, for new products are constantly becoming available, and most of the older fungicides have been sufficiently tested. Space and time are always limiting factors in such testing programs.

An adequate area of Seaside bentgrass was available on the University of Illinois Turfgrass Research Area for four replications of 25 sq. ft., or a total of 100 sq. ft. for each of 12 treatments. The Seaside bent was irrigated and maintained at a height of 7/32". The fungicides were applied at the rate suggested by the manufacturer. Applications were made at weekly intervals beginning on Monday, May 11, and terminated on September 14. All materials were applied in water at a gallonage equivalent to five gallons of spray solution per 1,000 sq. ft. of turf. To insure accurate applications, a constant-pressure portable sprayer and shield were used in applying the materials. The plots were not irrigated for at least 48 hours after chemical treatment. This year we had the highest incidence of turf disease in ten years. Melting-out, brown patch (*Rhizoctonia solani*), and dollar spot (*Sclerotinia homoeocarpa*) were present in significant amounts on the Seaside bentgrass, but were not as serious on Washington, Toronto, Penncross, and other strains adjoining these plots. Some pythium (*Pythium ultimum*) was present, but was rather erratic in occurrence. Data on the incidence of various diseases was taken on the dates indicated in Table 1.

Discussion of results:

By May 30 it had become apparent that some of the products being tested were phytotoxic to the Seaside bentgrass. The use of Bayer Expt. 47531 was discontinued, and Memmi and Memmi + Thiram were discontinued temporarily. At a later date, the rate of Memmi was reduced from one ounce to ½ ounce, at which rate Memmi and Memmi + Thiram did not injure the grass.

By July 20 leaf spot had become severe. From Table 1, it is evident that there was a wide variation in the amount of control obtained with different fungicides. Difolitan, Dithane M-45, and Dyrene plots exhibited no evidence of leaf spot while DAC-2787 plots had very little. On this same date (July 20) brown patch was present only in the plots which had received no treatment (5% affected). Dollar spot was also quite prevalent on this date.

Four days later, on July 24, and only four days following the previous chemical application, brown patch came in over leaf spot causing severe damage where both occurred in the plots. Definite circular patterns could be seen even in the plots heavily infested with leaf spot. From the weather data for the week of July 19-25 (Table 2) it is evident that the night temperature (min. temp.) was 15°F higher than the preceding week and the average weekly temperature was 9°F higher than the preceding week. This period, with its high night temperatures and high humidities, was the time of severe brown patch and pythium. The four materials which had looked good on July 20 when leaf spot had been rather severe, performed very well on brown patch. Ortho Lawn and Turf Fungicide and Thiram controlled brown patch, but the amount of leaf spot damage in these plots had doubled in only four days.

Again the first week in September, dollar spot became severe. Data for dollar spot taken on September 9 is fairly consistent with that taken on July 20, except for the lesser number of spots where no treatment was applied. Neither Difolatan nor Dithane M-45 gave effective control of dollar spot.

Table 1.--Fungicide treatment for disease control on Seaside bentgrass at Urbana, Illinois

| Fungicide | Rate/1,000 sq. ft. | Data taken 5/30-5+ | 7/20-7+ | | | 7/24-4+ | | 9/9-2+ |
|---|---|---|---|---|---|---|---|---|
| | | PHYTO. | D | BP | LS | BP | LS | D |
| Dyrene | 8 oz. | 0* | 4* | 0* | 0* | 0* | 0* | 2* |
| Zineb | 3 oz. | 4.0 | 14 | 0 | 37.5 | 48.5 | 10.0 | 7 |
| Ortho Lawn and Turf | 4 oz. | 0 | 2 | 0 | 18.8 | 0 | 41.3 | 0 |
| DAC-2787 | 6 oz. | 0 | 1 | 0 | 3.8 | 0 | 6.3 | 4 |
| Bayer 47531 | 8 oz. | 20.0 | -- | -- | -- | -- | -- | -- |
| Memmi | 1 oz. | 30.0 | -- | -- | -- | -- | -- | -- |
| Memmi + Thiram | 1 oz. + 2 oz. | 28.0 | -- | -- | -- | -- | -- | -- |
| Memmi | ½ oz. | -- | -- | -- | -- | -- | -- | 0 |
| Memmi + Thiram | ½ oz. + 2 oz. | -- | -- | -- | -- | -- | -- | 0 |
| Thiram | 2 oz. | 4.0 | 0 | 0 | 26.8 | 0 | 52.5 | 1 |
| Dithane M-45 | 4 oz. | 0 | 16 | 0 | 0 | 1.3 | 1.3 | 29 |
| Difolatan 80W | 4 oz. | 0 | 24 | 0 | 0 | 0 | 0 | 109 |
| Acti-dione-thiram | 2 oz. | 15.0 | 0 | 0 | 25.0 | 35.0 | 0 | 0 |
| No treatment | -- | 0 | 63 | 5 | 37.5 | 58.8 | 10.0 | 10 |

* Figure represents average percent injury or total no. for 4 - 25 sq. ft. plots.
+ No. of days following chemical application data taken.
PHYTO. - % plant injury attributed to chemical.
D - No. dollar spots/100 sq. ft. plot area.
BP - Estimated percent injury attributed to brown patch.
LS - Estimated percent injury attributed to leaf spot.

Table 2--Weekly data of weather, Urbana, Illinois

| Week of: | Prec. | Ave. temp. | Max. temp. | Min. temp. |
|---|---|---|---|---|
| May 24-30 | .06 | 66 | 85 | 46 |
| May 31-June 6 | .95 | 65 | 80 | 48 |
| June 7-13 | .12 | 75 | 92 | 52 |
| June 14-20 | 2.89 | 74 | 94 | 51 |
| June 21-27 | 1.11 | 77 | 92 | 63 |
| June 28-July 4 | .06 | 77 | 93 | 60 |
| July 5-11 | 1.29 | 73 | 88 | 54 |
| July 12-18 | 1.06 | 72 | 91 | 52 |
| July 19-25 | T | 81 | 94 | 67 |
| July 26-Aug. 1 | T | 78 | 97 | 57 |
| Aug. 2-8 | 0 | 80 | 101 | 57 |
| Aug. 9-15 | T | 67 | 92 | 51 |
| Aug. 16-22 | 2.00 | 72 | 89 | 54 |
| Aug. 23-29 | .47 | 70 | 88 | 52 |
| Aug. 30-Sept. 5 | .12 | 73 | 86 | 60 |
| Sept. 6-12 | .16 | 73 | 85 | 60 |

# MAINTENANCE CALENDAR FOR SHRUBS AND TREES

J. B. Gartner

Before we can go into a maintenance calendar we have to understand several basic maintenance principles. For instance, more harm than good can be done by improper pruning of trees and shrubs. The average person tends to overprune by removing too much of the top growth. The excuse is that the tree is getting too large and top heavy and will be damaged in windstorms. This is not true. Actually, by topping the tree, they are making the tree more susceptible to damage from windstorms. By removing an excessive amount of the top, the balance between top and root ratio is destroyed. By doing this, there is not enough leaf surface to support the extensive root system and results in a weak root system.

In addition to a weakened root system developing when a tree is topped, large stubs are left which very seldom heal over. This results in decay of the branch. The new growth usually consists of numerous shoots giving a witches broom appearance. These new shoots form weak crotches that split readily in windstorms. When a tree is topped, consideralbe harm is done to it.

The same theory holds true for shrubs. Overpruning is detrimental and will cause considerable damage to the plant.

## Pruning of Trees

The basic rason for pruning is to maintain the shape of a plant, remove dead wood, remove diseased branches, and remove any interfering branches.

Let us take these factors one at a time. The principle that is most often abused is maintaining the shape of the plant. We have plants of all sizes and shapes, and we should try to maintain the natural size and shape of the plant. If the natural size and shape does not fit the situation where the plant is located, then the plant should be removed and replaced with a plant of the proper size and shape. There are some exceptions to this rule, such as plants used in hedges or in espalier work. Even in these cases plants are selected that lend themselves to this use. If the proper plants are selected, only a minimum of pruning is required to maintain their natural size and shape.

The removal of dead wood is essential to avoid danger of breakage during a storm. This should be done periodically and when it is done the branch should be removed without leaving a stub. It should be removed back to a crotch or to the truck of a tree. If a stub is left and does not heal over, heart rot will occur. In addition to the removal of dead wood, any branches that are diseased should be removed beyond the point of infection in order to eliminate this source of inoculum for further infection. Any weak or interfering branches should also be removed. By doing this, future problems are avoided.

## Pruning of Shrubs

Before we can discuss pruning of shrubs we have to define a shrub. A shrub is a short woody perennial, usually several stemmed. Some good examples are: red stemmed dogwood, spirea, forsythia, etc. The same principle applies with shrubs as with trees. A balance must be maintained between top and roots. If this balance is destroyed a weak plant will develop. A common practice is to prune shrubs back to the ground periodically. This destroys the top-root balance and results in weak growth if pruned in this manner for a period of years. The proper way to prune shrubs is to practice gradual rejuvenation. When gradual rejuvenation is practiced, from one-fourth to one-third of the oldest branches are removed at the base of the plant each year. This permits vigorous new shoots to develop since food is being manufactured in the remaining shoots and they supply food to this new growth. Gradual rejuvenation is a continuous job.

## Hedges

The above pruning method is followed with shrubs; however, it cannot be practiced when the plant is used as a hedge. In this case the plant is kept clipped to the desired shape by removing one-half of the new growth periodically.

## Time of Year

As to the season of the year to prune, one must understand some basic principles. If heavy pruning is practiced at the wrong time of year, considerable damage can be done. Pruning of trees and most shrubs should be done in late winter or early spring. When a plant is pruned at this time of year, there is less adverse effect on the plant than at any other season since the new growth will have less competition and can utilize the greater amount of stored food within the plant.

If plants are pruned in late spring and early summer, the new growth will be weak since the stored food was utilized in the first flush of growth, and sufficient food has not been manufactured and stored to produce strong new growth.

If pruning is done in mid to late summer, leaves that manufacture the food are removed thus resulting in less food storage and more winter injury. In addition, the new flush of growth does not mature and more winter damage occurs.

If pruning is done in the fall when the food content of the plant is at its highest, less food will be available for spring growth and the new growth will be weakened.

It is evident from these facts that it is best to prune slow-growing trees in late winter and early spring, and if pruning is done at other seasons, it should be a light pruning in order to prevent as much damage as possible.

The same facts apply to shrubs except that if we pruned shrubs that bloom on old wood, such as forsythis, spirea, etc., in late winter we would be cutting off good flower buds. With this in mind we should prune shrubs that flower on old wood such as liliac, forsythia and spirea just after they bloom, and shrubs that flower on new growth, such as althea amd mock orange, in late winter prior to growth.

## Fertilization

Since most trees and shrubs are deep rooted, leaching is not a real problem and fertilization can be practiced at most any time of the year. However, it is preferred to place the fertilizer deep and it should be available for spring growth. With trees, it is only essential to fertilize every 2-3 years and this can be done in the winter any time after the plants go dormant.

With trees, the most common fertilizer used is a 10-10-10 or 10-6-4 at the rate of one-half pound of actual nitrogen per inch of trunk diameter. This is placed in holes drilled into the soil three feet deep and two feet apart out to the drip line of the tree.

## Transplanting

There is no real hard and fast rule when a plant can be transplanted. This depends on the care one is willing to give the transplant. Except for a few species, such as magnolia, mountain ash, and other thin-barked trees, the fall is the best time of year to transplant since some root growth will be made in the fall and the tree is ready for growth in early spring. Most landscape men will plant trees and shrubs bare root in the fall after the plants are dormant and in the spring before new growth starts. A disadvantage of bare root material is that it takes more care in watering for a longer period of time than plant material that is balled and burlapped.

At the present time nurserymen are transplanting balled and burlapped material at all seasons of the year with a high degree of success. They have always been able to transplant in the fall, winter and early spring; now they have extended this to the late spring and summer by the use of anti-desiccants.

When transplanting bare root stock the top growth should be pruned back to compensate for the reduction in root system. One of the biggest mistakes made in transplanting is that the average person fails to take care of the plants after they are transplanted. The average tree or shrub needs supplemental watering for two years after transplanting before it can withstand any extended dry periods.

## Mulching

To cut down on maintenance costs mulching is essential. By mulching properly, weeds are eliminated and moisture is conserved, labor costs are reduced many times that of the cost of mulching. Here in the midwest we have the best source of mulch at our disposal at a very reasonable cost. Cracked corn cobs have proven to be one of the better mulches. Some people object to their appearance but after they weather for a short time, the color and texture is not objectionable. Another complaint is that when corn cobs are used they rob the plants of nitrogen. This is true but this can be overcome by increasing the rate of fertilization by 50%. This is not a waste of money. As the corn cobs break down, the nutrients are released and become available to plant growth. There are many other mulches such as wood chips, pine bark, redwood bark, pecan hulls, etc. All of these are good, but are not local products and cost more than corn cobs.

## Spraying

In the control of insects and diseases in shrubs and trees, as on other crops, an ounce of prevention is worth a pound of cure. Therefore, a regular spray program should be practiced for prevention, using an overall fungicide as well as an overall insecticide.

Except for a few specific cases, the best insecticide to be used on trees and shrubs for the control of aphids and spiders is malathion. Captan will control a considerable number of the diseases such as leaf spot and other stem diseases. It is also essential that one keep a vigilant eye for any build up of insects and diseases. These should be properly identified and controlled. This information can always be obtained by contacting your farm adviser or state extension specialist. In addition to a good spray program a proper maintenance program should be follwed. Under these practices, plants will be healthier and less subject to damage from insects and diseases. At least these problems will be minor as the plants are in a good state of health.

## Maintenance Calendar

As you can see from the above statements it is essential to have a basic knowledge of pruning, transplanting, and maintenance prior to establishing a calendar. Those in greenskeeping, as well as park administration, are very fortunate that a good maintanance calendar can be worked into their program. Much of the work can be done in the off seasons particularly in the late fall, winter and early spring. For a more simplified program let us list the items by seasons instead of months.

### Winter

1. Pruning - This is an excellent time to start a pruning program especially on non-flowering trees and shrubs that flower on new growth. All dead, diseased, or interfering branches should be removed at this time, cut them flush and paint all wounds two inches or above with an asphalt based paint. Shrubs and trees that flower early in the spring or flower on the old wood should be pruned after they are through blooming. This way the flowers are not destroyed.

2. Fertilization - Fertilizers can be applied at this time to all shrubs and trees following the principles outlined above with a 10-6-4 fertilizer at the rate of two pounds per 100 square feet of bed area for shrubs, and one-half pound of nitrogen per inch of trunk diameter for trees.
3. Mulching - All mulching should be done in late fall or winter as this prevents freezing, thawing, and heaving and is the most desirable time for mulching.
4. Spraying - Dormant oil spray may be applied during the winter months for the control of scale, red spider and other insects.

<u>Spring</u>

1. Pruning - Prune all shrubs that flower on old wood, after they flower, or other plants that flower prior to the first of June. Included in this group are your early flowering trees such as flowering crabs and magnolias.
2. Transplanting - Transplant all thin-barked trees early in the spring and all deciduous material prior to leafing out.

<u>Summer</u>

1. Irrigation - Practice a good maintenance program by irrigating all transplanted plant materials during stress periods.
2. Pruning - Prune all hedges and all shrubs--remove the wild leaders in order to maintain proper shape.
3. Spraying - Maintain routine spray program of malathion and captan bi-weekly to prevent build up of insects and diseases.

Fall

1. Transplanting - Transplant necessary plant materials. Balled and burlapped plant materials can be transplanted in early fall but you should wait until after frost and dormancy to transplant bare root deciduous materials.
2. Irrigation - Water all transplanted material to enable adequate root formation prior to dormancy.

The above maintanance calendar should work in nicely with your regular work schedule and should keep a considerable amount of your personnel busy during the off-season months. By doing this you will have much nicer grounds and they will be much easier to maintain in the future.

# GOLF COURSES OF THE FUTURE

R. Nelson, Jr.

In a recent issue of the Golf Course Reporter, one of the articles made the statement that, "you as golf course superintendents are a potent resource for and a direct ally of those . . . who are serving in the total recreation movement of American to provide . . . wholesome recreational opportunities.: In other words, you are the good guys who must provide fine greens, and well kept fairways and roughs. But heaven help you if you should be so unfortunate as to have a visit from an army of sod web worms or from the evasive fairy rings or snow mold. As you know, to most golfers, you are personally responsible for the invasion of any of these pests or problems. In their minds, they know that you have brought these things about only to aggravate their pleasant dispositions and to make their chances of playing par golf even more remote.

What I am hinting at is the general public's lack of understanding or appreciation of the regorous maintenance requirements on a golf course, excluding any special problems introduced by diseases or insects.

The major challenge today to the golf superintendent is how to execute all of the needed maintenance jobs in the face of increased play on the course. You are all trying to devise means and ways for coping with the pitter-patter of golfers feet over and around the tees, fairways and greens, and particularly those self-propelled monsters on four wheels referred to as caddy carts.

But if you think you've got troubles now, let us look to the future. Seventy-five years ago we spent 5.6% of our time in school, 26% of our time working and 7.8% of our time at leisure. Today (in spite of our longer period of schooling) a man spends about 4% of his lifetime at school, only about 15% at work and has about 21% left for leisure. The proportion of his time devoted to eating and sleeping has remained just about the same. And what about the future? Every day medical science is coming up with discoveries that are lengthening the span of human life. In 1885, the average life span was 40 years, today it is well above 70, and by the turn of the century we may have a life span of 90-100 years. What does this mean? This means that for every increase in the span of human life we are adding more unemployed days to the average lifetime, and more opportunity for some type of leisure activity.

But we do not have to wait until these twilight years to have more time for leisure. The 30-hour or 4-day week is approaching rapidly as we can see in the new contracts signed with the automotive industry. And with increased technological developments, man will have to be retired much earlier than the accepted 65 year age now used as a guide.

There is no need to belabor the point further about the amount of leisure time we have and how much greater it will be in the future. But I do think that it would be worth our attention to spend a few moments considering the fact that in the next 25 years, the per capita income will increase 40%. Therefore, it will be possible for all of us to buy more leisure services and commodities than ever before. There will be more golfers, they will have more time to perfect their game. As they become more sophisticated in their play, they will demand more meticulous maintenance, putting an ever-increasing strain on the superintendents and their staffs.

Therefore, we are going to have to develop golf course designs that can accommodate the increased play and at the same time keep maintenance operations at a reasonable level.

One possible solution might be designing a course with reversible fairways. In this design, a tee and a green would be developed at either end of the fairway. Then you could alternate the pattern of play in order to rest the intensive use areas. Such a design has many implications as far as the total layout of the course is concerned, but it is not beyond the realm of serious consideration.

A second possibility, particularly on small acreage areas would be a nine-hole course, played on just three greens. I am told, however, I have not seen it, that there is such a development on a private estate in Iowa. While this does provide an answer to the problem of competition for land resulting from population growth, it increases the problems of green maintenance if play were extremely heavy.

Other possibilities include more par 3 courses and greater use of night lighting which would give extended hours of play. Also there is the new development by golf course architect, Charles A. Richards, called the Sporran system of golf.

The Sporran system lets the golfer select a famous course such as St. Andrews, Pebble Beach, Augusta National, or Glenn Eagles, and play it as if he were there. A distance calculator tells the player which Sporran hole duplicates the shot he is trying to make on the course he is playing. The balls are not retrieved in this system. The golfer never leaves the tee until his ball is on the green ready to hole out. The he walks to the green, places his ball where it landed and putts it into the cup. In reading over the material on this type of golf, it is apparent that the Sporran system is cheaper to build because it is so compact, not requiring a great deal of land and that it is easily maintained because of the lack of foot traffic over the area. But I don't want to spend a great deal of time on these possibilities because I would like to give you a verbal picture of the golf course of the future as I see it.

All that I ask is that you keep in mind that 50 years ago it was absurd to think of a car in every garage, let alone two; to think of flying from coast to coast in less than four hours; or to believe that the Buck Rogers space flights would ever become a reality. The year is . . . well, its sooner than you think. It's the time of the 28-hour week for which you are being paid 45% more than what you receive now for a 40-hour week. Leisure is your vocation and work is your avocation. And now to relate the story as I am able to perceive it in my crystal ball . . .

It's early afternoon on Wednesday and the whole weekend ahead. The fellow from the neighboring office opens the door with some wise crack about TGIW (Thank God it's Wednesday) and extends an invitation for a round of golf. It sounds like a good idea and he is taken up on the suggestion. But first, they had better find out if they can get a tee time. No use going to any course where you have several dozen waiting to tee off.

So the next step is to get out their golf I.D. number. (This is important in a number happy world of area codes, zip codes, employee I.D. numbers, telephone numbers, social security numbers, bank account numbers, etc.) To get a tee time this is the procedure. Call the course, 879-402-5326, there is a beep on the other end indicating that the electronic tee data processor is ready to receive your reservation. The conversation goes like this: "This is N233-005-6308 requesting a tee time for 8:30 tomorrow morning." Now if all is in order and the requested time open, there will be a cheerful gurling, chugging and hum concluded with a frantic crescendo of the three beeps to confirm your request. However, if this time is already taken, there is a click and a soft, sexy voice suggests that you re-dial and request another time. This exciting conversation is concluded with a cheeful - "this is a recording." All is set and now we move on the the links of tomorrow to see how the designers have coped with the flood of humanity that moves over the course each day.

As our golfers move the the first tee, it is interesting to note that they are not encumbered with bulky, awkward golf bags. Apparently there isn't even a need for those funny looking two-wheeled push carts like grandpa used to use. Now it's easy to see why. They have the fabulous, new, all-purpose club that was invented by that famous old timer, Arnold Palmer. It is really a clever piece of equipment, just make an adjustment on the club and you have your driver, long or short iron, chipper and putter.

Now they are moving onto the tee area. It is as you would expect, covered with a perfect, luxuriant, deep green plastic turf. It has all of the qualities of natural grass, the pleasant, fine texture, and a soft and comfortable resiliency on which to walk. Towards the center of the tee area are three, widely spaced openings in the "turf" and nearby a round disk. The golfer drops his ball over the opening and at the same time depresses the disk with his foot. Immediately a jet of air is expelled from the opening supporting the ball in what appears to be mid-air. With one or two additional foot adjustments on the disk, the ball is "teed" to the golfers desired height. This takes all of the drudgery out of inserting one of those antique plastic or wooden tees into the ground - in fact here your ball is teed without bending over. By the way, have you heard of the fantastic price those old-fashioned tees are bringing these days - a real collectors item!

Now our friends have teed off. One has a beautiful drive a little left of center and straight down the fairway. But our second friend was not quite so fortunate. He apparently teed too high (obviously he doesn't have an educated toe) and he sliced to the right and landed in the rough. Now in the olden days, this would mean that play would be held up while he searches for his ball. But the designer of this course recognized the importance of speeding up the play and developed a method of overcoming such delays. Now all the player has to do is move the the automatic loss ball finder at the edge of the tee. Aim it in the general direction of the ball location and press the blue button. A signal is immediately transmitted which in turn energizes the minute transistor within the ball. The player then proceeds toward his ball with the end of his club held a few inches above the ground. When within a few feet of the ball, a loud clicking noise is emitted, the volume of which increases as he moves closer. The tracking device is then shut off by returning the club to its normal position and play continues.

Oh yes, I almost forgot to tell you how he proceeds toward the ball. Designers, having studied their history well, were aware of the maintenance woes associated with self-propelled golf carts in the old days. In fact the favorite folk songs of the day tell the story of the harried golf superintendents of the primitive days trying in vain to maintain a playable course against the overwhelming odds of the golfer on wheels. To avoid this problem, the designer has contrived an ingenious device that is a combination of a moving sidewalk that is covered by two pieces of grass much like a zipper in clothing. In the case of the zipper, a lap of fabric covers the zipper as it is closed eliminating any exposure. In this case, as the walk on which the golfer is standing moves forward the area immediatly behind is covered over by two pieces of plastic grass. In this way an unnatural hazard for the player following is eliminated. There are three of these moving sidewalks on each fairway - one down the middle and one at either outside edge. After teeing off, the player moves to the golf walk that is closest to his ball. As he steps onto the walk surface he advances toward the green, but he can step off where needed for his second shot.

Of course the wealthier golfer can't lower himself to such pedestrian means of mobility. He actually flies through the air from spot to spot. This is accomplished by the jeticopter strapped to the back. With this device you can ascend vertically from the spot where you are standing to desired altitude, then with the flick of a wrist descend to the ground. If you are interested, the compact models start at $3,500.00

Play has progessed well and our two friends are ready to chip onto the green but are held up by the age-old problem of players taking so much time on the green. You know what I mean, each player studying the path of the putt as carefully as he would a weekend outing to Mars. So far designers have not been able to offer any solution for this problem and probably never will. There are, however, several innovations at the green that are worth noting. The putting surface is always ideal - never a disease problem, no top dressing and no mowing - just a continuous carpet of Seaside plasta-carpet. Again drawing on history, the designers learned that merchandisers in the mid-twentieth century always had soft music playing in stores so people would be more receptive to the merchandise and as a result buy more. Following this lead, the designers placed triple-stero speakers around each green to provide soft music for the golfer. This serves to relax his tensions and creates the most conducive environment conceivable for the critical putt. Once he has successfully holed the ball, it is immediately ejected from the cup omitting one more unnecessary bend.

On the second tee our two players decide that their score might be improved by some practice swings that can be critically analyzed to correct errors in stance, grip and swing. So with the deposit of 50¢ into the slot, the closed circuit television cameras strategically placed begin instant video tape recordings of each practice swing. After completing the practice swings, the golfer moves to the small television receiver located by the automatic ball finder to watch his performance. For another 50¢ the IGA (instant golf analysis) computer will analyze the mistakes and suggest methods for improvement. It is now obvious that there is no need for a club pro.

With the mistakes corrected the golfers now check the automatic score keeper. This compact little device is attached to the players belt and not only gives today's score but provides a concise comparison with your previous scores on the same hole during the current season. In addition it keeps track of your handicap. By now the second player has the airjet properly adjusted to his preferred tee height and is ready to drive. But there is no need for us to follow them through their 18 holes of play. However, there are several other design features of the course that should be brought to your attention. For example, the traps are filled with a synthetic material that is always the same consistency whether it is wet or dry. Raking and repairs to traps are a thing of the past. The particles are magnetized and will fall back into their original position. This also has the advantage of eliminating the spread of the materials on nearby fairway and green surfaces.

On hilly fairways the dangerous blind spots, periscopes with a scanning electric eye have been installed to protect the players ahead. When the beam of the electric eye is broken by players on the fairway, it sends back a warning signal that good golf etiquette demands be observed. Over the entire course is a thin, clear plastic membrane to protect the players from rain, adverse winds and harmful sun rays. Artificial trees and rough plantings are utilized to eliminate the leaf problem. They are available in all sizes. There is one other characteristic of the golf course of the future that has tremendous sociological consequences. They are segregated courses. Segregated not by race, not be religion, not by color, but by sex. Yes, you guessed it! They have separate courses for women and since their innauguration play has been speeded up on the men's course by some 500%.

# WEED CONTROL IN TURF

F. W. Slife and J. D. Butler

For the past ten years, we have had a steady stream of new materials for weed control. Many times when we see a weed problem we think automatically of using chemicals to control it and although this may be a good thing, it is important that we try to find out why the weeds have invaded the turf area. Good healthy, vigorous turf has very few weed problems. Although chemicals may be the best answer to eliminate a problem, unless the basic reason for the weeds invasion is corrected, the weeds will probably reappear. In the long run, good turf is the answer to the majority of weed problems with chemicals as a supplementary practice. The following chemicals that are new, or relatively new, would appear to have a place in the control of specific weed problems in turf:

Dicamba or Banvel D. This material was rather widely available in 1964. It is excellent for knotweed, and white clover control, in bluegrass turf. It is also effective on chickweed and some of the other broadleaf weeds, which are not well controlled by 2,4-D. Unfortunately, it does not give good control on dandelions and plantain. The tolerance of established bluegrass turf to Dicamba is good at a half pound per acre, but as the rate of Dicamba increases, the bluegrass becomes more sensitive. Occasional injury to the bluegrass turf can be expected from 1 pound of Dicamba, particularly when temperatures are high during the summer months. At this point, it would seem best to use one half, and not more than three quarters, of a pound of Dicamba per acre with the idea that a second treatment could be used later if needed. Since there is some hazard to Dicamba being picked up by the root system of desirable trees and shrubs, it is best not to spray above the roots of these plants. Where a wide variety of broadleaf weeds are present, including knotweed and dandelions, the best plan may be to use a combination of Dicamba and 2,4-D amine. Suggested rates would be a half pound of Dicamba and a half pound of 2,4-D, or one half pound of Dicamba and three quarters of a pound of 2,4-D. Insofar as bentgrass greens are concerned, we should remember that bentgrass is more sensitive than bluegrass to Dicamba. Applications of one quarter pound per acre may give some slight discoloration, particularly when the temperature is high. For white clover control or knotweed control in greens, however, applications early in the season when the temperatures are cool should result in a minimum of injury.

MCPP

MCPP has also been used rather widely in 1964. It is exceptionally good for white clover control, chickweed, and knotweed. MCPP is closely related to 2,4-d and like 2,4-D it will occasionally injure bluegrass turf if it is applied during very hot weather and heavier than recommended rates are used. Although bentgrass greens and fairways appear to have more tolerance to MCPP than 2,4-D, it is best to apply this material again in the spring or early summer before temperatures become exceptionally high. Where white clover is the major problem on a green, MCPP may be preferred over Dicamba because of slightly better turf tolerance.

Betasan. This pre-emergence crabgrass killer was not widely available in 1964, but is expected to be more plentiful in 1965. It is excellent for crabgrass control in both bluegrass and bentgrass. Newly established bluegrass or bentgrass would be injured by treatments of Betasan, but established bluegrass and bentgrass are quite tolerant. One of the most encouraging things about this new material is that silver crabgrass seems to be sensitive to it and Betasan would appear to be the best material available today for treatments on greens or on the collars. Betasan appears to have long soil residual and there may be some carryover into the next season. Suggested rates are from 10 to 15 pounds per acre.

Tupersan. This new pre-emergence crabgrass killer will apparently be available in 1965. It appears to be excellent for use on established turf, including bentgrass, fescues, and bluegrass. It appears to be an excellent control for most of the annual grasses, including foxtail, crabgrass, and silver crabgrass. Our studies would indicate that silver crabgrass, however, will require higher rates of Tupersan than ordinary crabgrass. Poa annua, either germinating from seed or established, appears to be quite tolerant. The germinating grass seedling of our desirable turf grasses seems to be highly tolerant to Tupersan. Rates of 7 pounds per acre or below have not reduced the germination or seedling vigor of Kentucky bluegrass, creeping red fescue, tall fescue, redtop, or bentgrass. Field trials would indicate that at 10 pounds per acre, some slight reduction in germination will result on Kentucky bluegrass, but even at this rate, a high degree of tolerance is present. Excellent crabgrass control was obtained at both the 4 and 7 pound rate. It would appear that this material could have a very important place in the establishment of new lawn and also brings about the possibility of establishing lawns throughout the summer months. Many of the species of broadleaf weeds are controlled with Tupersan, but it is obvious that the broadleaf control is not as good as the annual grass control. A suggested rate for trial use would be 6 to 8 pounds per acre, put on the soil surface immediately after planting.

Azak. This is a new pre-emergence crabgrass killer that was not widely available in 1964. It appears to give excellent control of crabgrass in established bluegrass. At recommended rates (10 pounds per acre), it would appear that established bluegrass is quite tolerant. The tolerance of established bluegrass to rates higher than the 10 pound rate has not been thoroughly established.

# Illustration of a Turf Grass Disease Study - Helminthosporium Leaf Spot of Creeping Bentgrass

M. J. Healy

The study of turf diseases comprises a very interesting area of Plant Pathology. Turf diseases are generally caused by one of a group of primitive parasitic plants called fungi. There are few if any known bacterial or virus diseases of turf. Small worm-like memebers of the animal kingdom which may be turf grass pathogens are nematodes. These organisms have already been shown to exert pathogenic effects on St. Augustine grass and other warm season species grown in the south eastern states.

In order to accurately diagnose the Helminthosporium leaf spot disease of bentgrass, the entire range of visual symptoms seen under natural conditions must be recorded and proven to be caused by the pathogen, *Helminthosporium sorokinianum*. Each time diseased turf is suspected of having Helminthosporium leaf spot, the known pathogen, *H. sorokinianum* must be isolated from the diseased plants. This shows that the fungus was present in the diseased plants. The isolated fungus must then be used to inoculate healthy plants, and the disease must be produced on them, and *H. sorokinianum* reisolated. If the original isolation is made from leaf tissue showing distinct leaf spots, inoculation of healthy plants should produce the same leaf spot symptoms. If the original isolations of *H. sorokinianum* come from leaf tissue that is completely blighted or wilted, inoculation of healthy tissue must also produce similar blighting or wilting symptoms. To artificially produce the full range of symptoms caused by *H. sorokinianum* as seen under natural conditions has required considerable regulation of the environment, especially temperature and moisture. Techniques of inoculation must be perfected so that the type of symptom desired may be obtained consistantly.

*H. sorokinianum* can be isolated from infected bentgrass by using the following procedure:

1. Wash the plant material in water. This will remove many microorganisms which may be on the surface of the plant material.
2. Dip the leaf into a solution containing a disinfectant. A ten per cent solution of a household bleach is commonly used. This will kill many microorganisms which are on the leaf. Any microorganism deeply embedded in the plant material will usually not be killed by this disinfectant.
3. Remove the plant material from the disinfectant and, under aseptic conditions, place the plant material on a sterile agar plate. Aseptic techniques are used to prevent the contamination of the agar plates by some other organism. The agar plate has little or no nutritive value. H. sorokinianum will grow slowly through the plant material and finally emerge producing a sparce mycelial growth on the agar. Spores of H. sorokinianum form readily on the agar plate and make it easy to identify.
4. After the organism has been identified, a small part of it (either an individual spore or individual mycelial tip) is transferred to another agar plate containing a nutrient such as potato or tomato juice, corn meal or sugar. This nutrient agar is also sterilized before use to guard against the contamination by other unwanted organisms. H. sorokinianum can be grown and maintained on nearly any common nutrient agar. The effects of some environmental factors on the growth of the fungus can be determined by studies with agar plate cultures. The minimum, maximum and optimum requirements for temperature, light, and pH can be determined as can the type of nutrient materials that will support the growth of the fungus.

Bentgrass plants can be successfully inoculated with H. sorokinianum using the following technique:

1. Bentgrass plants grown in pots under greenhouse conditions are enclosed in plastic bags for a period of 10 to 12 hours before inoculations are made. The closed plastic bag serves as a moist chamber and the leaves become covered with water droplets. The fungus spores will easily adhere to these damp leaves.
2. Plants are then inoculated with H. sorokinianum spores using an atomizer containing water with spores obtained from an agar plate culture of the fungus.
3. Since the spores need free moisture in order to germinate, the plastic bags are replaced on the pots for a period of 24 hours. After this 24-hour period, the plastic bags are are removed and the inoculated plants are placed in a growth chamber where temperature can be controlled.

Growing betgrass under normal greenhouse temperatures (65-95°F.) and inoculating these plants by the procedure given will consistantly yield distinct leaf spot symptoms. To produce wilted or blighted symptoms, the bentgrass is grown as before, but for a period of one hour before inoculation, the leaf tissue is placed in a water bath maintained at 108°F. Plants heat treated in this manner and inoculated with H. sorokinianum produce typical blighting or wilting symptoms found in the field during July and August. Plants heat treated but not inoculated show no visible adverse effects.

A study is being made to determine whether differences in symptom development in heat treated vs. nonheat treated plants can be ascribed to a more extensive growth of the fungus in the blighted leaves by observing the location of H. sorokinianum mycelium within the host plant tissue. Visual symptom development, whole mounts, and sections of plant tissue are being made at eight-hour intervals to determine the chronological progression of the pathogen into and through the host tissue. Visual symptom development is correlated with whole mount and leaf section studies. Whole mounts are made by clearing the tissue of chlorophyll with chloral hydrate and selectively staining the cleared tissue to differentiate the fungus from the host. The plant material is microscopically examined and the method of fungal penetration noted. After the fungus has penetrated more deeply into host tissue, sectioning is used to study its progress. Sectioning consists of many steps, however, these steps can be broken down into four main procedures. First, the plant tissue is fixed and then dehydrated using an alcohol series. Second, the plant tissue is embedded in some type of wax; paraffin is often used. Thirdly, the embedded material is cut into extremely thin sections--these sections may be only 15 microns thick. These thin sections are placed on a microscope slide and passed through a series of stains. The finished slide consists of a series of ultra thin cross sections of plant material stained so that the fungus may be differentiated from host tissue.

As a closing note, it cannot be emphasized too strongly that proper sample taking of diseased turf areas is extremely important in the diagnosis of all turf diseases. The area immediately between healthy and infected material contains plants which are newly infected and show only minute visual symptoms. Isolations made from these plants will usually be far more successful than isolations made from heavily infected or dead tissue because many secondary invaders which may or may not be pathogenic soon contaminate the diseased tissue. Isolations made from plant material containing many of these secondary invaders may hide the presence of the true pathogen due to their more rapid growth on agar. Take all samples from the edge of diseased areas as this newly infected area of plant material is most free from secondary invaders.

# Agricultural Chemical Use On Golf Courses
(Reprint from March, 1963, Farm Chemicals)

L. Holmes

Prior to preparing this report I thought it would be quite simple to obtain certain facts and estimates pertaining to overall consumption of agricultural chemicals on golf courses. To my surprise and chagrin such data is not obtainable at either the retail or manufactuer's level. I was repeatedly referred to consumer sales and estimates published by the U.S. Government. I was unable to locate statistics which specifically reported on pesticide or fertilizer usage in golf. Obviously, another approach was needed if this report was to be a reality.

Therefore, what could be employed to arrive at estimated quantities and qualities of materials used in golf? It must be established immediately that all such data are educated guesses derived from: 1) Ten years personal experience in the golf - turf consultant field; 2) Information obtained from publications of the National Golf Foundation, Chicago District Golf Association, Metropolitan Golf Association and the United States Golf Association; 3) Personal correspondence with acquaintenances in the chemical supply industry; 4) Correspondence and consultation with other United States Golf Assocation Green Section agronomists; 5) Information obtained from numerous golf course superintendents; and 6) Access to a number of golf course maintenance budgets. Even though the information obtained is considered an educated guess, it must stand until someone else challenges its accuracy.

The estimates made include the <u>cool season</u> area or northern area of the country, primarily because I am not adequately familiar with the <u>warm season</u> area. However, cool season data can be interpolated to meaningful estimates for warm season areas by anyone who is familiar with the variation in materials required because of the extended growing season and different requirements of local grasses.

I. Size of Area to Be Treated

To start with, let's establish the number of courses with corresponding acreage in the area under consideration, namely: New England; Mid-Atlantic; North Midwest, including Kentucky; and North Central, to include 20 states.

In 1962, according to a National Golf Foundation survey, there were 3618 nine-hole and 2903 eighteen-hole golf courses for a total of 6521 in the United States. The 20 state area we are considering has 1984 nine-hole and 1638 eighteen-hole golf courses for a total of 3622 or contains approximately 55% of the courses in the United States. Furthermore, of the total courses in the 20 state area, 55% are 9-hole courses, thus 45% are 18-hole courses. This ratio of 9-hole courses comprising approximately 55% of the total has remained quite constant for the past few years. In 1960, figures published by the National Golf Foundation, there were 582,003 acres in 6011 nine and eighteen full-length golf courses. It can be determined from this that the average size for 9-hole courses is roughly 60 acres and the average size for 18-hole courses is 140 acres. However, acreage estimates from 30 clubs in the New York and Chicago areas for 18-hole courses is closer to 155 acres per club. Actually, the total acreage per club is not of particular importance for compiling agricultural chemical use data. Of significant importance is the total acreage of rough, fairways, tees and greens. Obviously, herbicides, insecticides and weed killers occasionally are used in out-of-play areas but are not considered sufficiently important for inclusion here.

Now let's determine the size of areas which are to receive agricultural chemicals and follow this with data on the actual chemicals.

Fairways: The average 18-hole course consists of 10 par 4, 4 par 5 and 4 par 3 holes. Par 5 holes average 500 yards, par 4 holes average 400 yards and par 3 holes average 180 yards in length. The average fairway is 30 yards wide.

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|---|---|---|
| Therefore: | Par 5 holes include approximately | 12 acres |
| | Par 4 holes include approximately | 25 acres |
| | Par 3 holes include approximately | 5 acres |
| | Total | 42 acres |

Many people dealing in golf often figure that total fairway areas are 60 to 70 acres; but this can not be true unless roughs are not maintained and fairways are excessively wide. The more astute operators are aware that wide fairways are costly as there is a great variance in per acre maintenance cost between fairways and roughs.

Roughs: Ideally, rough areas are the same size as fairways, or slightly larger, for maintenance and budget consideration. Naturally there is a great variance here depending upon terrain and width of maintained fairways.

Tees: So called modern design includes larger teeing areas. Therefore, many of the newer courses have expansive teeing surfaces. Nonetheless, I have found that tees are far less in area than most estimates indicate. The average tee in the 20 state area we are considering is no larger than 1200 square feet, this includes the newer courses with larger tees. The average teeing area per course, then, is 19 x 1200 square feet or approximately ½ acre.

Greens: Here again estimates can be erroneous. One often hears that greens on a certain course average 5,000 square feet. On newer courses, greens are occasionally larger than this, even up to 14,000 square feet.

However, all courses considered, I would estimate that the average green is between 3000 and 4000 square feet; 3500 square feet is an ample estimate.

3500 square feet x 19 = 66,500 square feet of 1½ acres; for ease of figuring consider 2 acres for 18-hole courses and 1 acre for 9-hole courses. It must be remembered that this is an average.

Totals for the average 18-hole course then are as follows: 42 acres fairway, 42 acres rough, ½ acre tees, 2 acres greens to equal 86½ acres of a highly cultivated crop. Remaining territory consists of water, out-of-play areas, extended rough or deep rough, trees, waste area, parking, club house and other activities areas.

The average 9-hole course is: 21 acres fairways, 21 acres rough, ¼ acre tees and 1 acre of greens to total 43¼ actual playing acres.

As previously determined, in the 20 state area under consideration, there are 1984 nine-hole and 1638 eighteen-hole courses or, on 18-hole courses: 68,796 acres of fairway, 68,796 acres of rough, 819 acres of tees and 3276 acres of greens. On 9-hole courses: 41,664 acres of fairway, 41,664 acres of rough, 435 acres of tees and 1984 acres of greens for a grand total of:

| | | |
|---|---|---|
| Fairways | | 110,456 acres |
| Roughs | | 110,456 acres |
| Tees | | 1,254 acres |
| Greens | | 5,260 acres |
| | Total | 227,426 acres |

II. Application of Agricultural Chemicals

There is no definite or set maintenance program. Each individual golf course superintendent follows a program he personally considered superior. However, a few procedures are standardized which can be used to figure estimates of materials used.

Bentgrass fairways:

1. Requirements for plant nutrients are between 120 and 160 pounds actual nitrogen per acre per year and approximately ½ this amount of phosphoric acid and potash. The courses with higher maintenance budgets will fall within this range. As a matter of fact, if they expect to maintain bentgrass fairways in top condition at all times there is no choice. Obviously, parent soils vary with regard to quantities of phosphorus and potassium inherent in the soil along with histories of past fertilizer usage. Nonetheless, for estimate - analysis, the ½ total nitrogen ratio can be used. I would estimate that no more than 1/10 of the courses in the area under consideration fall in this category. An educated guess for an average would be 90 pounds of actual nitrogen.

2. There is an increase of fungicide usage on bentgrass fairways and this will continue to increase. Of the total 3622 courses considered I would estimate that 250 courses are regularly following a fairway fungicide application program. For all intents and purposes, at the present time fungicide use is limited to phenyl mercuric acetate mixed with iron sulfate. Rates are 1 quart of 10% PMA - 3 pounds of iron sulfate per acre. Six treatments per season is average.

3. All courses use herbicides. Both post and pre-emergent chemicals

are used. Bentgrass is quite subject to chemical damage from many post emergent hormone type products and care in their use must be taken. Nonetheless, 2,4D - 2,4,5T and 2,4,5TP continue to find the greatest use simply because superior products are not available. For the past couple seasons new chemicals which show considerable promise have been tried. To date, exacting toxicity data has not been adequately determined for many of these products. The weeds which consitute the most serious problem on bentgrass fairways are leafy weeds such as dandelion, planton, clover, yarrow and knotweed; also grasses such as Alta fescue, crabgrass, nimblewill and Poa annua.

Pre-emergent herbicidal chemical usage is gaining in favor. Still in greatest use is lead arsenate. However, many new chemicals are showing excellent results and their usage will increase to the point in a few years to where lead is no longer used. The high-budget courses can afford to apply lead arsenate at a rate of 400 pounds per acre. Lead is currently selling at or above 30¢ per pound, or cost is at least $120 per acre. Naturally, golf course people would prefer to spend considerably less than this but the fact remains that for adequate control of a pesky weed (and in this case insects also) many courses will spend up to $120 per acre.

Bluegrass fairways: (Predominantly Kentucky bluegrass)

1. Nutrient requirements for bluegrass (not including the Merion strain) is less than for bentgrass. Optimum requirements are between 90 and 110 pounds actual nitrogen per acre per year and approximately ½ this amount of phosphoric acid and potash. However, I would estimate that only about 1/5 of the courses which

maintain bluegrass fairways apply this amount. (I call on many courses which have never applied one pound of fertilizer to fairways). An educated guess here would be an average of around 30 pounds of actual nitrogen per acre per year.

2. Fungicides are rarely used on bluegrass. Occasionally leafspot becomes so severe that PMA and iron sulfate are applied. However, fungicidal usage on bluegrass fairways is hardly a discernible factor -- even though it should be.

3. Herbicides are regularly used. Damage to bluegrass is much less of a factor than with bentgrass. Also, once weeds have been eradicated from bluegrass, re-encroachment is slower than with bent. In actual dollars spent per acre, I would estimate that bentgrass is twice that of bluegrass.

4. Insecticide usage is about the same for both types of fairways. There is no set program for application of insecticidal chemicals but rather they are applied as needed. Infestation of insect grubs is the most serious problem and one which must be handled immediately. My experience would indicate that an insecticide is applied to all fairway and rough areas of all courses under consideration on an average of once every 3 years (except in areas where Japanese beetles are serious). In that insects <u>must</u> be controlled the $120 per acre figure for lead arsenate indicates the maximum amount which would be expended for this purpose. Many effective insecticides are available and are used.

<u>Greens</u>: I know of no other crop grown on as large a scale which is as expensive to maintain as is bentgrass for putting purposes. An estimate

here is \$100 per green per year for fertilizer and chemicals or \$1250 per acre. The following data can be used to determine total amounts of products used.

1. Fertilizer requirements are 7 to 9 pounds of actual nitrogen and approximately ½ this amount phosphoric acid and potash per 1000 square feet per year. This amount is used on all courses with few exceptions.

2. Fungicides are applied on an average of 8 times per season for all courses in the 20 state area considered. This is my own estimation and is derived from experience and available budget data. The better courses will treat up to 20 times per season; the poorer courses treat at least once.

3. Pre-emergent herbicidal chemicals are used more frequently than are post-emergent products. Hormone type products are rarely used because of the toxicity factor. Lead arsenate finds extensive use, rates are 6 to 10 pounds per 1000 square feet per year. Other chemicals are being tested and their use will no doubt gradually increase. The amount spent or the cost per acre to overcome some serious problem on putting surfaces can be extremely large. I would estimate up to at least \$1000 per acre for the better courses.

4. Insecticides are applied as needed. I simply am not able to arrive at accurate estimates with data at my disposal. It might be worthwhile to note that grubs are not a problem in greens where lead arsenate is regularly used, and that contact insecticides are used at rates recommended by manufacturer

every time a brood of the various kinds of cutworms or sod web worms hatch. This is done on all courses regardless of the size of budget as insects must be eradicated. If necessary, insecticides are purchased even though the particular purchase is not included in the budget and budget estimates are exceeded.

Tees: For all intents and purposes, bentgrass teeing areas receive basically the same care as bentgrass greens, and bluegrass tees receive the same care as do bluegrass fairways.

Roughs: I would estimate that insecticides and fertilizers are applied to rough areas once ever 5 years - average - on all courses under consideration. Herbicides of the hormone type are applied once every 1½ years. Pre-emergent products are rarely applied to rough areas. However, with the newer products being tested, I believe pre-emergent chemicals will gradually consume the majority of this market.

III. Budget Consideration

I have in excess of 270 budgets. These are estimates made by various golf associations and budgets which I have personally obtained. In the majority of cases fertilizer and chemical costs are grouped and reported under the same heading. However, there are a sufficient number which list chemicals (insecticides - fungicides - herbicides) and fertilizers seperately to develop a trend. This trend indicates that approximately twice as much money is spent for fertilizers than is spent for chemicals. The average expenditure for agricultural chemicals -- including fertilizers -- is $6250 per course. No break-down between greens - tees - fairways - rough is available from these budgets. This would mean that approximately $2085 is spent for chemicals and $4165 is spent for fertilizers. Further, my experience indicates that the total cost for chemicals roughly could be divided as 2/5 for fungicides, 2/5 for herbicides and 1/5 for insecticides. The above figures are for courses with bentgrass - watered fairways and are the top-budgeted, best-maintained clubs. The amounts spent will spread between $6250 for the best clubs as indicated and $1000 for the lesser budget courses. These courses with higher budgets will not comprise more than 15 to 20% of the total.

Conclusion: With data currently available, exacting estimates of amounts of agricultural chemicals used in golf can not be determined. However, estimates derived from the dearth of available information along with various personal correspondence and experience has been used to arrive at "educated guesses" as to quantities and qualities of products consumed.

In the 20 state area reported on, there are 227,426 actual acres of golf playing turf or that area of golf courses which will at some given time receive "agricultural chemicals". This acreage is contained on 3622 full-length 9 and 18 hole courses. The higher budgeted clubs spend an average of $6250 for agricultural chemicals; the lower budget clubs will spend in excess of $1000. The most expensive and difficult turf to maintain is "watered" bentgrass.

# METHODS OF TESTING TURFGRASSES

T. Gaskin

Adequate testing of a new turfgrass variety or selection is essential to determine its value and possible uses. Proper testing can tell whether a variety will be adapted to a certain area and the best uses for a turfgrass variety. Adequate testing and the knowledge from such tests can prevent the improper use of a turfgrass or planting in the wrong location. Testing can also tell us of a special use for a variety or a new area in which a variety is adapted.

In addition to the testing of presently used varieties of turfgrasses, testing will also help in the selection of new improved varieties. It can be easily seen that a carefully designed testing program will eliminate the poorer types and leave the better. Thus, one can screen hundreds or even thousands of different turfgrass types; discarding the poorly adapted strains and putting the better looking strains under more and more severe tests. In this manner, one or a few of the best adapted types can be selected from a large number of selections.

## TESTING OBJECTIVES

Every cultivated plant has one or more characteristics that are considered important for that plant. For some yield is important, others adaptibility to a particular area is important. Turfgrass, being considered "ornamentals", must have an attractive appearance. In addition, there are many other features of a turfgrass that must be considered in any testing program. The following list of characteristics are the ones that are considered most important in many turfgrass testing programs. Most, if not all are related to the appearance of the grass.

1. Disease and insect resistance.
2. Adaptibility to many conditions of heat, cold, moisture, fertility, etc.

3. Recovery from injury.

4. Turf-forming ability.

5. Wearing ability.

6. Specialized uses such as shady areas and under short cut.

The importance of each of these criteria will vary in various parts of the country. In the east and north-central part of the United States disease is of the most importance. In the drier areas to the west where disease is not a severe problem, adaptability to conditions of heat, cold and drought are important.

If one is concerned with a grass for golf course tees and greens, one of the major criteria is the ability to grow under short cut and recover from injury while disease is of less importance as one can afford to control disease with fungicides. Therefore, in each program, the most important objectives must be selected for the grass and area involved.

METHODS OF TESTING TURFGRASSES

In order to completely and adequately test a grass, one must have a piece of turf. A great deal of information can be determined from unmowed individual plants such as rate of spread and disease resistance or susceptibility. However, a well grown mown plot is necessary to determine important turf characteristics.

Since we are only interested in the methods used in turfgrass testing, the methods used to propagate selections and the source of the selections or varieties used in the test are unimportant here.

One of the most important things that must be included in each test plot are check varieties. In this way, one can compare the standard types which have a known performance over a wide area with newer selections and strains. The check variety or varieties must be chosen with care for the conditions that most likely will be encountered. For example, Merion Kentucky bluegrass would be an excellent check variety where one had severe leafspot attacks since it has the highest known resistance to leaf spot and any bluegrass selection should have, at least, an equal resistance to be worthy of introduction. In areas where stem rust is a problem, Merion would not be a good check as it is very susceptible.

Another very important point is the necessity of having replications of each variety. This is necessary so one can recognize that a grass in one plot is superior to another grass because of location or better soil rather than being superior in itself.

With these things in mind, we can take up the methods used to test grasses for each of the six characteristics.

METHODS OF TESTING THE REACTIONS OF TURFGRASSES TO DISEASE AND INSECTS

The method that takes the least amount of time and effort is to allow natural invasions of disease-producing organisms or infestations of insects. These attacks are excellent when they occur but the big problem is that they cannot be relied upon to occur every year. Many important diseases appear only once or twice a year and may not appear at all during the year. Because of this, methods have been devised to produce artificial outbreaks of disease. This is done by several means. One of these is to plant plots and strips of a susceptible variety around the test plots which allows the disease organism to build up and it will later spread to the varieties to be tested. Other methods that have been widely used are to grow the disease producting organism in artificial culture and spray the pathogen, a fungus usually, on the turf to be tested. If the pathogen cannot be grown on artificial media, diseased leaves can be collected and placed on the plots. This is the way rusts and mildews are handled.

After the inoculation has been made, the plants must be kept moist in order for the disease to develop. Placing moist cloths or burlap on the plots has been used to keep the plants moist. After a period of time these are removed and the disease allowed to develop. Artificial climate chambers have been used for complete moisture control but they are limited in space.

In addition to the direct effect of the weather on disease development, there are many other factores such as level of fertility, age of the plant, etc., which will determine the severity of the disease attack and this will be important in the validity of the results.

Natural infestations of insects have been relied upon to screen for insect resistance although in some cases the insect infested material has been gathered and spread on the plots.

After the injury has occurred from either disease or insect, records must be taken of the damage. In areas of short turf the area killed or diseased can be measured. In taller growing turf, the number of diseased leaves or the amount of each leaf diseased can be recorded. Often a general reading of disease or insect activity is taken.

ADAPTIBILITY TO MANY CONDITIONS

A turfgrass that can be grown over a wider area and under more different conditions is more valuable than one that can only be grown in a few locations or under certain limited conditions. Several methods can be used to test adaptibility. One is to have a number of test plots scattered across the country and in different types of locations, such as plots on different soil types as sand or clay. These widely scattered plots are then subject to many different condtions, some of which the experimentor is not even aware of but which effect the performance of the grass.

There are several drawbacks to this method. Some are the high cost of this type of plots, the problem of getting proper maintenance at widely scattered places, the difficulty of taking readings at many places at once, the relatively few numbers of different selections that can be tested, and lack of consistent conditions out in the field. Because of this, experimentors have tried to test in one location for specific conditions by artifical means. One must remember that any particular selection that is considered for release to the public should be widely tested. But one can eliminate a lot of poor material by artificial means to start with, taking the best selections into the field. Some of the methods used to test or screen turfgrasses for specific characteristics are described below.

### Heat and Drought Tolerance

The most common method used has been to grow the plants in pots and subject them to a period of heat or drought in the green house or controlled climate chamber. These chambers are kept at a high temperature, a low humidity, and a fan blows across the plants. After a period of time, the plants are removed and the survival and recovery of the plants recorded.

### Cold Tolerance

A method similar to heat tolerance has been used but a deep freeze is used instead of a climate chamber. The plants are allowed to become adapted to the cold and then are put in the deep freeze and cooled to about -15°F. After a few hours, the temperature is raised and the plants grown on and their survival recorded. These results have compared well with outdoor results.

In both heat and cold tolerance mature sod or seedings can be tested. The ability of seedlings to develop under conditions of heat, drought, and cold is important.

### Levels of Fertility

The ability to grow under different levels of fertility is important. The best method is to use a split plot outdoors where part of the plot receives a high level of fertility and another part of the same plot receives little or no fertilizer. Records can be taken of clippings removed or measurements made of plant parts such as number of leaves, shoots, etc. Of course, one must take into consideration the type of soil, the type of fertilizer applied, the amount of water as rain or irrigation, etc.

Soil Conditions

The ability of certain turfgrass to grow under adverse soil conditions can be tested in the greenhouse or in the field. The usual procedure is to establish various turfgrass varieties or strains in pots of various treated soils and then determine the growth reduction of the plants in the poorer soils or soils with low PH or high in salts. In this way, it is possible to isolate types of grass that will grow under these condtions.

Herbicides and Other Chemicals

Because of the wide range of chemicals that are applied to turf to control weeds, diseases and insects, the reaction of turfgrass varieties to chemicals are important. Since even the varieties in one turfgrass species will vary in their reaction to one chemical, this testing is important. The testing can be done in the green-house or the field. Applications of the chemical are made and the effects observed. Careful measurements of changes in production of clippings or number and size of plant parts are more desirable than visual readings.

There are many other tests that can be applied to evaluate turfgrasses. In the future, we can expect a greater emphasis on testing and screening varieties under controlled artificial conditions.

RECOVERY FROM INJURY

There have been several methods used to test this characteristic. Because it is related to wearing ability, readings can be made on the recovery of grasses tested by wear machines, which are described under wear ability. Other methods used have been to manually walk on the turf at frequent intervals, cut slits or holes in the turf, or strip the sod with a sod cutter. Natural occurrences of disease or other agents can produce injury. The recovery of the grass can then be measured.

There are two factors to be considered. One is the speed which the damage areas fill in, the other is the completeness of the recovery. Creeping bent is an example of the first group while Meyer Zoysia is a grass which fills in slowly but solidly.

TURF-FORMING ABILITY

This characteristic is the ability of a turfgrass to get off to a quick start when planted, spread rapidly, and form a good turf in a short period of time. This ability is linked with high seed germination, vigorous seedling growth, aggressive spreading ability, and resistance to disease.

One of the ways that has been measured is to plant an individual plant either a seedling or a vegetative proprogation and see how fast it will spread and form a turf. This can be rated either visually or by measuring the circumference of the plant. Other more refined (and laborious) methods include counting length and numbers of shoots, leaves, and rhizomes, etc.

If one is interested in sod, one can cut a strip of sod and either roll and unroll it several times or in some other way give the sod a rough treatment. Those selections that do not crumble or break up can be considered superior in turf-forming ability to those that break apart.

Density is an important criteria of a well developed turf. Measurement of density is an important way of evaluating a turfgrass. The most widely used method to measure density is to take samples and count the number of shoots or buds that are present. Other workers have measured the amount of chlorphyll present as an index of density.

WEARING ABILITY

A superior turfgrass variety or selection must be able to withstand traffic. This is particularly important in golf course tees and greens, playgrounds, and football fields. The first approach used to measure wearing ability was to walk across plots with various types of shoes and evaluate the injury. The next step was the development of a machine to do the job. These machines scuff the turf and the ratings are taken on the period of time it takes to produce a specific damage, such as wearing the grass down to bare ground. Other workers have driven a truck over the plots at regular intervals and rated the injury. This, however, results in compaction as well as wear.

Once wear or injury is produced, one can measure recovery and the ability of the strains or varieties to form a new turf.

SPECIALIZED USES OF TURF

The uses of turf are varied from one extreme the short cut, low-growing grasses for putting greens which are frequently mowed, to the taller-growing grass for airports and parks which may be mowed only several times a year. In addition, grasses are grown under special conditions such as shady areas which demand special types of grass. Special tests have to be devised for each of these cases. The special tests for putting green grass and shade grasses will be discussed here.

Because of the many adverse factors affecting putting green grass such as the short and frequent mowing, the heavy continous use resulting in compaction of the soil and wear of the grass, the increased disease activity due to short cut, etc., the testing of putting green grasses is difficult in any other place than on a putting green. Special machines have been devised to compact the soil and the wear machines have been used to simulate wear but none have been successful in duplicating conditions on a putting green. So the best test is testing under conditions that the grass will be used, i.e. a putting green.

Testing grass for shady areas is a little simpler. The use of plastic shade cloth has provided a cheap shading device that can be put up and taken down easily. The use of photographic light meters to determine light intensity has standardized many experiments. Other tests have been run in the shade of trees which is more variable than under the shade cloth but more typical of many shaded areas. Density and disease ratings can be taken to evaluate performance of grasses in the shade.

Other Considerations

The importance of replication of the varieties and the necessity of having check varieties has been mentioned. The size of the plots is important. A plot that is too small just will not give enough information to make it worth while. And as the plots get larger it costs more to plant and maintain as well as reducing the number of items to be tested. The smallest suitable size is about 3 x 3 feet. If a larger plot can be planted, it can be subdivided into several mowing and fertilizer plots. One of the methods used has been to plant one 3 x 15 foot plot and two other 3 x 8 foot plots as replications. Part of the sod of the larger plot can be stripped off for testing in other locations while a 4 x 3 foot plot can be mowed a low height which will favor disease and a 4 x 3 foot plot at the normal mowing height. The plots can also be subdivided for fertilizer treatments. Other testing methods can be used such as shading part of the plot or treating with chemicals.

Data on the performance of grasses should be recorded as it is taken. Written records have a great deal of value since one can check how a variety has done in the past. There are many different kinds of data sheets, each divised to record a certain amount of information. The major aim of any data sheet is to be simple and easily and quickly filled out yet have room for all the data and be able to rank the different grasses. A sample data sheet is included in this report.

The testing of turfgrasses has been going on for a relatively short period of time and we can expect great improvements in the future.

BLUEGRASS

Testor Warren's Turf Supplier "X" Company Strain Brand X

Check Variety Merion Location Palos Park, Ill. Date Oct. 1, 1964

Appearance: Excellent - Good - Equal Check - (Poorer Check) - Not Acceptable

Density: Excellent - Good - (Equal Check) - Poorer Check - Not Acceptable

Texture: Coarse - (Medium) - Fine - Very Fine

Color: Yellow - Light - Medium - (Dark) - Very Dark Green

Vigor: Excellent - Good - Equal Check - (Poorer Check) - Not Acceptable

Other: SHOWS DROUGHT INJURY

DISEASE

| | None | Light | Medium | Sus. | Severe | Check Variety | Present |
|---|---|---|---|---|---|---|---|
| Leaf Spot | | | | | X | NONE | YES |
| Melting Out | X | | | | | NONE | NO |
| Mildew | X | | | | | SUS | YES |
| Stem Rust | | | X | | | SUS | YES |
| Other Smut | | | | X | | SUS | YES |

INSECTS and OTHER PESTS

Sod Webworm SOME DAMAGE - MERION PREFERRED HOST

Other Armyworms PRESENT BUT NOT DAMAGING

Weeds: None - (Few) - Many - Severe Kind: Crabgrass

No. strains in trial 10 Rank of this strain 7 Rank of check 2

Replication 3 times

Remarks: THIS STRAIN APPEARS TO HAVE SUFFERED FROM DROUGHT AND LEAF SPOT

# HOW A PLANT GROWS

T. K. Hodges

The growth of a plant is an extremely complicated phenomenon. Many separate and intricate processes are involved and these processes must all proceed in harmony with each other or the plant does not grow normally. To pretend that I know how all of these processes are integrated together to give an efficiently functioning unit would be presumptuous indeed. However, we do have at least a rudimentary understanding of the major events which take place during the growth of a plant and I would like to discuss some of these with you today. To illustrate how the many separate processes can be carried out simultaneously within the plant I will then briefly describe the internal structure and function of a plant cell.

A plant goes through several distinct phases during its life cycle. These phases can be diagrammed as follows:

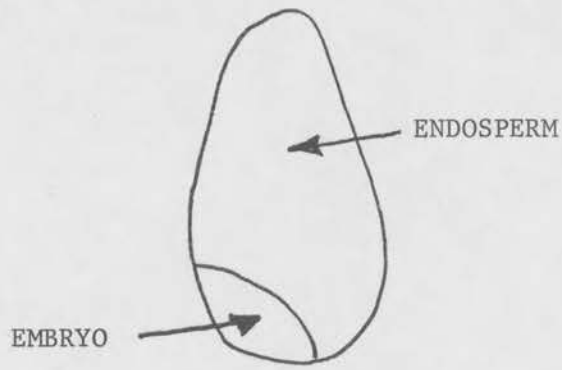
seed germination ⟶ greening ⟶ vegetative growth ⟶ reproduction

For todays discussion I will only mention some of the physiological aspects of the first 3 phases.

## Seed germination

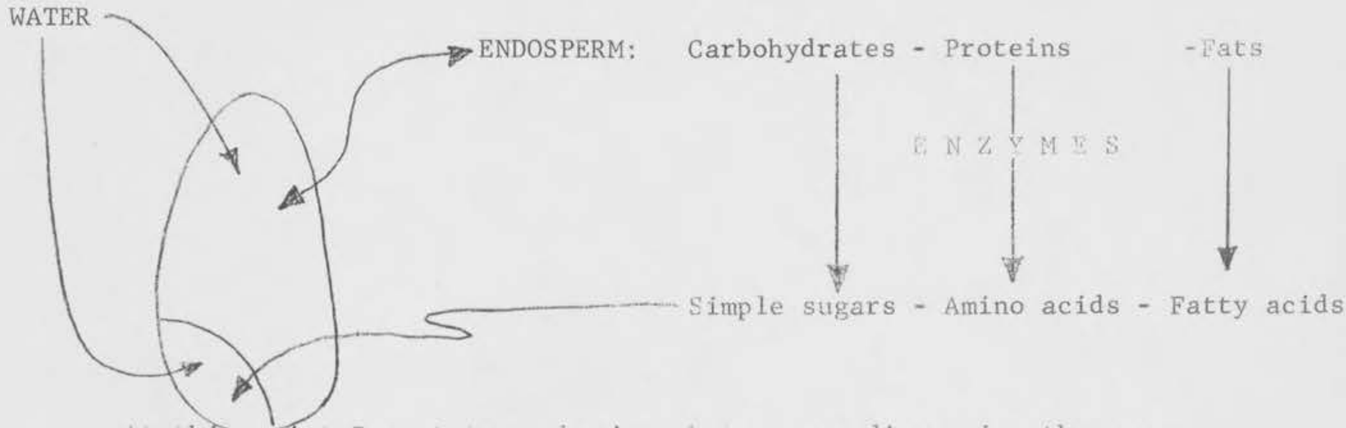
When we speak of seed germination we mean that certain external conditions have become favorable so that the living cells of the dormant seed can resume activity. Cells of the embryo begin to divide and redivide. The cells expand and eventually organs such as roots, stems, and leaves take form.

In order to understand the physiological events which occur during seed germination it is first necessary to know the structure and composition of a seed. I have diagrammed below a typical grass seed. The two most important parts of the grass seed are the embryo and the endosperm.

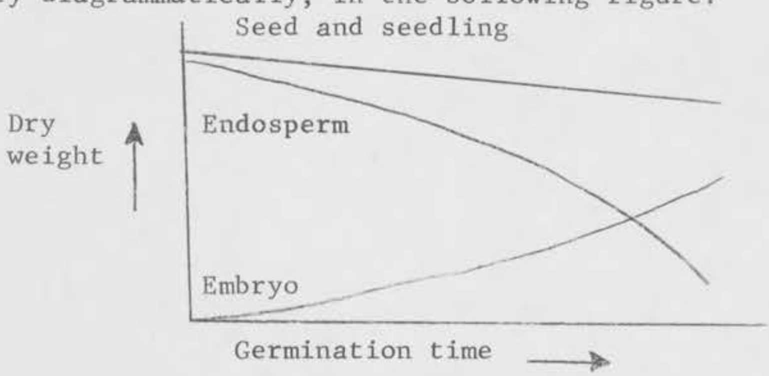



The embryo contains the cells which, when the proper environmental conditions prevail, divide, redivide and expand into a new seedling. The endosperm is a storage tissue containing reserve carbohydrates, proteins, and fats.

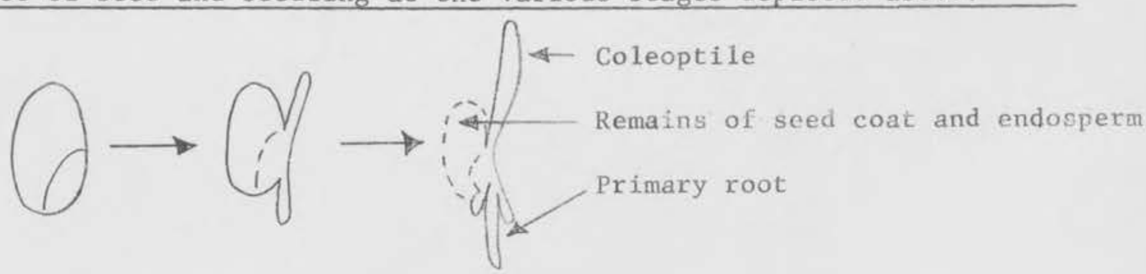
When a seed, planted in the soil, inbibes or absorbs water, the activity of the embryo cells increases markedly. They start to divide, expand and increase in dry weight. However, the embryo itself cannot sustain growth for an unlimited time because of its lack of raw materials needed for growth. This is where the endosperm of the seed plays a very vital role. The action of water absorption by the seed not only sets the embryo cells into motion, it also initiates activity in the endosperm. One of the first things to occur is the synthesis or activation of enzymes (proteins which can serve as catalysts to speed up reactions). These enzymes start breaking down the stored food reserves (carbohydrates, proteins, and fats) of the endosperm and the simpler products formed, namely sugars, amino acids, fatty acids, etc., can then move to the embryo cells to serve as building blocks for the synthesis or production of materials needed for the growth of seed. Thus the act of water absorption by the seed sets into motion an array of events which leads to the growth of the embryo to form a new seedling at the expense of materials stored in the endosperm. These events are depicted in the following drawing:




At this point I want to emphasize that we are discussing the very early events which occur in seed germination. The new seedling is still underground, in the dark, and very yellow in color. I mentioned previously that the embryo cells began to gain in dry weight very early. It should be mentioned that although the embryo cells are indeed gaining in dry weight the entire seedling, including the seed, has undergone no net gain in dry weight. This is because the gain in weight of the embryo cells has been at the expense of the dry weight of the endosperm. This is illustrated, very diagrammatically, in the sollowing figure:



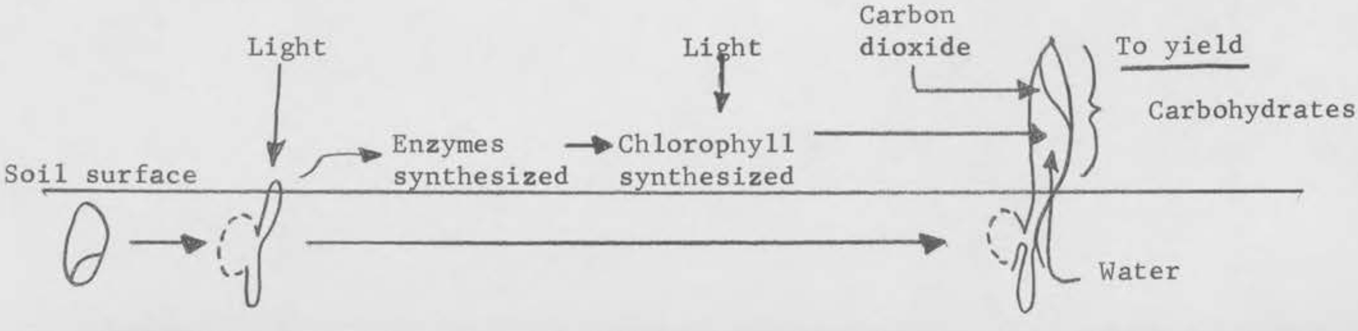

Appearance of seed and seedling at the various stages depicted above:



I think it is apparent now why it is important that small seeds, such as grass seeds normally used for turf, should not be planted too deep. If they are planted too deep the food reserves of the endosperm will all be used up prior to shoot emergence above ground and the new seedling will simply wither and die.

Greening

Let us assume that the new, yellow (etiolated) shoot or coleoptile does break through the soil surface and become exposed to light. When light strikes the plant shoot, a new series of events are initiated. Again new and different enzymes (those protein substances which catalyze or speed up reactions) are synthesized. One of the more important groups of enzymes synthesized are those responsible for the synthesis of various plant pigments such as chlorophyll which gives the plant its green color. For once chlorophyll is made, the plant can start to photosynthesize; i. e. it can, in the presence of light, convert carbon dioxide from the air and water from the soil solution into carbohydrates. And now the plant truly begins to grow or gain in dry weight. This phenomena of photosynthesis is truly a remarkable feat for it enables the plant to convert light evergy into chemical energy. This phenomena is obviously one of the major ways in which plants differ from animals. That is, with animals all of the essential components needed for growth must be supplied to it, whereas, the plant can manufacture its own materials needed for growth by converting light evergy into food energy. The events outlined here for the greening of a plant and the initiation of photosynthesis can be summarized briefly in the following sketch:



Photosynthesis

$$\text{Light energy} \xrightarrow{\text{Green plant}} \text{Chemical energy}$$

or

$$\text{water} + \text{Carbon dioxide} \xrightarrow[\text{Chlorophyll}]{\text{Light}} \text{Carbohydrates} + \text{Oxygen (given off)}$$

Vegetative growth

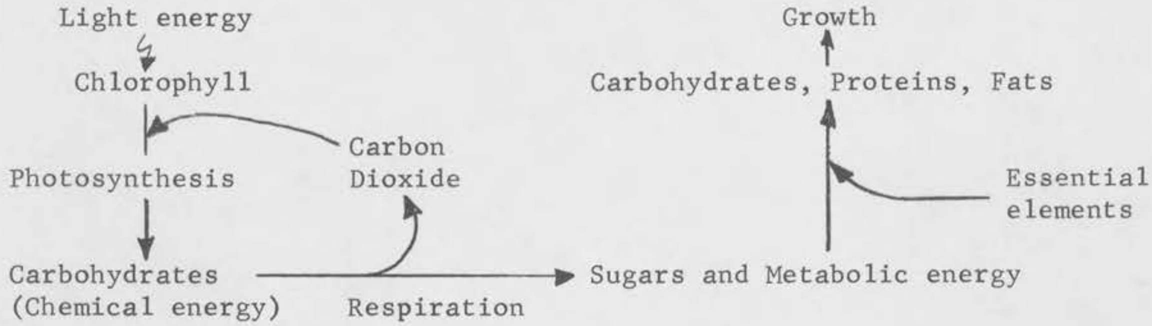
as already pointed out, the plant begins to grow or gain in dry weight as soon as photosynthesis begins. However, I also mentioned that the main product of photosynthesis was carbohydrates. Now, in order for a plant to grow normally it needs other substances in addition to carbohydrates such as proteins, fats, nucleic acids, etc. The next obvious question then is how does the plant manufacture these additional components. It does this by utilizing the energy that is stored in the photosynthetically produced carbohydrates. In other words, some of the carbohydrates are broken down by the plant such that some of the energy within these substances can be captured and then diverted off into the production of proteins, fats, etc. The phenomena of breaking down carbohydrates and capturing part of its energy is called respiration. Respiration is essentially the reverse of photosynthesis, and can be written as follows:

$$\text{carbohydrates} + \text{oxygen} \longrightarrow \text{carbon dioxide} + \text{water} + \text{energy}$$

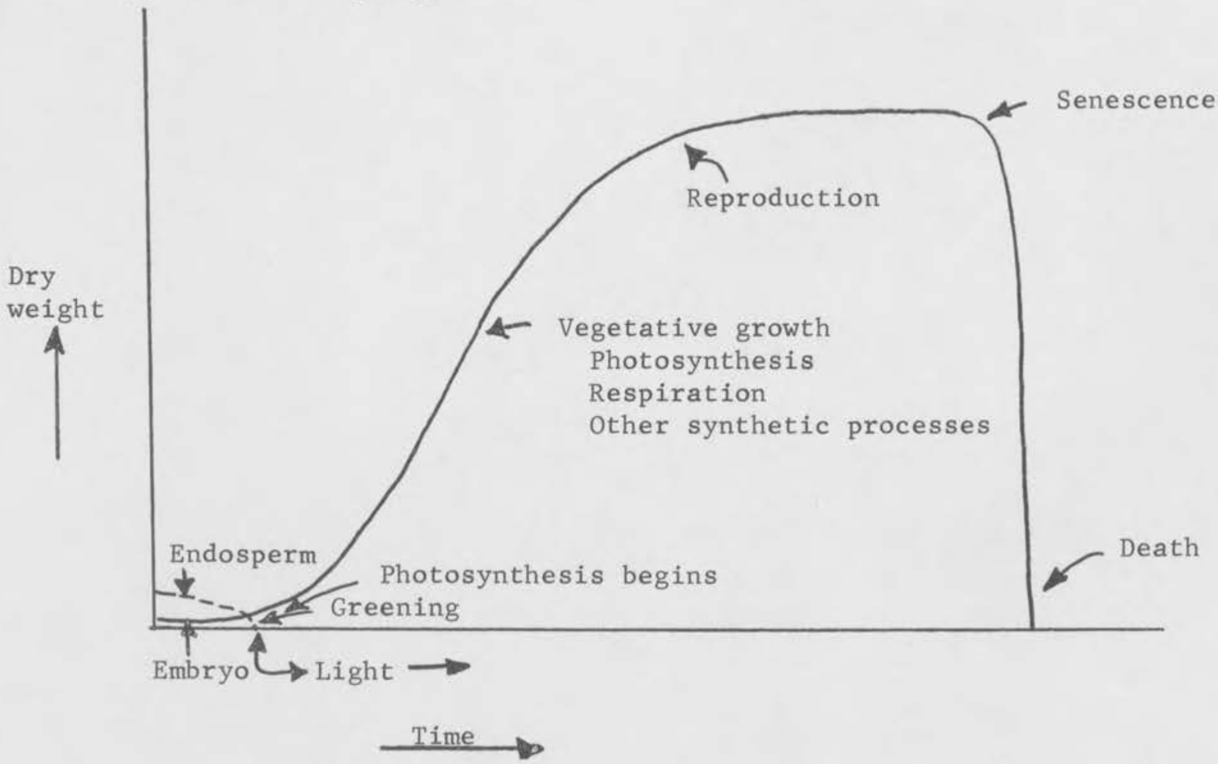
The energy released from carbohydrates by respiration can now be used for converting sugars and various inorganic ions such as nitrogen, sulfur, phosphorus, etc, into other constituents that are needed for growth. This phase of growth can be depicted as follows:

sugars from photosynthesis
energy captured from respiration } → proteins, fats, nucleic acids → growth
essential elements

The various events which I have discussed so far which contributes to the growth of a plant can be summarized as follows:




The rate of growth of a plant is obviously dependent on many external environmental factors such as light intensity, carbon dioxide supply, moisture availability, amount of foliar material exposed to light, etc. If we assume, however, that none of these factors are limiting growth we can visualize the growth rate of a plant at various stages in its life by the following figure:



I have only discussed a few of the major physiological events involved in the growth of a plant. Because of lack of time and your interests, I have intentionally omitted the reproductive and senescence phases of the life of a plant. Perhpas these phases can be discussed at a future conference.

Structure and function of the cell

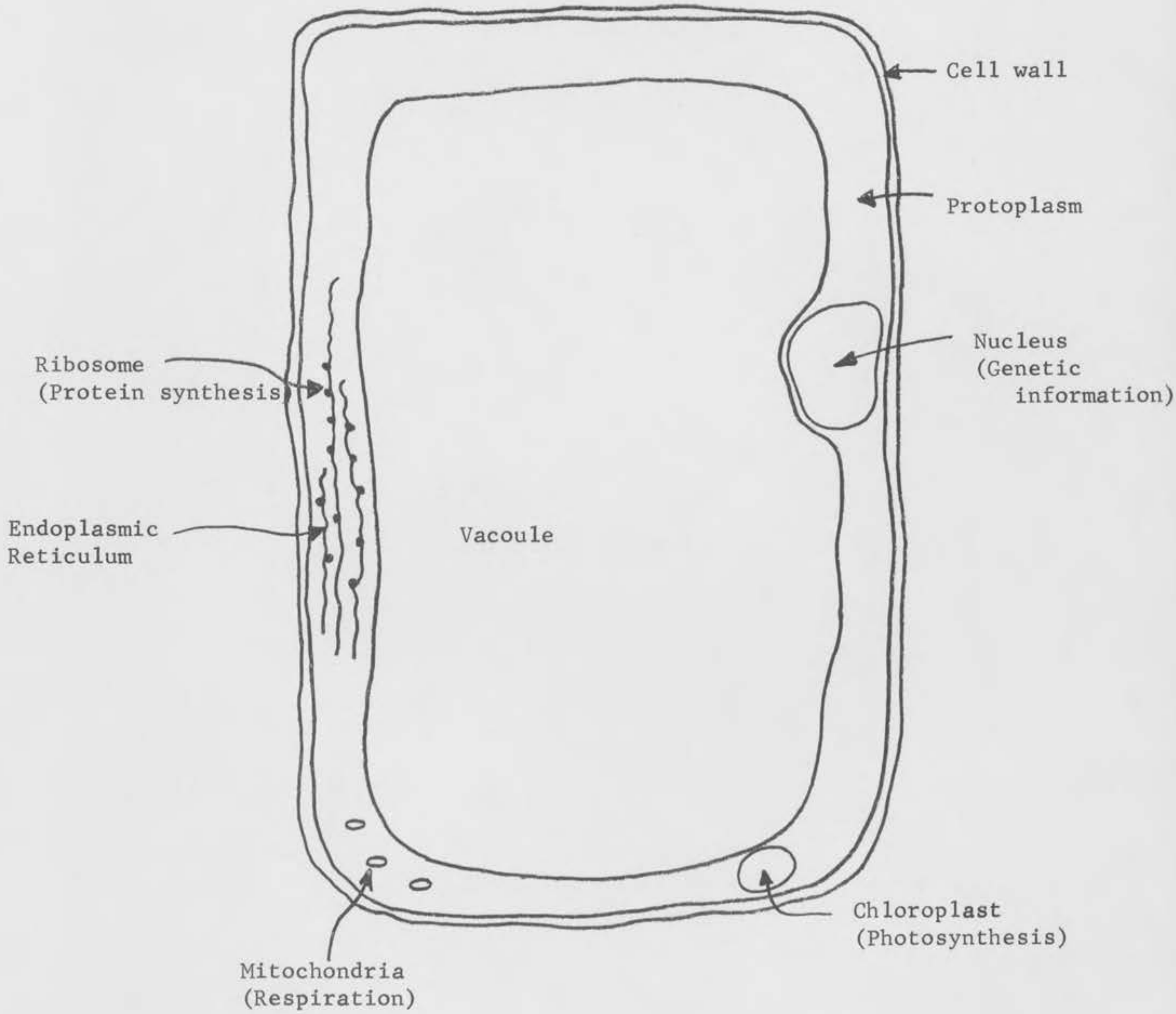
One of the most interesting aspects of the growth of a plant is how all the many intricate processes that are invloved can proceed in an organized fashion simultaneously. To understand how this is possible one needs to consider the structure of a plant cell. The plant cell is the basic unit of the plant. Leaves, stems and roots all consist of cells which are similar but certainly not identical. For example leaf cells contain chlorophyll whereas root cells do not, etc. For todays discussion, however, I am going to illustrate and discuss the major constituents of a typical leaf cell.

The cell (see following diagram) basically consists of a cell wall, protoplasm and a vacuole. The cell walls provide support to the cell and to the plant. The vacuole represents primarily a watery junk yard for the storage of inorganic salts and excess organic compounds. The protoplasm is bounded on either side by membranes which serves to separate it from the outside environment and the vacuole. It is within the protoplasm where the various events described earlier take place. These various events can all take place simultaneously and in or organized way because the protoplasm consists of several very specialized bodies for conducting specific jobs. The nucleus is the largest of these organelles. Chromosomes, the carriers of genetic information from one generation to the next, reside in the nucleus. The composition of the chromosomes thus determine whether a plant is going to be Kentucky bluegrass or a pea plant. It does this primarily by regulating what type of enzymes (proteins) that are made.

The next largest organelle in the plant cell is the chloroplast. The chloroplast contains the chlorophyll which is needed for photosynthesis. The carbohydrates which are formed as a result of photosynthesis move out of the chloroplast into the cytoplasm where they can then be broken down to simpler sugars and respired. Most of this respiratory process takes place in still another body within the protoplasm - namely, the mitochondria. The mitochondria is a small body surrounded by two membranes, the inner membrane being invaginated such that the mitochondria appears to consist of many smaller internal compartments. It is within the mitochondria where most of the energy liberated from carbohydrates is converted into a more useful form such that it can be used for the synthesis of other substances such as proteins. The actual synthesis of protein appears to occur in another cytoplasmic body called the ribosome. Ribosomes are very small bodies consisting of protein and fat plus ribonucleic acid, and they are attached to a membranous network called the endoplasmic reticulum. Although it is known that protein synthesis occurs in the ribosomes the exact mechanism of how this is accomplished is still questionable.

I hope that from this description of the structure and function of a cell that you can now visualize how it is possible for the plant to carry out simultaneously photosynthetic processes, respiration, protein synthesis and the many other processes that are involved in its growth.

The Cell



Cell wall
Protoplasm
Ribosome
(Protein synthesis)
Nucleus
(Genetic
information)
Endoplasmic
Reticulum
Vacoule
Chloroplast
(Photosynthesis)
Mitochondria
(Respiration)

# HOW TO RECOGNIZE QUALITY TURFGRASS SEEDS

Dr. Norman Goetze

Someone once said, "Seed is a living plant, packaged for shipment." In the case of turfgrasses, this is certainly true. Seed used in Illinois turf production may have been locally produced, but most likely came from the Pacific Northwest, Europe, or Canada. It was most probably produced one to three years before its ultimate use, had been stored under a variety of environmental conditions, and had been shipped large distances. Yet, upon planting, it shortly produces a plant not always exactly like its parents, but very similar in most detail. Marvelous life processes are carried from the parent plant through the seed to the emerging young plant.

There are all types, varieties, qualities, and prices of turf seed available on the market. Often the highest quality ones may not be the most expensive per pound, but they always are the best buy. Considering the total labor, equipment, soil, irrigation, fertilizer, and other costs involved in turf establishment, seed cost is certainly minor. In far too many cases excellent care is given in all details of seedbed preparation, only to ruin the entire operation because of some bargain lot of inferior seed. Purpose of this presentation is to outline some guides to use in selecting high quality seed in the market.

The seed industry involves a wide array of procedures to make final delivery of the seed to the customer. The industry is composed of producers, processors, transporters, packagers, warehousemen, salesmen, researchers, technologists, regulatory officials, and public relation men. In processing, the seed may be blown, delinted, scarified, chilled, evacuated, dried, chemically treated, scalped, differentially burned, magnetized, irradiated, or decorticulated. Obviously, the seed industry is a complex one and many of these operations can alter the seed quality.

Because seed is shipped long distances and its quality cannot be readily recognized by physical inspection, it is desirable to have regulations to protect the customer. Early laws in Connecticut, Michigan, Illinois, California, Missouri, and Nebraska legislated against the sale of seed containing Canada thistle. Early Federal legislation restricted the importation of poor quality seed. Later legislation required labeling of seeds. The present Federal Seed Act requires all seed moving in interstate commerce to be labeled specifically and provides for rigid penalties for non-compliance. As an additional protection for local seed consumers, every state has enacted state seed laws which apply to seed sold within the state boundaries.

Any seed moving in interstate commerce is required by federal law to have the following items on the label:

1. Kind - The accepted common name of seed. Variety may also be given but is not required or guaranteed.
2. Lot number
3. Percentage of pure seed
4. Percentage of weed seed. Non-noxious weeds are not identified by kind.
5. Percentage of other crop. If any one crop exceeds 5 percent, it must be identified.
6. Percentage of inert matter.
7. Germination percentage including hard seeds.
8. Date of germiniation test.
9. Name and address of the shipper.
10. Identification and content of weeds declared noxious by states into which seed is transported.
11. Origin by state or country.

The Illinois seed law specifies that any seed offered for sale or shipped to Illinois containing weeds under the heading "Primary" in Table 1 cannot be offered for sale in Illinois. Any seed lots containing weeds listed under "Secondary" in Table 1 have very low limits of tolerance and the content must be on the label.

Table 1. Illinois Noxious Weed Seeds

| Primary | Secondary |
|---|---|
| Hoary cress | Buckhorn plantain |
| Canada thistle | Bullnettle |
| Johnsongrass | Wild carrot |
| Field bindweed | Oxeye daisy |
| Russian knapweed | Curled dock |
| Perennial sowthistle | Dodder |
| Leafy spurge | Giant foxtail |
| | Wild garlic |
| | Wild mustard |
| | Quackgrass |

Both the Federal Seed Act and the Illinois Seed Law were originally designed for field seed crops. Many of the noxious weeds listed in Table 1 are not particularly troublesome in turfgrass. Other more common weeds, such a annual bluegrass, chickweed, false dandelion and crabgrass, are much more troublesome than some of the noxious weeds. Small amounts of other crops such as tall fescue in creeping red fescue, and bentgrass in Merion bluegrass, are just as troublesome as weeds. These low contaminations may not be readily recognized by inspection of the seed label. Unfortunately, prices are most often quoted on standard purity and germination percentages, with little regard to other crop and weed content. For those who are vitally interested in freedom from other crop and weed content, specifications for zero crop and zero weed analyses should be made. If such seed cannot be found readily, then a copy of the detailed laboratory analysis sheet should be requested from the supplier.

Copies of the pertinent information from three typical quality lots of bluegrass are shown in Table 2.

Table 2. Comparative Quality of Three Bluegrass Seed Lots

| Lot | Purity % | Other Crop % | Inert Matter % | Weed % | Germination % |
|---|---|---|---|---|---|
| A | 98.67 | 0.20* | 1.13 | 0.00 | 94 |
| B | 98.89 | 0.15* | 0.86 | 0.10** | 94 |
| C | 97.07 | 0.00 | 2.93 | 0.00 | 91 |

* Canada bluegrass

** 900 speedwell and 450 dog fennel seeds per pound

By conventional seed marketing standards, Lot B would be rated the highest quality, because of its high germination and high purity. However, if the purchaser had examined the detailed work sheet from the seed laboratory, he would have found that the 0.10% weed content was made up of 900 speedwell seeds per pound and 450 dog fennel seeds per pound. Both of these weeds can be rather serious in the establishment stage of Kentucky bluegrass. Lot A would have been the second choice by routine seed marketing procedures, since it has zero weed content. However, the other crop, as indicated on a detailed seed laboratory analysis sheet, was shown to be Canada bluegrass. This is not too serious, but there is nothing on the official seed label to indicate that it might not have been bentgrass, tall fescue or some other objectionable crop, which at that low concentration could be a serious weed under Illinois conditions. Lot C, even though it contains the lowest purity and the lowest germination, is the best quality for turf use, because it contains no crop and no weeds, and still has a reasonably high germination. The low purity is a reflection of a higher inert matter content, which certainly will not have any objectionable features in the newly established turf. It is readily seen from these examples, that the seed label is not always sufficient to identify high quality seed lots, except in the case of the label bearing no crop and no weed. Reputable seed dealers will provide detailed laboratory work sheets in the support of the sale of their best quality seed lots, and those customers who demand that high quality, should ask for them.

Neither the Federal Seed Act nor the Illinois Seed Law absolutely require lableing as to variety. If a variety of Kentucky bluegrass, such as Merion or Delta, or a variety of creeping red fescue, such as Pennlawn is desired, certified seed should be purchased. Both the Federal and Illinois seed laws require that in order for a lot of seed to be marketed as certified seed, it must bear the tag of the agency making that certification. Certified seed is produced in accordance with state certification agencies in the United States or by many foreign governments. In order for seed to be eligible for certification tags, it must meet rigid physical standards, as well as having a known genetic history. In other words, certified seed is produced from known parental stocks and when bearing the certified label, the customer can be reasonably sure that the lot will perform as expected of that variety. Various state and governmental certifying agencies have different requirements for eligibility of seed lots to receive certification tags. It will be necessary for the customer to become familiar with the procedures used by the various certification agencies to judge the quality of the certified seed in terms of its varietal performance. The mechanical purity of the sample, however, is guaranteed by the labels as regulated by the Federal and Illinois seed laws, as outlined earlier.

Obviously, all commercial customers of turfgrass seeds cannot hope to become proficient seed technologists. It is their responsibility, however, to become more cognizant of the variations in quality of turfgrass seed and to become familiar with the legal protections available to them in choosing better quality seed. Since the cost of seed is one of the lowest cost items in the total turfgrass management operation, seeking better quality seed is one of the best instruments to improve the overall quality of Illinois turfgrass.