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Most of our readers have received a questionnaire concerned with the possibility of developing a “Massachusetts Turf Alumni News Column” as a feature in the “Turf Bulletin.” Many graduates have responded. Included below are a few of the suggestions which we hope might be incorporated into a column in future “Bulletins”:

1. “An up to date list of where various alumni are presently employed.”
2. A separate luncheon program for alumni at the “Massachusetts Turf Conference.”
3. Formation of an alumni job mart.

The Massachusetts Turf and Lawn Grass Council Incorporated is chartered under the laws of the Commonwealth of Massachusetts as a non-profit corporation. The turf council seeks to foster “Better turf through research and education”.

More detailed information on the subjects discussed here can be found in bulletins and circulars or may be had through correspondence with the editor.

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Trends In Golf Course Development

GEOFFREY S. CORNISH & WILLIAM G. ROBINSON
Golf Course Architects
Amherst, Mass.

The knowledge and skill of the Nation’s golf architects has increased immeasurably because of scores of new courses each has designed and numerous established layouts each has re-designed. A profession that almost became a lost art in Depression and War has been given a new and vigorous lease on life by the extended boom in course construction.

There are more than thirty course architects in the United States engaged full time in design and development. Golf course design and construction has become vastly more sophisticated. Still the question of how a young man can enter this idyllic but restricted field is often asked and is worthy of thought and study.

Last year we talked to groups outside of New England at Penn State, New York, Cleveland, Dayton, Cincinnati, Chicago and Vancouver, British Columbia. One question arose again and again. How can a young man prepare himself to become a course architect? More is needed than love and knowledge of the game. We discussed this question with many, in and out of the profession, and feel the consensus is for training as follows:

(a) A degree and perhaps an advanced degree in LANDSCAPE ARCHITECTURE with plenty of AGRONOMY AND TURF as well as all courses offered in ELEMENTS OF DESIGN.
(b) A season or more under a superintendent to become intimately aware of his problems.
(c) Extensive travel on this continent and abroad to study famous layouts. The thoughtful statement has been made that the only enduring texts on golf architecture are the ancient links of Scotland.
(d) And of profound importance, a period of several years working with an established course architect. Many of us now in the profession were once associated with renowned architects of pre-World War II days, such as Stanley Thompson, Donald Ross, Dr. McKenzie and others. And they had once been associated with still older Scottish architects. Through this continuity the wisdom of the profession grows.

We believe the future of golf architecture belongs to young men who prepare themselves thoroughly. Fortunately, many are doing so.

Because of the tight money situation there were fewer golf courses built in the United States in 1966 than in 1965. Nevertheless it was a record year for several North Eastern States in construction of new courses, additions of new nines and reconstruction of established layouts. A few trends and current projects where Stockbridge and Winter School graduates are playing a prominent role are described briefly below.

THIRD NINES

One trend is for many a club to add a third nine without increasing total membership. The Country Club of Avon, owned by the City Club of Hartford (Superintendent Joe Bidwell, Stockbridge '50) is an example. With a large active membership the 18 holes could not accommodate play comfortably. The third nine eases this situation with no enlargement in the clubhouse because no new members have been accepted from a huge waiting list.

CLUBHOUSE COSTS

Clubhouse costs have risen astronomically. Truly magnificent buildings, substantially built, such as Crestview's at Agawam, Spring Valley's at Sharon and Alpine's at Cranston, R.I., that cost half to three-quarters of a million only a few years ago would now run at least twice that. But Jack Smith (Stockbridge '56), who supervised construction of his course Indian Ridge at Andover in 1961, took over supervision of construction of his new clubhouse in 1966 and effected great savings.

ALL-MALE CLUBS

Another trend is formation of all-male clubs with a most elaborate course of the Runaway Brook style but with a modest clubhouse. One of the first of these in the North East to complete construction is the Golf Club at Aspetuck, Connecticut, (Superintendent James Ganley, W.S. '63). Conceived by Lawrence A. Wien, who also heads the group owning both the Empire State Building and Penn Station, the course together with other facilities is for men only.

PAR 3'S AND PAR 60'S

Construction of par 3's of the style of Blue Rock on Cape Cod and Powder Horn at Lexington and par 60's similar to Westwoods at Farmington, Connecticut, is booming. Both types are highly successful. Bart Brown (W.S. '67) and his superintendent, Mat Spokas (W.S. '65) opened the Middleton (Mass.)

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Golf Club in late May of 1966. Play was heavy from opening day onward. And one widely travelled golfer claims Middleton's 7th from the back tees is among the world's most exacting par 3 holes.

In par 3 golf more flies can be caught with vinegar than with honey. To this end Dave McCarthy (Stockbridge '58) and Tom Niblett (Stockbridge '54) are opening Holly Ridge at South Sandwich on the Cape in May. This 18-hole par 3 is a fair but testing layout with huge tightly trapped rolling greens similar to New Jersey's Pine Valley.

FEDERAL, STATE AND MUNICIPAL PROJECTS

One of the largest golf developments on the continent in 1966 was construction of four courses in State Parks of West Virginia. Harry Ellis (W.S. '67) is the superintendent. Located in high mountain country, the scenery is breathtaking and at one course native tree species are almost entirely rhododendron, redbud, dogwoods and holly.

These projects under the State Department of Natural Resources are financed through Federal loans under A.R.A. Several other states contemplate similar ventures and at least one Province in Canada, New Brunswick, already has a like project under way with Bill Mitchell as architect. Larry Brown (W.S. '67) and Dale Colpitts (W.S. '67) are the superintendents.

Municipal golf development is also booming in both U.S. and Canada with new municipals rivalling country clubs in design and maintenance standards. For examples Riverside, Portland, Maine's municipal, is adding a third nine with John Davis (W.S. '49) as superintendent and Hamden, Conn., is building a new eighteen to augment its present 18 with Dick Cumpstone (W.S. '65) as superintendent.

A problem at all municipals is how to permit children to play without congesting the course. Austin Kelly, "Mr. Golf of the Penobsot Valley" in Maine, solved this by building a four-hole 355-yard layout for children only at the Bangor Municipal. This worthwhile feature can be used to advantage at other courses and will be emulated elsewhere.

DAILY FEE COURSES AND NON-EQUITY CLUBS

Construction of privately owned daily fee layouts is also booming. Most are proving profitable and many built only a few years ago are also adding new nines. An example is Blackledge at Hebron, Conn. (Superintendent Ken Pierce, W.S. '67) built in 1963, which is now building an additional nine.

Non-equity clubs are also increasing. These are strictly private. Members join but own no part of the facilities. A new and magnificent non-equity now under construction is Far Corner Farm Golf Club at West Boxford (Superintendent Jack Cronin, Stockbridge '64). Jack has scheduled opening of the 18 for April 1968.

REBUILDING PROJECTS

Many old established clubs are rebuilding with construction phased over many years. A few of these in the Boston area with programs well underway are Woodland (Supt. Norman Mucciaron, W.S. '49), Dedham (Supt. Robert Mucciaron, W.S. '49), Wapole (Supt. Wayne Ripley, W.S. '63), Weston (Supt. Phil Cassidy) and Meadowbrook (Supt. Bert Clark, W.S. '49). Two courses starting rebuilding programs this year are the New London C.C. (Supt. Pat O'Connor, Stockbridge '63) and Mill River C.C. (Supt. Dick Bator, Stockbridge '64). For long distance Dick Mitchell (Stockbridge '61) takes the prize. Formerly of Thorny Lea, he is now superintendent at Shaughnessy Golf and Country Club (scene of the 1966 Canadian Open) in Vancouver where he is also in charge of a long-range rebuilding program.

CONSTRUCTION COSTS

Course construction costs are going up, but to nowhere near the extent of clubhouse costs. Golfers today expect greater quality together with a more magnificent layout and they are willing to pay for these. Therefore new courses are bound to cost more.

DESIGN STANDARDS

There is a trend toward more imaginative design. Courses are more interesting, their eye appeal is greater and yet maintenance-wise they offer fewer problems than older layouts.

THE FUTURE

Not long ago we forecast 12,000 to 15,000 golf courses in the United States by 1975 as contrasted to around 8,500 in 1966 and 5,200 in 1952. No one can accurately forecast future golf development. But pressures are now obvious that could limit the rapid growth of new courses as we have known it in recent years. Our estimate of twelve to fifteen thousand is therefore less likely to be realized.

One thing is, however, certain. Dr. Joe Troll's Stockbridge and Winter School graduates will continue to play a very prominent part in the development and maintenance of the continent's courses both new and old.
Par 3's are booming. The watery 7th at the new Middleton (Mass.) Golf Club owned by Bart Brown (W.S. '67) is said to be among the world's most testing par 3's from the back tee.

The 8th at Pine Valley? No — this is the 9th at Holly Ridge at South Sandwich on the Cape, an 18 hole par 3 owned by Dave McCarthy (Stockbridge '58) and Tom Niblett (Stockbridge '54).

The 17th at Pipestem State Park, West Virginia. This is one of four courses under construction in that state in high mountain country. Harry Ellis (W.S. '67) is superintendent.

The 10th tee at the new Far Corner Farm Golf Club, a non-equity club under construction in West Boxford, Mass. Jack Cronin (Stockbridge '64) is superintendent of this elaborate course.
THE LITTLE WILDFLOWERS
AND HOW THEY GREW

by Dr. Irene H. Stuckey
Associate Research Professor of Plant Physiology

 Appreciation of natural beauty is mostly an unconscious reaction. Watch where the truck drivers park to eat lunch. Usually it is in the prettiest spot available. Around noon, most scenic spots in Rhode Island contain a few parked trucks or cars, with the drivers eating lunch, checking sales records, or merely resting. This is genuine appreciation, but unfortunately, in spite of appreciation, there seems to be little or no awareness that the number of scenic spots in Rhode Island is dwindling, and that drastic effort must be made to save them while there is still time.

The same is true of wildflowers, which Rhode Island has always had in such abundance that they are taken for granted. Wild orchids were once so plentiful that around 1889 the rose-purple arethusa were sold on the street in Providence, and white and yellow fringed orchids were picked as late as 1920 to decorate the dining rooms of summer hotels at Watch Hill or to be sold as cut flowers. Even now, there are still more interesting wildflowers to be seen close to cities in Rhode Island than near any other urban areas in New England. But preservation areas and zoning for scenic beauty are now necessary to save some of the wildflower habitats from the explosion of building developments.

Most people assume that the decrease in wildflowers is a direct result of man's destructiveness. In many cases this is so, of course. Good examples are the destruction of wild orchids when Cat Swamp in Providence was filled in to make a playground at Hope Street and Blackstone Boulevard, and when Quonset Point and Charlestown Naval Air Stations were constructed. For Rhode Island as a whole, however, more wildflowers have been lost as a result of the changing pattern in agriculture than by building developments and highways.

Wildflowers, especially orchids and other species that grow in wet, sunny meadows, were most plentiful in Rhode Island between 1880 and 1920. Production of grain had gone west after 1870 when cheap land and cheap transportation by rail became available, but demand for hay to feed the draft animals in the rapidly growing industrial cities kept the Rhode Island farms in production. The hay economy of that period was quite different from modern agriculture with its power machinery, fertilizer and high yields. Late cutting and low yields of hay-making 60 to 75 years ago encouraged the growth of wildflowers by removing competing grasses and keeping woody plants from growing.

When horses were replaced by gasoline engines, demand for hay decreased and hay fields reverted to forest. As a result, the woodland pink lady's-slipper and the roadside ladies tresses, species rare in 1905, are relatively common today, while arethusa and orange and white fringed orchids are almost extinct.

May is a good time to start looking for Rhode Island wildflowers. The weather is usually good—not too hot and not too cold—and the mosquitoes and blackflies have not yet become nuisances. There is an abundance of flowers, and best of all for an amateur, the different kinds are easy to recognize and to identify.

Where are good places to find wildflowers? Private land is out of bounds unless you know the owners. The wildflower preserve and nature trails being developed at the Jones (Hiantoland) Campus of URI, like the rest of that campus in West Greenwich, are open only by permit, at least until proper supervision is possible.

State parks and picnic grounds are probably the best general hunting grounds for wildflowers, since they provide a variety of areas, as well as trails. Some of the places that are especially good for wildflowers are the Ledges and Stepstone Falls in Beach Pond State Park, Pulaski, Arcadia and Burlingame State Parks, Kimball Bird Sanctuary in Charlestown and Norman Bird Sanctuary in Middletown. The Cliff Walk in Newport has interesting summer plants, but few in May.

One good rule to remember in looking for wildflowers in Rhode Island is that most of them grow in well lighted places rather than in deep shade. Even woodland species grow best where the shade is not too dense, and many of the spring flowers bloom early before the tree leaves have developed enough to shut out the light. As for mois-

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interesting plants may be found at various levels from extremely wet to extremely dry.

When you find something interesting, resist the impulse to pick it. At times, when the plant grows in abundance, it is permissible to pick a small piece for study, but in most cases the plant should be left untouched to produce seeds.

What flowers are likely to be encountered in May? May 1 is likely to be a little late to find the spicy fragrant flowers of trailing arbutus (Epigaea repens) blooming among last year's leaves, but if you do find it in flower, notice the ring of hairs in the throat.

Cowslip or marsh marigold (Caltha palustris) also blooms early and might be gone by early May, but its size (to one foot), and brilliant daffodil yellow flowers make it conspicuous in the wet woods where it grows. Cowslip often grows near the tall rounded shrubs of spicebush (Lindera benzoin), which has flowers that individually are small and insignificant, but numerous enough to fill large areas of wet woods with clouds of pale gold. Everybody knows skunk cabbage (Symplocarpus foetidus) and its characteristic pungent odor. The maroon and yellow striped sheaths that enclose the flowers unfold early in April.

Mayflower (Anemone quinquefolia) with its snowy white or sometimes pale pink flowers and five-parted leaves appears about the first week in May in damp woods or along roadsides. Dog-tooth violet (Erythronium americanum), also known as trout-lily, blooms about the same time as mayflower, and often in lawns. Its flowers resemble small pale gold lilies, and the broad flat leaves are spotted with purple.

The white or pale blue tubular flowers of bluets (Houstonia caerulea) appear in large numbers throughout May in old fields and pastures, along roadsides, and even in lawns if the fertility is low. The flowers have four pointed petals, star-shaped yellow eyes, and a slender stem rarely more than three inches tall.

Three species of trillium are native in Rhode Island. The most common is nodding trillium (Trillium cernuum), so named because the white flower hangs below the leaves. Painted trillium (T. undulatum) is less common. The erect white flowers are marked with delicate red lines that look as if they were applied with a paint brush.

The state flower of Rhode Island is a blue violet, species not designated, but 20 species of violets have been recorded as native, and 12 of these are blue. The rest are white or yellow.

The old fashioned name for jack-in-the-pulpit is jacks and jennies. Three green and purple species have been recorded from Rhode Island.

Solomon's-seal is represented by two species: Polygonatum pubescens, with downy leaves; and P. canaliculatum which has smooth leaves. Both species have arching stems about one foot tall with parallel veined leaves spaced at regular intervals, and a pair of greenish bell-shaped flowers dangling at the junction of each leaf with the stem.

Bellwort has leaves and stems similar to those of solomon's-seal. The yellow flowers are bell-shaped with flaring petals, and are borne singly at the tips of the branches. The common species is Uvularia sessilifolia, which has leaves attached to the stem at the basal end.

Wild geranium (Geranium maculatum) is common and handsome. The plants are one to two feet tall, and have lacy cut hairy leaves and delicate single flowers about one-half inch across. In full sun, the flowers are lavender-blue, in shade, rose-pink.

The delicate plants of dwarf ginseng (Panax trifolius) are 3 to 4 inches tall with a globular cluster of tiny five-petaled white flowers on a slender stem. There are usually three leaves with 3 to 5 leaflets each. Dwarf ginseng grows in mixed hardwood forests in company with violets, trilliums, ferns and other woodland flowers.

The most common and best known orchid in Rhode Island is undoubtedly pink lady's-slipper (Cypripedium acaule). It grows in light shade in oak or pine woods and blooms May 10 to 25. The common color is rose pink, but white flowered forms are known in a few places. In many parts of the United States, pink lady's-slipper is an exceedingly rare plant. We in Rhode Island are fortunate in having such an abundance of them.
Winter Injury and Prevention
By DR. JAMES B. BEARD
Michigan State University

When I addressed this group four years ago on the topic of winter injury, the information was quite limited. Since then extensive investigations have helped to elucidate the primary causes of winter injury as well as some of the cultural practices which can be utilized to minimize the chance of winterkill. The three major causes of winter injury are desiccation, winter diseases, and direct low temperature kill.

Desiccation occurs when water loss from above ground grass tissue exceeds the rate of uptake by the root system. The inability of grass roots to take up water may be due to, (a) a lack of soil moisture, (b) the water being in a frozen, unavailable state, or (c) due to loss of the root system caused by injury such as direct low temperature kill to the lower portion of grass crowns and roots. Kill of this type commonly occurs on elevated locations which are exposed to dry winds. Desiccation is more prevalent during dry, open winters, and is particularly serious in the northern plains states and Canadian provinces. Desiccation may also be a secondary cause of winter injury where extensive damage occurred to the root system, due to direct low temperature kill. The primary cause of kill is low temperature which renders the plant incapable of providing water for above ground plant parts. As a result, total kill is caused by the secondary factor, desiccation.

A snow cover is one of the more effective ways of preventing winter desiccation problems. The use of snowence, brush, or similar techniques which encourage snow accumulation on turf areas prone to desiccation will assist in eliminating desiccation problems. Dr. James Watson of Minneapolis has conducted extensive investigations concerning the use of plastic covers which provide a barrier to the evaporation of water from plant tissues during the winter. A critical factor in use of these tarps is proper timing in their removal. It appears that practical experience will provide the best basis on which to make this decision. In some areas of the plains states, the hauling and application of water to greens and tees has been effective in preventing serious desiccation injury. The causes of desiccation and methods available for its prevention are fairly straightforward, and I will not take any further time to discuss this phase of winter injury.

Winter diseases such as Fusarium and Typhula species are major causes of winter injury. In the southern states, spring dead spot is a great concern. I am sure you are all acquainted with the symptoms of these particular diseases. They can cause serious injury to turfs if steps are not taken for their control. The snow mold problem can be especially severe if the soil does not freeze before a lasting snow cover is established. Under these conditions the microclimate is especially favorable for low temperature fungicides are available for protection and control. The relative susceptibility of seven bentgrass varieties to Typhula snow mold is shown in Table 1.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Percent of area killed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astoria</td>
<td>17 a</td>
</tr>
<tr>
<td>Congressional</td>
<td>18 a</td>
</tr>
<tr>
<td>Penncross</td>
<td>38 b</td>
</tr>
<tr>
<td>Washington</td>
<td>53 b c</td>
</tr>
<tr>
<td>Toronto</td>
<td>60 c</td>
</tr>
<tr>
<td>Seaside</td>
<td>73 d</td>
</tr>
<tr>
<td>Cohanseay</td>
<td>75 d</td>
</tr>
</tbody>
</table>

Astoria and Congressional bentgrasses showed a minimum susceptibility to snow mold. Cohanseay and Seaside ranked as the most susceptible varieties, with Washington and Toronto being intermediate. Penncross ranked as the third least susceptible variety. The use of less susceptible bentgrass varieties must be combined with an effective fungicide program to eliminate the snow mold problem.

The importance of the time of the fungicide application for snow mold control is emphasized in Table 2. The importance of a fall application in achieving adequate snow mold control is emphasized. Neither winter alone nor winter-spring applications provided the degree of control of a single fall application. When a fall snow mold fungicide treatment is missed, a reduction in control of up to 45 percent can be anticipated. Evidently a significant degree of injury from snow mold does occur during the early winter period. If the fall treatment is missed for some reason, it would be of value to make a mid-winter application as soon as possible, or even a spring application if an earlier winter application is not feasible. This procedure will reduce the severity of snow mold, but will not prevent a significant degree of kill.

<table>
<thead>
<tr>
<th>Time of Application</th>
<th>Rate*</th>
<th>Percent of Area Killed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>133</td>
<td>1a</td>
</tr>
<tr>
<td>Winter + Spring</td>
<td>133 + 100</td>
<td>37 b</td>
</tr>
<tr>
<td>Winter</td>
<td>133</td>
<td>36 b</td>
</tr>
<tr>
<td>Untreated</td>
<td>.......</td>
<td>90 c</td>
</tr>
</tbody>
</table>

* Calo-Gran was used.

The effectiveness of six fungicides on Typhula snow mold control of a Penncross creeping bentgrass green is shown in Table 3. This study was conducted in northern Michigan at Traverse City where Typhula snow mold is quite severe. Under this adverse situation, Calo-Clor and Calo-Gran were the two products which gave a consistently adequate snow mold protection. Tersan O M was fairly satisfactory on Penncross creeping bentgrass but not on annual bluegrass. Also, a four-ounce rate of Calo-Clor applied in the fall was superior to three ounces
applied in both the fall and spring. Dyrene gave inadequate control.

Table 3. Effect of six fungicides on TYPHULA snow mold control on Penncross bentgrass.

<table>
<thead>
<tr>
<th>Fungicide treatment</th>
<th>Percent of area killed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calo-Clor + Milorg. (Milorg.-4 in F)</td>
<td>1a</td>
</tr>
<tr>
<td>Calo-Gran (Gran-133-in F)</td>
<td>1a</td>
</tr>
<tr>
<td>Calo-Clor (Spray-4-in F)</td>
<td>2a</td>
</tr>
<tr>
<td>Calo-Clor (Spray-3 + 3 in F + S)</td>
<td>5a</td>
</tr>
<tr>
<td>Tersan OM (Spray-8 + 3 in F + S)</td>
<td>5a</td>
</tr>
<tr>
<td>Dyrene (Spray-4 +4 in F + S)</td>
<td>28 b</td>
</tr>
<tr>
<td>Untreated</td>
<td>90 c</td>
</tr>
</tbody>
</table>

Experience has shown that Tersan O M will give adequate snow mold control in the East Lansing-Detroit area whereas in northern Michigan, its effectiveness is marginal. This is particularly true on greens which have not had a history of mercury fungicide use. Therefore, the severity of snow mold and the past history of fungicide use are important considerations in selecting the specific fungicide to use for snow mold control.

The third major cause of winter injury and the one which is least easily controlled is direct low temperature injury to grass tissue. This type of injury is caused by freezing temperatures and involves mechanical destruction of the protoplasm in living plant cells. Hardened plant tissue is more capable of surviving low temperatures because of changes occurring within the cells. These changes include (a) an increase in the soluble carbohydrate content, (b) a reduction in the water content in the tissue, and (c) an...
alteration in the types of proteins present. Temperature conditions averaging between 30 and 40°F, for a period of three to four weeks will produce a plant which is low temperature hardy. Any management practice which stimulates growth, such as nitrogen fertilization or excessive irrigation, will reduce the hardiness level.

The direct low temperature survival of 19 turfgrasses is shown in Table 4. The grasses were permitted to harden naturally in the field until December 5, 1963. Plugs of the various varieties were collected, subjected to the temperatures ranging from 30°F. through -10°F. and the amount of injury observed. The bentgrasses as a group exhibited greater low temperature hardiness than any of the other grasses evaluated. The vegetative creeping bentgrasses, Toronto, Cohansey and Washington, exhibited no serious injury from air and soil temperatures as low as -5°F., while Seaside, Penncross and Congressional showed serious injury at temperatures below -5°F. The colonial bentgrass, Astoria, showed considerably more injury than any of the creeping bentgrasses with serious injury occurring below 5°F.

The crown tissue moisture content of the hardened annual bluegrass was quite low, ranging from 54 to 66 percent.

Table 4. The percent low temperature survival of grasses sampled December 5, 1963.

<table>
<thead>
<tr>
<th>Grass</th>
<th>Crown Moisture</th>
<th>Temperature treatment (°F.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25 20 15 10 5 0</td>
<td>-5 10</td>
</tr>
<tr>
<td>Creeping Bentgrass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toronto</td>
<td>61.3</td>
<td>100 100 100 100 99 98 97</td>
</tr>
<tr>
<td>Cohansey</td>
<td>64.5</td>
<td>100 100 100 100 100 99 98</td>
</tr>
<tr>
<td>Washington</td>
<td>61.0</td>
<td>100 100 100 100 100 98 94</td>
</tr>
<tr>
<td>Seaside</td>
<td>62.2</td>
<td>100 100 100 100 100 99 97</td>
</tr>
<tr>
<td>Penncross</td>
<td>55.5</td>
<td>100 100 100 100 97 93 90</td>
</tr>
<tr>
<td>Congressional</td>
<td>54.0</td>
<td>100 100 100 100 99 97 93</td>
</tr>
<tr>
<td>Colonial bentgrass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Astoria</td>
<td>66.1</td>
<td>100 100 100 99 94 71 30 7</td>
</tr>
<tr>
<td>Redtop</td>
<td>55.0</td>
<td>100 97 78 70 60 47 27</td>
</tr>
<tr>
<td>Roughstalk</td>
<td>72.1</td>
<td>100 100 100 100 99 96 76</td>
</tr>
<tr>
<td>Bluegrass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kentucky bluegrass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Merion</td>
<td>76.6</td>
<td>100 100 100 100 96 79 50 32</td>
</tr>
<tr>
<td>Common</td>
<td>77.9</td>
<td>100 100 100 100 91 65 15 2</td>
</tr>
<tr>
<td>Newport</td>
<td>73.2</td>
<td>100 100 100 98 85 65 4 1</td>
</tr>
<tr>
<td>Annual bluegrass</td>
<td>79.8</td>
<td>100 100 100 100 95 31 8 3</td>
</tr>
<tr>
<td>Creeping Red Fescue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pennlawn</td>
<td>78.0</td>
<td>100 100 97 90 63 17 4 0</td>
</tr>
<tr>
<td>Tall Fescue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kentucky 31</td>
<td>74.1</td>
<td>100 100 100 83 40 27 5 3</td>
</tr>
<tr>
<td>Alta</td>
<td>77.4</td>
<td>100 100 98 72 33 22 4 0</td>
</tr>
<tr>
<td>Perennial ryegrass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norlea</td>
<td>79.3</td>
<td>100 100 100 100 71 4 1 0</td>
</tr>
<tr>
<td>Common</td>
<td>81.1</td>
<td>100 100 98 78 13 0 0 0</td>
</tr>
<tr>
<td>Annual ryegrass</td>
<td>85.5</td>
<td>83 68 17 3 0 0 0 0</td>
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</tbody>
</table>

Redtop showed increasing injury from 15° to -10°F., but still survived 27 percent at -10°F. Roughstalk bluegrass proved to be the most low temperature hardy of the bluegrasses evaluated with no serious kill through -5°F., and only 24 percent kill at -10°F. The Kentucky bluegrasses exhibited extensive kill below 0°F. Merion was the most hardy, followed in order by common and Newport. Annual bluegrass exhibited serious injury below 5°F., with the increase in kill as temperature decreased being greater than the other grasses tested. The crown moisture content of hardened annual bluegrass was relatively high, approaching 80 percent.

Pennlawn creeping red fescue also had a high crown moisture content of 78 percent and serious kill below 10°F. Of the tall fescues, Kentucky 31 showed slightly better low temperature hardiness than Alta, as well as a lower crown moisture content. Both showed serious injury at 10°F. Norlea perennial rye-grass was more low temperature hardy than common, exhibiting severe kill below 5°F. Both had quite high crown moisture contents. Common annual rye-grass exhibited serious injury below 25°F. and had the highest crown moisture content of the grasses evaluated, 85.5 percent.

It should be indicated that the critical killing temperature is determined not by the air temperature, but by the soil temperature. Therefore, in comparing the relative temperatures at which kill of the various turfgrasses occurred, you must think in terms of the actual temperature of the soil itself.

The relative amount of injury varies through the winter period as is illustrated in Table 5. The maximum degree of low temperature hardiness was observed on December 5. At the January 24th sampling, a slight decrease in hardiness was observed. In general, serious injury occurred approximately 5 to 10°F., higher than at the December 5th sampling. In comparing crown moisture data, all species showed an increase in crown moisture content from the December to the January 24th sampling, except annual bluegrass. A very sharp decrease in low temperature hardiness was noted at the April 10th sampling which was set at the time of spring thaw. In comparing the June 5th sampling with that of April 10, no great differences could be noted. The June 5th sampling was with plants which would be a non-hardy state. It is of interest to note that most species show a similar low temperature survival pattern.
when in a non-hardy state, with serious injury occurring below 15°F. The crown moisture contents at the June 5th and April 19th samplings were similar. It can be seen from this data that turfgrasses usually reach peak hardiness in December and then decline. The decline is relatively slow during January, but is accelerated during February. The greatest low temperature decline of the entire winter period occurs in March and April. Thus, two critical periods for potential low temperature injury of turfgrasses occur. One is during late winter thaws in March and the second is just after the spring thaw has occurred. Combinations of freezing and thawing with the freezing temperature being below 25°F., have been shown to cause serious injury to turfgrasses during the late winter or early spring period. Annual bluegrass is particularly susceptible to this type of kill since it initiates growth quite early and is in a very low state of hardiness at this time. Low temperature injury to turfgrasses seems to be most prominent in the region from Chicago east through Michigan, Ohio, Pennsylvania, New York, and New England.

Studies at Michigan State have not shown that oxygen suffocation under an ice cover or toxic accumulations of respiratory products under an ice cover are of any major concern in winter injury of turfgrasses. Based on the available data, it appears that an ice cover would have to be in existence for at least 75 days before any significant amount of injury from either of these types of kill would occur. This is an unusually long period which would rarely occur in the United States. Even after 75 days it appears that only certain varieties such as annual bluegrass are prone to injury due to accumulations of toxic gas. Other varieties such as the creeping bentgrasses appear to be as tolerant of this injury mechanism as they are to direct low temperature kill.

<table>
<thead>
<tr>
<th>Sampling date</th>
<th>Temperature Treatment (°F)</th>
<th>30</th>
<th>25</th>
<th>20</th>
<th>15</th>
<th>10</th>
<th>5</th>
<th>0</th>
<th>-5</th>
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<td></td>
<td>100</td>
<td>99</td>
<td>98</td>
<td>96</td>
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<td>89</td>
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<td>100</td>
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<td>96</td>
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<td>74</td>
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<td>90</td>
<td>56</td>
<td>21</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>June 5</td>
<td></td>
<td>100</td>
<td>99</td>
<td>74</td>
<td>74</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Prevention of Winter Injury

There are six cultural factors which turfmen should recognize and practice in order to minimize the chance of winter injury, especially direct low temperature injury. Each will be discussed separately.

1. **Adequate Surface and Internal Soil Drainage**

Any increase in the tissue moisture content increases the hydration level of a plant resulting in a greater susceptibility to low temperature kill. Increased hydration levels can be the result of standing water which accumulates in the vicinity of turfgrass crowns and which diffuse into the crown tissue causing an increased water content. Standing water is due to poor surface or internal drainage and should be corrected wherever this problem exists. Compacted soils also result in poor drainage and tend to impair water drainage from around the crown. It has been observed that winterkill caused by low temperature kill frequently occurs on heavier soils and soils which are compacted. A grass plant which has been in standing water for a period of time will have an increased water content and will be particularly susceptible to low temperature injury, especially if soil temperatures drop below 25°F.

2. **Avoid Excessive Nitrogen Fertilization During the Late Fall Period.**

Nitrogen fertilization stimulates top growth and causes an increase in the hydration content of plant tissue. This, in turn, as has been previously explained, will decrease the low temperature hardiness of the plant. Several studies on both warm and cool season turfgrasses have shown that tissues receiving excessively high nitrogen applications or nitrogen which is applied in late fall, will be more prone to low temperature injury. It should be pointed out that this is one of the factors effecting low temperature injury, but not as critical as the hydration factor. Maybe four out of five years you will not experience increased low temperature kill due to late fall or excessive nitrogen applications. However, on that fifth year, conditions may be such that much greater kill will result from an overly ambitious nitrogen fertilization program.

3. **Insure Adequate Potassium Levels**

Potassium has been shown to increase the low temperature hardiness of both warm and cool season turfgrasses. The exact mechanism by which this nutrient influences low temperature responses is not well understood. It should be pointed out that it is not just low nitrogen or high potassium that is important in low temperature survival, but a balance between these two nutrients. It appears that a ratio somewhere in the order of a 2:1 or 3:1 (nitrogen to potassium) is the key to maximum low temperature survival. Turfmen concerned with potential winterkill problems should insure that the potassium level is adequate going into the winter period. The effects of nitrogen and potassium are not important on the more low temperature hardy species such as bentgrass. However, on such species as annual bluegrass, red fescue, ryegrass, and tall fescue these nutrient relationships can be quite important.

4. **A Higher Cutting Height**

Investigations at Michigan State have shown that Kentucky bluegrass has greater low temperature survival as cutting heights of 1½ inches or higher. There is a great increase in low temperature kill at cutting heights of 0.5 and 1.0 inches. It appears that on Kentucky bluegrass and annual bluegrass turfs, a higher cutting height of approximately 1½ inches will be an additional factor that will minimize the chance of winterkill. Short cutting heights on bentgrasses are of no concern due to their extreme low temperature hardiness. The mechanism involved in cutting height is related to the increased leaf area and subsequent greater carbohydrate production. A key property in increased low temperature hardiness is the accumulation of carbohydrates. Turfs which are cut at a higher height will be able to store greater quantities of carbohydrates.

5. **Avoid Thatch Accumulation**

A thatch build-up tends to elevate the crowns, rhizomes, and roots of turfs above the soil. The soil functions in protecting against extreme low temperatures. When these vital plant parts are elevated above the soil surface, they are more subject to low temperature kill. In addition, the reduced rooting will cause the turf to be more susceptible to desiccation injury and the thatch itself enhances snow mold disease activity to a great extent.

(Continued on Page 21)
Good Planting For Safe Enjoyable Motoring

By

JOSEPH L. BEASLEY
Highway Landscape Supervisor
Massachusetts Department of Public Works
Boston, Massachusetts

The title of this paper, "Good Planting for Safe and Enjoyable Motoring," is self explanatory and everyone in this gathering is aware of our part in this phase of Roadside Development.

 Beautification is a word we have heard a great deal of in the last few months; I am one of those people who can remember when it was considered a naughty word and Beautification, as well as Roadside Development were considered a luxury that we could do without.

 I realize that many of you are professionals and that some of the basics and fundamentals I am going to mention are not new to you.

 I still feel that all of us should develop broader perspectives, new visionary thinking and new approaches in Roadside Development to enable us to conceive and prepare our roadsides for future generations.

 The following comments are submitted for your consideration:

 It must be emphasized that our highways should be looked upon as a wide corridor passing through our countryside. This would be called the highway corridor. Prior to, and after highway development, we should make adequate land acquisition in order to fully improve and protect this corridor.

 Landscaping and Roadside Development in its various phases would further improve this corridor.

 The restoration, preservation and enhancement of scenic beauty along our roadsides both before, during and after construction must be one of the prime requisites of any successful highway construction program.

 Improvement, restoration and enhancement of scenic strips and vistas that must be acquired is another important phase of the President's Beautification Program.

 Many special problems arise in Urban highway beautification. There are two categories in this type of beautification, (1) City Streets, (2) Expressways.

 We should create areas for landscaping on City Streets.

 We should respect public parks and other open spaces. They have not been saved for us to put highways through.

 All remnants of land left after a highway has been constructed, whether Urban or in Rural areas, should be used as small parks or planted with trees or shrubs for posterity.

 The fact must be emphasized that in Urban situations we need more large-scale landscaping. We should be thinking both in greater scope and in the use of larger plant material.

 Roadsides on urban sections of the Interstate System are usually narrow, thus limiting roadside development possibilities. Good landscaping in these areas can only be achieved through careful, detailed study and by using specialized plant material.

 Each stretch of highway and each interchange presents an individual problem in Roadside Development. There are times when planting is advantageous and others when such policy will create blind, accident prone areas.

 President Johnson's Beautification Program is certainly a mandate to all of us, including our superiors, to take a realistic look at what we are doing, where we are going, and what we are going to leave as a heritage for future generations under the category of Roadside Development.

 This program has created so much interest in Massachusetts that one large real estate concern has made an outright gift to the Department of Public Works of the major portion of the plant material from a large tract of nursery land that they intend to develop. It is estimated that there are 15,000 usable plants in the area, valued at an estimated $100,000. They may receive a tax rebate for their contribution.

 In another instance, people from the Town of Canton donated and planted 2,000 evergreen seedlings at one of our interchange areas.

 All plantings and mulchings should basically strive to induce any natural growth that may be in the area.

 Natural growth is not a cure-all, but has a prominent place in roadside design along with grass and the more sophisticated landscaping.

 Grass should be planted for a distance of 30 feet on both sides of all roadways which will result in adequate sight distance for safety, the prevention of shading the road surface thus helping snow and ice control operations, the elimination of tree hazards close to road surfaces, and the feeling of ample width so that traffic will make full use of all travel lanes. The 30-foot distance should be regarded only as a starting point in design. Fill slopes with guard rail should not be planted to grass, but rather to some low-growing natural growth ground cover. Grass should not be planted on cut slopes beyond a point five feet from the toe of slope or a distance greater than can be reached by the cutterbar of a tractor mower. Grass can be used effectively for a much greater distance than 30 feet in certain places, particularly on areas more or less level with the road surface. In other words, the back line of the grass should not be a straight line parallel with the road surface but should vary from place to place.

 From the back grassline to the outer limits disturbed by construction, first consider replacing the type of natural growth removed. For instance, if pine growth was removed, design the area to use a woody mulch and plant pine seedlings spaced about five feet on centers. If they should all survive, it will be necessary to do some salvage thinning at a later date.
Certain parts of the rural section of the Interstate System should be landscaped, particularly at interchanges. Bowl areas should be planted to groves of various types of trees and plantings should be made at bridge abutments. Plantings should be designed to screen junkyards, borrow pits and other unsightly areas. Group plantings should also be designed to break up long sections of open roadsides. These plantings should be of comparatively small stock and survival is better, the initial cost less, and the desired results will be obtained in only a few additional years of growth.

It is my opinion that plantings increase in value and the roadsides improve in appearance each and every year, whereas grassed areas are more apt to decline as the years pass.

Barren roadsides can contribute to Turnpike Fatigue, a cause of accidents. Well grouped plantings of diversified materials promote a feeling of interest that will avert drowsiness while driving.

Soil erosion, on either cut or fill slopes, can develop into full-scale washouts, thereby creating traffic hazards, causing delays to the travelling public. Proper planting and mulching on slopes creates a root body that prevents erosion and at the same time gives an appearance of natural beauty, such as created by Mother Nature.

It is my opinion that a beautiful highway is a safe highway. Attractive, neat and clean roadsides, together with inspiring scenery from our natural vistas, tend to reduce highway monotony and, therefore, reduce driver fatigue.

The reforestation and planting approach that I am presenting to you for the realistic restoration of nature in highway roadside design, is not just a theory or a cloud nine approach. It is a bread and butter landscape plan based on years of practical experience and dozens of successfully completed projects.

I want to stress the fact that we are not planting trees just for the sake of planting trees. We have a reason and need for every tree, shrub or yard of mulch used.

I also believe that the mortality rate of all roadside planting can be reduced by the use of all balled and burlapped or container grown trees and shrubs. Smaller seedling evergreens, woody shrubs and vines should be delivered to the project in "Root through Pots", with a two-year supply of modern non-burning fertilizer in the soil mixture. These could be planted as a unit in the designated areas as is, without the necessity of filling pits with loam.

In the following lists of tree planting locations, I wish to call your attention to the fact that in many instances there are more unsatisfactory locations for planting shrubs and trees than there are satisfactory locations.

There have been many instances where improper planting at channellizing islands, narrow median strips and in other locations, for reduction of oncoming headlight glare and to provide crash barriers, have reduced visibility and curtailed sight distances, thereby creating a greater problem than the cure that had been anticipated.

TREE PLANTING

General — Other than necessary replacement planting, tree planting is done primarily on roads where ample layout width is available. In planning for tree planting, all of the physical features of the roadsides and the meteorological conditions of the area should be considered.

Selecting Species Several different species of trees should be grouped in each area to be planted so that not all the trees will be destroyed by any one blight or disease. Consideration should be given to trees which are indigenous to the locality. Flowering and evergreen trees should be included in the selection for planting in any area.

Mass planting of trees and shrubs is, by far, more effective than spot planting. Various plantings should be drifted into one another. Trees should be planted in groves, groups or clumps to present natural appearance.

Closer spacing of plant material on slopes, at bridge abutments and in beds, is more effective, tends to fill in quicker and will reduce the work required to weed and maintain these locations.

Satisfactory Locations for Planting

1. Trees should be planted as near as possible to the location line.
2. On highways having wide layout groups of low growing trees may be planted halfway between the shoulder and the location line with taller growing shade trees and evergreens planted in back of or between these groups and the location line.
3. In bowl areas at interchanges trees should not be planted less than 35 feet from the ramp road and not less than 15 feet outside the toe of the slope so that they will not interfere with sight distance or mowing.
4. Trees should be planted and grouped in such a manner that will cause a minimum of interference with mowing equipment or other maintenance operations and overhead utility lines.
5. Evergreens may be planted in checkerboard fashion on abutment slopes and on the fill slopes of interchanges.
6. Trees set out in groups should consist of three to five, seven or 15 of the same species. At interchanges or wide layout areas, the number of trees should be increased up to 15 to 50 in a group.
7. Willow trees may be planted in moist locations and far enough back within the layout to allow for their size at full maturity.
8. All gravel pits, dumps, maintenance areas and unsightly views should be screened with evergreens.
9. Unsightly areas that are difficult to mow and which are not practical to grade and seed should be planted with groups of trees and evergreens.
10. The planting of trees at roadside rest areas for shading should be given prime consideration.

Unsatisfactory Locations for Plantings

1. Under utility wires, unless low growing specie.
2. In grassed areas between curbing and sidewalk.
3. On the inside of curves where sight distance would be decreased appreciably.
4. In areas close to street intersections at grade or at drives where sight distance would be decreased.
5. Less than 12 feet from edge of the shoulder on narrow layout highways and less than 35 feet on wide layout or limited access highways.
6. In straight rows or at set distances. (Plantings should be in groups or staggered.)
7. In median strips less than 30 feet in width.
8. In open areas within the layout where there is already a suitable background of trees and shrubbery.
10. In front of attractive bridge abutments.
11. Where planting might screen vistas or picturesque scenery.

It is the feeling of many people that we are using and setting out a large volume of planting material, namely: Trees, Shrubs, Seedlings, Ground Cover, Natural Growth Sods, etc. Though it may appear that we are using a tremendous quantity of planting material, it is only 30% of the total needed for replacement, in areas stripped of plants and trees, during the construction of our new highways.

I believe each and every one realizes, and appreciate by experience, the basic and elementary fact that Nature disturbed must of necessity be effectively restored.

The planting of seedling evergreens, woody shrubs, swee fern, bearberry, low bush blueberry, natural growth sods, other ground cover plants and similar materials along with the use of wood chips and other woody mulches is a suitable and adequate approach not only for blending our roadsides into a naturalistic state but it contains the economic advantage of eliminating large areas from mowing and reducing maintenance costs.

Particular attention must be paid to long, steep, cut slopes where erosion control or mowing is, or could be, a problem. These slopes should be mulched with two inches of wood chips or other type of woody mulch. Then the slope should be planted with a combination of seedling evergreens, low growing woody shrubs, vines, ground cover or natural growth sods. The mulch and the plantings will stabilize the slope, eliminate mowing and help induce natural growth.

In closing, I shall enumerate and summarize my philosophy and beliefs in “GOOD PLANTING FOR SAFE AND ENJOYABLE MOTORING”.

1. It is time to face facts, we must recognize maintenance problems by providing better roadside turf management.
2. Restoring the balance of nature by proper planting and land usage on our highway systems should be of paramount importance and the direct responsibility of Highway Officials.
3. The planning and developing of mass planting of large roadside areas and interchanges to assist in providing a green belt of natural areas and resources for the tremendous increasing tourist trade.
4. Reduction of Roadside Maintenance Costs, through the planting of trees, woody shrubs, vines and various other ground covers, thus eliminating the mowing of grass forever, and providing scenic highways for future generations.

The maintaining of the balance of Nature in Highway construction is a natural law and certainly not a luxury. Roadsides should be constructed in the interest of developing a buffer strip and green belt along our roadsides for future generations. If we fail to continue to plant trees, shrubs and ground coverings, the future generation will never enjoy or view a naturalistic retreat.

The eyes of the citizens of the Country are on us. President Johnson’s Beautification Program is basic and sound and has received the approval and support of everyone. These people will be looking for results. It is up to us to produce. We have public sentiment behind us. It is our responsibility to leave a heritage of green and beautiful roadsides for future generations to enjoy.

Are YOU GUILTY?

E. H. WHEELER, Professor of Entomology
University of Massachusetts
Leader, Pesticide Chemicals Program

Young children are poisoned by pesticides more frequently than any other age group. Improper storage of pesticides and unsafe disposal of “empty” containers are major causes. Youngsters are curious and they get from “here to there” before anyone knows it. If your children, or anyone’s children, can get to your pesticides or “empty” containers there is something wrong — something that is YOUR responsibility to correct. These suggestions, if followed, will help you keep out of trouble.

1. Store all pesticides (and other hazardous materials) in original, plainly labeled containers.
2. Have one place for pesticides — one which can be locked! (Another spot may be needed for products spoiled by freezing.) A shed, garage or other open area is not a safe place to keep pesticides. Opened packages increase the danger.
3. A separate, well-marked building is best. Second best would be an enclosed corner or end of a structure in which no animals are housed — no people either.
4. Never leave pesticides outside the locked storage even though you may be planning to use them again tomorrow.
5. Pesticides and “empties” left unattended in the open at the mixing-filling station are an invitation to tragedy in this day when farms are not so isolated from non-farm families.
6. A ditch, stream bank or an open dump anywhere is NOT a safe place to throw “empty” pesticide containers. They are never empty!
7. Burn “empties” that will burn (except hormone-type, 2,4-D, etc. weed killers) in a spot where ashes can be buried; this amount of heat does not destroy some pesticides. And remember, smoke from organic phosphate insecticides is especially dangerous.
8. Bury bottles and metal containers 18 inches or deeper at a spot where, in so far as possible, you have determined there is no chance of later exposure or that waters can be polluted. It is best to break bottles and to puncture and/or crush cans and drums, but, do it in the hole or so that surface soil is not contaminated. Avoid splashing with the concentrates!

Remember! Accidents with pesticides don’t just happen — somebody lets them happen — someone who failed to carry out his full responsibility.
Observations On Fusarium Blight Of Turfgrass

George A. Bean
Department of Botany, University of Maryland
College Park, Maryland

INTRODUCTION
'Merion' Kentucky bluegrass (Poa pratensis) is widely used as a turfgrass throughout the United States. Under proper management, Merion forms a beautiful, vigorous, dense turf that is both weed resistant and drought resistant. It is resistant to leaf spot (Helminthosporium spp.), but is susceptible to stem rust (Puccinia graminis Pers. f. sp. agrostis Ericks.), stripe smut (Ustilago tritici West.) and mildew (Erysiphe graminis DC.). Although Scherry (3) considers the climatic conditions of the Washington, D. C. area unfavorable for Merion, it is still considered the most desirable bluegrass variety.

In 1962, a crown rot was observed in some Merion lawns in the Washington, D. C. area. Numerous irregular patches of dead turf rapidly appeared in a lawn (Fig. 1). In 1959, Couch made similar observations in Pennsylvania and later found that Fusarium roseum (L.) amendment. Snyd. & Hans. was the causal organism (2). This report summarizes observations made on Fusarium blight in 16 turf areas in the Washington, D. C. area since 1963.

SYMPTOMATOLOGY AND TIME OF OCCURRENCE
Symptomatology: Fusarium blight has both a crown-rot and a leaf-spot phase. The most characteristic symptom of crown rot is irregular, tan areas of dead sod, 1-3 inches in diameter. At the stage the symptoms resemble dollar spot infection caused by Sclerotinia homeoccarpa F. T. Bennett. If favorable conditions persist, however, the Fusarium-blighted areas increase in size and finally coalesce. In a Merion or Kentucky bluegrass lawn with dollar spot disease, affected areas tend to remain relatively small and rarely coalesce. Fusarium blight can develop very rapidly and large areas of sod have been completely destroyed within 7 to 10 days after the first symptoms. As the blighted areas increase in size, grass bordering these areas is usually wilted and mycelium of Fusarium spp. may be isolated from the crown area of affected plants. Occasionally a small amount of healthy sod persists in the center of a blighted area and this "frog eye" effect is considered by Couch (2) to be the characteristic symptom of Fusarium blight. The frog eye symptom is rarely observed in this area and should not be considered a reliable symptom of this disease.

Although leaf lesions are normally present on plants with crown rot, they can also be found on plants without crown rot. One to many lesions can occur on a single leaf. Lesions characteristically have white centers surrounded by a light brown margin of infected tissue and resemble dollar spot infections. Lesions eventually extend across the width of the leaf and have a yellowish appearance. Fusarium lesions can readily be distinguished from Helminthosporium lesions which are blue-black, elongate and rarely extend across the width of the leaf.

'Merion' Kentucky bluegrass sod affected by Fusarium blight.

Time of Occurrence: In the Washington, D. C. area, Fusarium blight was first positively indentified on July 18, 1963, although turf workers have observed similar symptoms in turf in this area since 1952. The fungus remained active throughout August in 1963, but by September, as temperatures decreased, the fungus was no longer active. In lightly infected areas, healthy sod grew back into the dead areas. In 1964 and 1965 the disease symptoms appeared on June 28 and June 23, respectively, and remained active throughout August and September of both years. Many infected areas had to be either reseeded or re-sodded in 1964 and 1965. An increase in inoculum may have accounted for the earlier appearance of Fusarium blight in 1964 and 1965. There was less rainfall from June through September in 1964 and 1965 than in 1963, which may also have been important. The total rainfall during June-September in 1963, 1964 and 1965 was 19.4, 7.6 and 11.4 inches, respectively. Severe drought during 1966 made observations on Fusarium blight difficult and unreliable.

MATERIALS AND METHODS
Isolation of Fungi: Leaves with typical Fusarium lesions were collected periodically from September 1964 to September 1965. After surface sterilization with 0.5% sodium hypochlorite, the tissues were incubated on potato-dextrose agar for 10 to 14 days at 25°C. During September 1964, Fusarium spp. were isolated from 32% of diseased leaves and species of Curvularia and H. triplumpatum Drechs. from 54%. Curvularia spp. and H. triplumpatum are relatively weak pathogens of turfgrasses (1). From October 1964 through May 1965, only Curvularia and H. triplumpatum were isolated. From the first week in June 1965 until the middle of August, Fusarium spp. were isolated 66% of the time and Curvularia spp. and H. triplumpatum were the predominant species (71%) and Fusarium spp. occurred in 23% of the leaves collected. The predomiance of Fusarium spp. isolated from infected leaves during June, July and August correlates with the appearance of Fusarium blight during the same period.

Influence of Environment: The first area of a lawn to become diseased is usually on sloping land close to a driveway of walkway. Severity of infection is directly proportional to intensity and duration of sunlight, and sod on south facing slopes is usually more severely infected than sod on north slopes. The most severely diseased sod receives full sun during the warmest part of the day, from 12 noon to 4 p.m. As the amount of shade increases, disease severity decreases. Often, only a small opening in a dense tree canopy will result in infection of the exposed turf below. Diseased turf has not been observed in heavily shaded areas. I was unable to correlate disease severity with high nitrogen levels or low calcium levels as reported by Couch (2).

1 Scientific Article Number AI305, Contribution Number 3847, of the Maryland Agricultural Experiment Station.
2 Assistant Professor of Botany, Department of Botany, University of Maryland, College Park.

(Continued on Page 18)
TURF BULLETIN

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In the most severely infected areas, more than 50% of the sod was destroyed, which necessitated re-seeding or re-sodding. The disease was more prevalent and severe within Washington, D.C. than in outlying suburban areas. This pattern may be the result of generally higher temperatures that prevail in the center of the city as reported by Woollum (4).

Susceptibility of Turf Grasses: Couch (2) found that under greenhouse conditions, 'Highland' bent grass (Agrostis tenuis) was most susceptible to F. roseum, with 'Merion' bluegrass and 'Pennlawn' red fescue (Festuca rubra) ranking next in order of susceptibility. Observations were made on the following turf grasses, either in pure stand or in mixtures: Kentucky bluegrass (Common, Merion and Windsor), creeping red fescue (F. rubra), Bermuda grass (Cynodon dactylon), bent grass (T. Tenuis) and 'Meyer' zoysia (Zoysia japonica). Characteristic symptoms of Fusarium blight have been observed in pure stands of Merion, Windsor, Common Kentucky and on a mixture of Common bluegrass and creeping red fescue. Fusarium blight has not been observed in red fescue, Bermuda, bent grass or zoysia. A putting green of 'Pennlu' bent grass remained healthy while surrounding Merion sod was destroyed by the disease. Prior to installation of the sod, the soil was fumigated with methyl bromide to destroy any Bermuda grass. Although the sod was healthy when laid in the fall, by the following summer Fusarium blight was present in epidemic proportions.

The level of thatch in a lawn has little effect on the speed with which Fusarium can destroy a lawn. In one area of Merion sod, severity of Fusarium blight was higher in 1964 than in 1963, although the entire area had been thatched during the fall of 1963 and spring of 1964. The clippings were also collected after each cutting. In another area, a stand of Merion has been free of blight disease for 6 years although it has not been thatched or cuttings collected since its establishment. Fungicides have not been applied to the latter sod.

CONTROL STUDIES
Fungicides: Couch (2) reported that a coordination product of zinc and maneb (Dithane M-45) at the rate of 4 to 6 per 1000 sq. ft. was the most effective fungicide for controlling Fusarium blight. In 1964 an area of Merion sod which had been moderately infected the previous year was sprayed throughout the summer with zinc+maneb (Dithane M-45). The first application was made 1 week prior to the first appearance of the disease and at 8- to 10-day intervals thereafter. At the 6-oz dosage rate zinc+maneb did not control the disease. Fungicide test plots were established at this location in July 1964. Two applications of the following fungicides were made 7 days apart at recommended rates: N-((1,1,2,2-tetrachloroethyl) sulfonyl)-cis-4-cyclohexene-1,2-

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dicarboximide (Difolatan), zinc ion+maneb (Dithane M-45), 2, 4,-dichloro-6 (o-chloroanilino)-s-triazine (Dyrene) (Dy.), Dyrene+Dithane M-45, and 45% thiram+10% 2-chloro-4-(hydroxymercury) phenol (Tersan OM). Half of each plot was thatched once with a "Ryan mat-away" to obtain better chemical coverage. Seven days after each application, the number of infection sites and the diseased areas were measured. None of the fungicides tested reduced severity of disease, with or without thatch removal. In 1965, zinc ion+maneb and Dy. were each tested again at 8 oz/1000 ft². The first application was made 3 days after the first symptoms and at weekly intervals thereafter. The size of the total infected area was estimated prior to each fungicide application. After six applications, there were no differences between unsprayed sod and sod that received the Dy. or zinc ion+maneb. Additional fungicide studies are underway.

Resodding: Replacing infected sod with healthy sod may not be practical if a lawn is severely diseased. In the fall of 1963, severely diseased areas of Merion sod in one lawn were replaced with 1-year-old healthy sod. During the following summer, disease symptoms first appeared in the original sod. Within 1 week the new sod became infected, and 2 weeks later it was as heavily infected as the original sod.

Where traces of disease occur in a lawn, Fusarium blight may be controlled by removing the infected areas and replacing with healthy sod. To eliminate the mycelium in crowns of plants, at least 3 inches of healthy sod beyond the circle of dead sod should be removed. Unless this is done, remaining mycelium continues to spread and will infect the original sod.

CONCLUSIONS

Fusarium blight of turfgrasses is a serious problem only in certain areas even though the casual fungus is widely distributed. The disease is active only during the warmest part of the summer, and the first area of a lawn to be infected is usually the warmest location. Furthermore, the disease is not found in shaded areas, which indicates that light, temperature and moisture, or a combination of these factors, may be important in the disease syndrome. Control of Fusarium blight by cultural means may be possible and should be investigated further. For example, allowing turf to wilt before watering has long been a standard recommendation. This may not be advisable, however, if periodic low moisture levels increase the susceptibility of turfgrasses to Fusarium blight. More frequent irrigation may help lessen disease severity by keeping soil temperatures lower.

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—Reprinted from the Agronomy Journal
Phosphorus In Soils And Plants

V. Allan Bandel, Extension Soil Specialist
University of Maryland

Of the three major plant food elements generally contained in commercial fertilizers, phosphorus has been perhaps the most critical as far as plant growth is concerned. Phosphorus, as superphosphate, was the first element to be applied to soils as a manufactured fertilizer.

Phosphorus is one of 16 elements considered essential for plant growth. Phosphorus has a number of functions in plants. Some of the more important ones being: (a) promotes vigorous root growth and development, (b) hastens maturation of crop (counterbalances effect of nitrogen), (c) increases stiffness of straw in cereals (reduces lodging), (d) increases disease resistance, (e) promotes seed formation (quality of fruits and seeds increased), and (f) serves as an energy source for anaerobic respiration in plants.

Most phosphorus is absorbed by plants as the phosphate ion (H$_2$PO$_4$), but the form absorbed depends upon the pH of the system from which the ion was absorbed. At very high pH levels, a greater proportion of phosphorus would be absorbed as the HPO$_4$ or PO$_4$ ion.

Phosphorus is mobile in plants. It is transferred from one part of a plant to another, particularly when the supply of soil phosphorus is short. In cases such as this, phosphorus would be drained from older tissues to newer growing tissues and finally into the seeds. For this reason, deficiency symptoms appear on the older parts of the plant first.

The recovery of fertilizer phosphorus from the soil by plants is quite low. Often as little as 10 to 30% of applied phosphorus is all that is recovered during the year of application. But phosphorus is not lost by leaching. Surface applied phosphorus will remain within the top 2 to 3 inches of soil unless incorporated by plowing or disking. The most serious means of depletion of soil phosphorus is by crop removal. Why then is phosphorus fertilizer so inefficient?

The efficiency of phosphorus recovery depends upon a number of factors, a few of which will be discussed. Phosphorus recovery varies between plant species and varieties. Some plants are "strong feeders" of phosphorus from soils while others are not. Some possible reasons for this difference between plants may be related to the following factors.

1. Plant root growth. Since phosphorus does not move in the soil, plants can absorb it only by growing into closer contact with it in the soil.
2. Cation-exchange capacity. Some plant roots can absorb relatively insoluble calcium phosphate compounds better than others.
3. Calcium requirement. More of the insoluble calcium phosphates in the soil dissolve than when calcium tends to accumulate.

Numerous other factors associated with species and variety influence the ability of plants to absorb phosphorus. However, of great importance on Maryland soils are certain characteristics of the soil system which influence phosphorus availability. The soil must possess all those physical properties such as adequate moisture, favorable temperature, aeration, tilth, etc., which are favorable for optimum root growth. As previously indicated, roots must be capable of growing to close proximity with the phosphorus particle since soil phosphorus does not move great distances.

Of the chemical factors affecting phosphorus availability, soil pH is one of the most critical. A pH of about 6.5 is ideal for maximum phosphorus availability to most crops on Maryland soils. At pH levels less than the ideal, iron, aluminum, and manganese compounds become more soluble. These ions can then combine with phosphorus to form insoluble iron, aluminum, and manganese phosphates. Similarly, at pH levels higher than ideal, excessive calcium is present which can combine with phosphorus to form insoluble calcium phosphates. For maximum phosphorus availability, it is essential that the pH be maintained at about 6.5 for general farm corps.

It is also important to realize that phosphorus ions react not only with iron, aluminum, and manganese ions, but also with the hydroxides of these elements. It is quite likely that fixation as hydroxyl phosphates in acid soils may even exceed the chemical precipitation by the soluble iron, aluminum, and manganese.

It is also possible for phosphorus to be fixed by certain silicate clays. The mechanism is not fully understood, but the clay probably supplies certain ions which precipitate phosphorus in a similar manner to that just described.

It is obvious that phosphorus fertilization is essential for optimum plant growth. It is also obvious that phosphorus fixation is a serious problem, one which greatly reduces the efficiency of phosphorus fertilizers. How can fixation losses be reduced and efficiency of recovery increased?

1. Lime soils to a pH of about 6.5 for general farm crops (corn, soybeans, red clover, etc.) and pH 7.0 for alfalfa. This will minimize the formation of insoluble iron, aluminum, manganese, and calcium phosphate compounds.

2. Minimize soil to fertilizer phosphorus contact. This can be accomplished in at least two ways. (a) Band part of fertilizer in the row. (Regardless of fixation, it is still best not to band all fertilizer in row, but to incorporate a part with the soil through plow-down applications.) Banded phosphorus will provide a supply for young seedlings to become established before extension root growth has occurred. (b) Granulated fertilizers help reduce fixation particularly when phosphorus is broadcast. Only a small portion of phosphorus in a fertilizer granule comes immediately into contact with the soil and is subject to fixation.

3. Estimate the plant availability of soil phosphorus by a soil test. A soil test enables fertilizer phosphorus applications to be accurately correlated with the availability of soil phosphorus.

—Agronomist
Vol. 4, No. 1, Page 1, Jan. 1967
The Influence Of Height Of Cut On The Development Of Turfgrass Roots

by Peter A. KASKESKI

University of Massachusetts

The removal of the top parts of a plant, as in the cutting of the leaves of a turfgrass, will cause a reduction in photosynthetic capacity of that plant. As a result, various parts of the plant will be affected. That portion that is influenced the most and with the future of the plant lies is the root system.

The reduction of the top growth of turf effects the root system in such a manner as does low fertility of the soil, both are detrimental to the plant. The deficiency in photosynthetic capacity of that plant. As the root system in such a manner as does low fertility cutting of the leaves of a turfgrass, will cause a reduction of that period of time and the cutting of 1/2 of the foliage resulted in a temporary halting of root growth immediately after the cut.” Even though a low height of cut reduces the root growth over a period of time, low cutting for the first two mowings may be desirable in the establishment of the bluegrasses and fescues. This low cutting while the grass is immature promotes increased tillering which will increase the density of the sod. This practice should be discontinued after two mowings as it will become detrimental to the plant. If not discontinued, or if established turf is cut too low too frequently, the turf will show signs of low root, rhizome, tiller and leaf growth. Also, recovery will be slow and there will be an increase in weed infestations. Another injury caused by excessively low cutting is scalping. This is due to the cutting off of all the leaves and the killing or damage done to the crowns. The area so affected will turn a light brown.

The relationship between the height of cut and root growth can be explained by the presence of carbohydrates in the plant. Grasses that are growing normally are manufacturing carbohydrates in the leaves. These are then translocated down to the roots where the excess, if there is any, is stored after the roots use what they require for growth. When the grass plant has been cut it draws on these carbohydrate reserves in the root for the renewal of its top growth. This new growth produces more carbohydrates but these are immediately used by the plant and it takes a while before enough can be produced so that some can be stored. The lower the height of cut the more leaf area removed. This in turn reflects upon the plant’s ability to produce carbohydrates for reserve purposes. As the plant is continually cut low there will be a constant drain on the reserves for top growth. This will continue to a point where the carbohydrates will become the limiting factor in the plant’s ability to regenerate itself. At this point carbohydrate starvation and the death of the plant will result.

Nitrogen fertilization is used as an aid to supplement the plant’s nutrient requirements. Available nitrogen in the soil may become the limiting factor in good root development. If there is a deficiency of nitrogen the photosynthetic organs will not develop sufficiently to supply the roots with carbohydrates. If the nitrogen is applied after a low cut it will promote top growth but root growth will be slower. If the turf is kept short the rapid removal of the tops will deplete the roots all the faster. So the addition of excess available nitrogen in the soil acts in a reciprocal manner on the excess of carbohydrates in the root. This is not to say that nitrogen fertilization is detrimental to the plant; on the contrary, it is beneficial if applied at regular intervals so vigorous, steady growth and the establishment of a strong root system can be obtained. Experiments have shown that grasses receiving low nitrogen fertilization and high height of cut (2 inches) produced more roots than at high nitrogen fertilization and a low height of cut.

Most of the work that has been done with turf and cutting heights has been with the Bluegrasses. Most of the results obtained can be applied to the other types of grasses with a few exceptions. The general observations were: root development was influenced more by cutting height than by interval of cutting, top growth decreased with low cutting heights and the total plant vigor and ability to recover decreased with low and frequent cuttings. It was found that; in Merion bluegrass the carbohydrate-nitrogen ratio was higher than in many other grasses. This accounts for the fact that Merion is better able to withstand closer clipping than Common Kentucky Bluegrass and still be able to maintain an adequate root system. Also at a cutting height of 2 inches Merion produced a thicker turf than the Common Kentucky Bluegrass.

Law 8 worked on different varieties of bluegrass and found that the dwarf varieties such as Merion, Cougar, Nebraska Dwarf and Newport were able to withstand closer clipping than the taller variety, Delta. Here it seems that the proper choice of varieties that are tolerant to different heights of cut could be used for different purposes such as lawns and golf tees.

For a general recommendation the bluegrasses (except Poa annua), the fescues and the other slow growing erect types of grasses should not be cut any lower than 1 1/4 inches. In the spring and fall when the grasses are growing faster it may be possible to use a lower cut but only temporarily. On grasses such as the bents, carpet grasses, centipede and other low growing grasses the height of cut can be from 1/8 to 3/4 of an inch or shorter in the spring and fall. This is possible because they form a dense mat of foliage close to the ground. On all types of grasses no more than 1/2 of an inch should be taken off at any one cutting or the turf may be injured by shocking.

Winter Injury (continued)

6. Avoid Traffic During Slushy Periods When Freezing is Imminent

Studies at Michigan State have shown that under slushy conditions, concentrated traffic by a single individual over an area can cause total kill of Kentucky bluegrass, roots, rhizomes, and stolons. If this period of traffic on a slush occurs prior to a severe freeze, considerable kill is likely to occur. It is hypothesized that the traffic results in a compression of the water into the existing air space in the turf.
thatch. As a result, an increase in the hydration level and susceptibility to low temperature kill will occur. Based on these observations, winter traffic during wet, slushy periods can result in severe injury to the turf. In addition, traffic during wet periods can cause severe compaction of the soil which will not result in immediate kill, but can increase the management problems during the subsequent summer stress period.

One final point which has been significant throughout our research at Michigan State is the much greater susceptibility of annual bluegrass to all phases of winter injury. Management practices which minimize the encroachment of annual bluegrass into bentgrass and bluegrass turfs would be important in reducing the winterkill problem. We have been impressed with the winter hardiness of the bentgrasses.

If turfmen will keep in mind the six management factors which have been discussed, they will have done all that is currently known to minimize the chance of winter injury. Our technology has not developed to the point that we can guarantee 100 percent protection against low temperature kill. Much progress has been made in clarifying the causes of winter injury and in the development of cultural practices to minimize its severity. However, much yet remains to be done.

* The above article was presented at the “1967 Massachusetts Turf Conference.”

FERTILIZER IN PLASTIC PACKETS KEEPS TREES WELL-FED

If you sprinkle an ounce of fertilizer in the hole when you’re planting a tress or shrub, you’ll probably kill it. The salts in the fertilizer dehydrate the tender roots, say University of Wisconsin scientists.

But if you put the same ounce of fertilizer in a plastic packet, there is no salt, they say. By punching four to eight pinholes in the packet and placing it about 6 inches deep and 6 to 12 inches to the side of the tree or shrub, the packet becomes a self-feeder. It gives the tree a quick start and keeps it well-fed for as long as five seasons.

The scientists say that the packets work because what little air there is in the soil is usually near 100 percent relative humidity. As each drop of the fertilizer-water mixture spills out the moisture in the soil dilutes it to the strength the plants like. Results over the past 5 years indicate that the packets will keep a tree or shrub well-fed for 3 to 5 years.

—Crops & Soils Magazine
Vol. 19, No. 4, Page 24, Jan. 1967

FESCUE FERTILIZATION
ELWYN E. DEAL
Extension Turf Specialist
University of Maryland

Some confusion still persists about how to fertilize the fescues — tall and red. Tall fescues require slightly higher nitrogen fertilization rates than Kentucky bluegrasses but red fescues require less nitrogen.

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ANNUAL BLUEGRASS

ELWYN E. DEAL

Extension Turf Specialist
University of Maryland

If you have not yet noticed that annual bluegrass, Poa annua, L., is a serious weed problem in Maryland, take a look at turf areas now. And if that doesn’t convince you, check again in May when this pest is flowering and in July or August after it has died out due to summer heat and drought.

Healthy turf — thick, vigorous, fast growing grass — is one good way of helping to prevent its encroachment but somehow it still manages to get started. Once it makes its first appearance in an area, watch out! A single annual bluegrass plant may produce from a few dozen to several hundred seeds and from there it mushrooms.

Where does it come from? In recent years much of the annual bluegrass that has been found in new turf areas has been introduced with the turfgrass seed. The Maryland Seed Testing Laboratory has found as many as 44,000 annual bluegrass seeds per pound in imported lots of Kentucky and rough (stalk) bluegrass seed. Note the word “imported” since annual bluegrass seeds seldom show up in American-grown bluegrass seed in any large quantity.

The State of Maryland limits the number of “restricted noxious” weed seeds in seed offered for sale in the state to no more than 16 per ounce of seed for annual bluegrass. A few other states have taken similar steps to control the dissemination of this objectionable weed.

If you buy most of your seed in large quantities, you should take steps to be sure that you do not buy this weed in your seed. 1) Write up specifications for your seed and state that it is to be “free of annual bluegrass seed”. 2) After your seed is delivered but before you plant any of them, take a representative sample from the lot and submit it to the Seed Testing Laboratory for testing.

What rates then do bluegrasses require in Maryland? Our recommendations call for 3 to 4½ pounds of elemental nitrogen per 1000 square feet of area per year — 1 to 1½ pounds applied in September, 1 to 1½ pounds in October and 1 pound in March. Bluegrass turf that is predominantly the Merion variety should receive the higher rate, near 4½ pounds, whereas common Kentucky bluegrass can grow very well with the lower rate. Merion can also use an additional application in May — about one-half pound of nitrogen per 1000 square feet.

Tall fescue or turf composed primarily of tall fescue requires at least as much nitrogen per year as Merion Kentucky bluegrass — 4½ pounds. Nitrogen should be applied according to the same schedule as for bluegrasses. Additional applications are also needed in May and June if the turf is heavily used and can be irrigated during the summer months. Three-fourths to one pound of nitrogen in early May and in mid June is sufficient.

Red fescue requires very little nitrogen in comparison to tall fescue. Turf that is all or predominantly red fescue requires even smaller amounts of nitrogen than bluegrasses but should be fertilized according to the same schedule as bluegrasses — September, October and March. The rate of application should be reduced to about one-half or three-fourths of a pound of nitrogen per 1000 square feet for each date. If preferred, the fall applications may be combined into a single application.

The red fescues usually grow well under shade. In areas where there is a lot of competition between the fescue and other plants, slightly higher rates of nitrogen than those suggested above should be used.

Red fescues should not be over-fertilized with nitrogen. As indicated above, they require very little fertilizer and in fact will not tolerate heavy fertilization.

—The Agronomist
January 1967

CHEMICAL RESIDUES LEAVE SOIL
BY VARIOUS ROUTES

Contract applicators concerned about chemical residues in the soil — as an aftermath of spraying for weed or insect control — have a number of natural forces working in their favor, it is reported by the Institute of Agriculture, University of Minnesota.

One of these forces, and a primary one, is microbial decomposition. Tiny soil microorganisms attack virtually all chemical molecules in one way or another.

There are other ways in which pesticides are lost or inactivated. Some are lost through vaporization (volatilization). Some residues leach down into the soil where they cause no further problem.

Some disappearance is due to plant removal or the breakdown of pesticide molecules as they are taken up by plants. Finally, there is some chemical breakdown of pesticides, although very little has been proven by research to occur.

Since soil microorganisms are so important, they have long been in the scientific limelight where the residue problem is concerned. According to Russell Adams, Jr., soil chemist at the University, there seems to be no pesticide molecules that will not be attacked eventually by some soil microorganisms.

Considerable concern has been voiced about adding unnatural organic compounds to soil. However, recent research has shown that chlorinated hydrocarbons can undergo breakdown through action of soil microorganisms.

Microorganism Can Adapt to A Pesticide

Apparently, microorganisms can adapt themselves to a peticide. In one study, organisms were subjected to 2,4-D, and a lag period elapsed as the compound was slowly and then more rapidly attacked.
The above students of the University of Massachusetts were recipients of Golf Superintendents' Association of America Scholarships: Robert Dill (2 year), Edward Horton (2 year), Gerald Peters (4 year), Oliver Leach (2 year), Jim Fitzroy (2 year) and Gregory Gimblette (2 year). Presenting the awards were Richard Blake (G.C.S.A.A. director) and Dr. Joseph Troll.

as the metabolizing organism developed.

Then, later additions of 2,4-D were more quickly decomposed.

There is some scientific controversy over how this adaptation develops — whether it is due to formation of enzymes or mutations. In any case, once an organism becomes able to break down a pesticide, it retains this ability for some time.

Do insecticide or herbicide chemicals affect microorganism? At normal field applications, research shows, there is rarely any effect. In some cases, small quantities of pesticides actually stimulate microbial activity.

Another important factor in pesticide residues is sorption, or the process by which soil takes up and holds the chemical. Importance of sorption — adsorption or absorption — of molecules depends on the type of soil.

Organic residues disappear most quickly from sand, but develop strong bonds with clay, particles of which have charged sites on the surface. Pesticides which are taken up to these charged sites are absorbed, and are thus inactivated.

However, molecules taken up in such a way are a constant source of the pesticide in the soil solution.

INSECTS, ANTI-FREEZE

Question: Last week, I came across this piece in our local paper. "Some insects, like chinch bugs, produce an anti-freeze chemical that keeps their inside from turning into ice in winter. Others freeze without injury, and await the spring thaw." I was wondering if this statement was accurate, if so, about the mechanics of such a phenomenon? (N.J.)

Answer: In answer to your question about an anti-freeze chemical produced by chinch bugs to prevent freezing, this phenomenon undoubtedly concerns glycogen (glycol), a carbohydrate related to starch and found in insects and warm-blooded animals.

Many, if not all, insect species (including chinch bugs) do have the built-in ability to survive very low (minus 0-degrees centigrade) winter temperatures without apparent deleterious effects. Obviously, glycogen plays a major part in survival.

It would also appear that the water within the insect’s body cells moves out of the cells into the inter-cellular areas where freezing will do no harm. If this translocation of moisture did not occur, the accumulation of water crystals inside of the cells would rupture their previous walls.
Phosphorus Fertilization

ELWYN E. DEAL
Extension Turf Specialist

We have been using phosphorus quite liberally on turf areas in the past on the theory that it increases root growth. Some reports in recent years have indicated that extremely high phosphorus concentrations in soils may not be desirable for established turf.

The importance of adequate phosphorus in starting turfgrass from seed has been well documented. But the question arises as to what harm, if any, is being caused by the presence of large amounts of phosphorus in established turf areas.

Some research work we did with Merion Kentucky Bluegrass showed a definite reduction in root and rhizome growth even with low concentrations of phosphorus (3 parts per million), but top growth increased gradually as phosphorus increased. This research was done with sand cultures under conditions where all of the phosphorus was very available to the plant.

Dr. Felix Juska, U.S.D.A. at Beltsville, applied phosphorus to bluegrass and to red fescue turf at rates up to 4,000 lbs. P₂O₅ per acre and reported the following results:

"Root weight of Merion Kentucky bluegrass increased rapidly with up to 1500 lbs. P₂O₅ per acre, then dropped sharply; but, root growth of common bluegrass leveled off after the first increment (250 lbs. P₂O₅). "With N, top growth increased with rate of P; whereas in the absence of N, top growth leveled off after the first increment of P."

Dr. Juska's research was done with turf grown on two different soils. His results suggest that grasses can tolerate very high levels of phosphorus in the soil.

A large percentage of phosphorus applied to the soil is tied up rapidly by combining with other elements in the soil and by adsorption onto the soil particles themselves. However, at a satisfactory pH much of the phosphorus is released back to the soil solution very slowly over a long period of time. This "tie-up" in the soil largely explains the difference in our results and those of Dr. Juska. These results also show the big difference in "applied" and "available" phosphorus.

These reports strongly suggest that there is no need to maintain such high levels of phosphorus in our turf soils, and we may in fact be causing some trouble. The balance of N-P-K in the soil is very important as well as the actual concentration of these elements. Many grasses absorb N-P-K in a ratio of about 4 parts N to 1 part P to 3 parts K.

If you have a relatively high phosphorus situation in your turf, especially on putting greens, we would suggest that you take the necessary steps immediately to remedy it, and keep a close check on it in the future.

—Reprinted from The Agronomist U. of Maryland, April 1967

Decontamination of Large Non-Combustible Containers

JAMES V. PAROCHETTI
Weed Control Specialist
University of Maryland

The proper decontamination of large metal containers should be of importance to all who handle pesticides. Under proper conditions these containers can be utilized with a minimum of danger to the handler, livestock and others. Under no circumstances whatsoever should empty containers of this type be abandoned or be allowed to accumulate in an area accessible to unauthorized persons. Pesticide residues remaining in these containers may be a hazard to children, pets, livestock and wildlife, as well as to adults who may convert the containers to other uses.

Large, non-combustible containers are defined as 15-, 30-, or 55-gallon metal containers. These types of empty containers are of special importance since they do have a certain economic value, not only to the basic manufacturer but to the formulator and to the user. However, it is this type of container that can become most hazardous if improperly handled.

The following procedures for disposing of large, empty non-combustible containers has been recommended by the Grady Committee, Subcommittee on Container Disposal. These procedures reflect the opinion of the committee and are based on experience and opinion; they are not intended to supersede the manufacturers directions. The procedures are recommended in the order of preference, with the first procedure being the most desirable. Before following any procedure, however, carefully and completely wash the outside of the container with water and decontaminate the inside of the container as recommended in table 1.

The first preferred procedure:

A. Tighten all bungs and closures; then transport or otherwise arrange for transportation, to an assembly point previously designated by a professional drum reconditioner for its eventual pick-up. The containers will then be professionally reconditioned following approved methods which will make the drum suitable for use as a container for non-food products.

The second preferred procedure:

B. After decontamination by procedures outlined in Table 1, drums may be used for transporting other non-food products which would react chemically to degrade the pesticide residues that may remain in the drum. (For example: Lime-sulphur solution in phosphate ester pesticide drums).

The third preferred procedure:

C. Mutilate the container by puncturing or other means to prevent re-use. Either burn in a supervised public or private dump, notifying the supervisor of the nature of the material or, if this is not feasible, bury at least 18 inches deep in an isolated area away from water supplies.

—Reprinted from The Agronomist U. of Maryland, April 1967
of finely powdered or flowers of sulphur prior to placing the seeds has been found to be satisfactory on sandy soils, and ½ ounce per square foot effectively acidifies alkaline silt loams.

In tests with sulphuric acid in several North Dakota nurseries, it has been found that applications of ¼ fluid ounce per square foot can double or triple the number of usable plants produced. The use of sulphuric, or other mineral acids, also assists in the control of weeds.

After considering the damaging effects, and the degree and persistence of the acidification obtained, a recommended treatment to acidify a moderately alkaline soil condition consisted of applying ¼ to ½ fluid ounce sulphuric acid or ¼ avoirdupois ounce aluminium sulphate per square foot. For subsequent retreatment of areas where previous crops had been acidified, ½ to ¾ fluid ounce sulphuric acid or ½ ounce aluminium sulphate was sufficient.


—Sulfur Institute Journal Vol. 2, No. 3, Autumn 1966

FERTILIZER IN PLASTIC PACKETS KEEPS TREES WELL-FED

If you sprinkle an ounce of fertilizer in the hole when you’re planting a tree or shrub, you’ll probably kill it. The salts in the fertilizer dehydrate the tender roots, say University of Wisconsin scientists.

But if you put the same ounce of fertilizer in a plastic packet, there is no salt, they say. By punching four to eight pinholes in the packet and placing it about 6 inches deep and 6 to 12 inches to the side of the tree or shrub, the packet becomes a self-feeder. It gives the tree a quick start and keeps it well-fed for as long as five seasons.

The scientists say that the packets work because what little air there is in the soil is usually near 100 percent relative humidity. As each drop of the fertilizer-water mixture spills out, the moisture in the soil dilutes it to the strength the plants like. Results over the past 5 years indicate that the packets will keep a tree or shrub well-fed for 3 to 5 years.

—Crops & Soils Magazine Vol. 19, No. 4, Page 24, Jan. 1967

AMERICAN PRACTICE

We report as a matter of interest that during a trip to the United States of America the Director of the Institute noted that fairways tended to be fed far more (e.g. every year) than in Britain and to be cut less shortly and we have seen recommendations for fairways to be cut at 1 in. - 1½ in.! Possibly there is some relation between these observations and the fact that the average run on a “check” hole during the American Open in 1966 was reported as only 12 yds.

—Sports Turf Bulletin, March 1967

Bingley, Yorkshire
Soil Amendments Related To Turf

by Herbert C. Fordham
University of Massachusetts

Although it has often been said that grass can be grown on almost any type of soil, it is seldom that we find ideal conditions for growing fine turf grasses. In New England many soils are very sandy and therefore provide excessive drainage and loss of plant nutrients. Other soils are a fine silty-loam or clay-loam in character, both of which become tightly compacted and poorly aerated under heavy wear.

The cost of altering the existing soil structure by incorporating various soil amendments can be expensive and almost prohibitive, depending upon the materials used and their availability.

In most soils, it is the organic matter and clay particles which are responsible for water and nutrient retention. Unfortunately, organic matter will decompose quite rapidly, while clays could be a more permanent part of the soil. Clays will also react with organic matter in the soil and tend to stabilize it.

In working with an unproductive Plainfield sand, Mortland and Erickson in 1954 incorporated a Wyoming bentonite clay at rates of 6 1/2, 12 1/2, 25, and 50 tons per acre, plus limestone at the rate of 1 ton per acre and a 10-10-10 fertilizer at the rate of 1 1/2 ton per acre. They started with a crop of oats, followed by alfalfa, wheat and corn, during the years 1954-1957. Corn yields ranged from 6 bushels per acre without clay to 23 bushels per acre where 50 tons of clay per acre had been applied.

Preliminary results from these trials showed that the increase in yields was due primarily to the concentration of moisture and nutrients.

Although the use of clay as a soil amendment may not be economically feasible for use on large land areas, it may be practical in smaller quantities for use in home lawns or golf course construction work.

Peat and muck are both important sources of organic material which are available in commercial quantities. Peat is the remains of aquatic, marsh, bog or swamp vegetation preserved under water in a partially decomposed state. It varies with respect to vegetation, stage of decomposition, mineral content and degree of acidity. Muck is the term more correctly applied to a cultivated peat and to its surface layers. It is in a more advanced state of decomposition and the plant remains are no longer identifiable.

If organic matter such as peat or muck is incorporated into clay soils, it may not aid much in retaining the available water, although it will render the soil more pervious to percolation. Sand or sandy soils, on the other hand, will have their moisture-retaining qualities greatly improved.

During the past few years there has been considerable interest in the use of calcined clays as a means of improving the physical characteristics of soils. The calcined granular clays are composed of hard inorganic mineral granules about 1/8" wide which are the products of Montmorillonite clays or attapulgite clays that have been fired at very high temperatures.

The physical characteristics of such clays are in general:
1. ability to absorb water in greater amounts than their own weight but release it gradually to the soil medium.
2. maintain a loose, friable, porous system in the soil without compaction.
3. sterility due to high temperature firing in the milling process.
4. dependable uniformity of particles with no foreign matter.
5. ease of handling and low cost.
6. applicability to problems of poor drainage.

Calcined clays have been used very successfully on putting greens to reduce compaction and improve drainage. They can be applied in one of three ways. On established greens it is recommended that the turf area first be aerified with a Ryan Greensaire, Westpoint or similar machine using 1/2" spoons. The calcined clay is then spread at the rate of 50 lbs. (1 bag) per 200 sq. ft. and then raked or dragged into the aerified holes.

A second method is to incorporate the calcined clay as a 15% to 35% component in the upper 3 1/2" when building or rebuilding putting greens.

A third method is to mix the calcined clay as a 50% soil-clay top dressing. Used in this way it helps to dilute thatch, speeds up thatch decomposition and helps to increase water infiltration. When used in this way it requires about 50 lbs. per 500 sq. ft.

A number of universities have had excellent results using this material on their athletic fields to reduce compaction.

In 1962 Smalley, Prichett and Hammond set up plots to determine relative values of vermiculite, colloidal phosphate, calcined clay and peat as they affect the yield and quality of putting greens. In these trials, the various materials were mixed in 6" and 12" depths in the soil at percentages of 0, 5% and 10%. These plots were then sprinkled with Tifgreen Bermuda grass.

From these trials it was found that the peat and vermiculite greatly increased permeability. The hydraulic conductivity (rate of water movement) was increased by the addition of calcined clay but decreased by use of vermiculite and colloidal phosphate. The clay and peat increased the non-capillary pore space while the reverse was true of vermiculite and colloidal phosphate. The grass yield and quality both decreased as the hydraulic conductivity increased so it was concluded here that the vermiculite and colloidal phosphate produced better turf than the fine clay or peat moss. It was noted, however, that all of the plots, including check plots, produced good quality turf.

In 1963, Lage and Roberts while working on the influence of nitrogen and calcined clay soil conditioner found that the calcined clay increased the number of rhizomes and dry weight production of roots but decreased the dry weight production of foliage during early summer.

Sand is frequently used as a soil amendment to improve drainage and aeration. It is particularly helpful in clay soils or fine-silty loams. In order to

(Continued on Page 28)
Maleic Hydrazide

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After the highly successful 2,4-D had become widely used in the control of broad-leaved weeds, researchers got to thinking, "Why not come up with a compound of similar qualities as 2,4-D but for use in the control of grasses?" Of those available at the time, Maleic Hydrazide seemed to fit best. Consequently, in 1950 Currier and Crafts first announced the selective inhibition and killing of grass by MH. As a result of experiments with cotton, they suggested a possible use for MH as a lay-by spray to inhibit grass growth in cotton. They subsequently experimented with it on other crops, mostly vegetables and grains, and found that grass species are more susceptible than broad-leaved species.

Effects, injury, and death of tissues at a distance from the area of application seemed to prove that MH was a growth-regulating chemical. At 4% and above, its principal action seems to be growth-inhibiting, particularly in grasses, often resulting in death. Because of this potential of inhibiting the growth of grass, much research has been done with MH in control of unwanted grass along highways, rights-of-way, fence lines, walls, cemeteries, and other areas which are "hard-to-get-to," areas where it is desirable to control the height of growth without killing the grass cover.

The following is from the Final Report 1965, Investigation No. 616, of the State of Minnesota, Dept. of Highways, Materials and Research Section. Work done in Massachusetts in 1960 by Joseph L. Beasley, Highway Landscape Supervisor, Mass. Dept. of Public Works; and work done by John M. Zak and Evangel J. Bredakis of the Dept. of Plant and Soil Sciences, Univ. of Mass., Amherst, Mass., pretty much parallels the findings of the Minnesota findings. The Minnesota report is given here only because it is of a more late publication date than Beasley's and because of its similar climate to Massachusetts.

The proper timing of MH application is important (MH-30). In an area such as Minnesota, which has a northern continental climate, spring comes on very quickly and lasts but a short time. Proper timing of the MH application was found to be difficult for research personnel whose main activity was the conduction of the research work. When application comes under maintenance field operations, proper timing for any large scale use becomes so much more difficult as to be also impracticable. This is due to the relatively short period (2-3 weeks) in the spring when MH can be applied at the proper stage of plant growth. (In the cases where MH was applied before June, grass was effectively inhibited. Several areas were sprayed during the period June 7 to 9 and the results indicated that these sprayings were not effective as the earlier applications. Fall treatments were the least effective.)

When properly applied at a rate of 6 pounds of active material per acre, MH will retard grass growth and seedstalk formation. The plant growth retardation and seedstalk formation effect will vary according to the plant species. Kentucky bluegrass, while somewhat retarded in growth, will form some seedstalks.

Physical application also becomes a problem. When spraying 2,4-D it is a common practice to spray against a cross-wind so as to minimize drift into adjacent residential or agricultural areas. However, with MH it is important to obtain uniform application over the entire mowing area to its outer limits. Thus, when applying 2,4-D in conjunction with MH for broad-leaved weed control, the actual spray operation becomes more difficult. If the mowing areas are not uniformly sprayed, uneven retardation results, especially along the outer portions of the spray pattern. Also, if a small skip or miss occurs and an area is not sprayed, the entire appearance is ruined (especially if no 2,4-D is used ... many perennial weeds come in).

In contrast to perennial weeds being resistant to MH, some grasses, such as Redtop, are extremely sensitive to MH. Also, the application of MH increases the number of discolored leaves of grass and increases the rust infestation on certain species. When applied to Kentucky Bluegrass in the fall (in order to retard seedstalk formation in the spring) a browning effect lasts well into the spring as a result of the slow start of spring growth made by the MH treated plants.

When properly applied MH did reduce the number of mowings by 1 to 5 times depending on the area ... rural or urban, on the quality of the turf ... good or poor, and the type of weed infestation present. In the rural areas, where the roadside is normally mowed only twice a year, it is doubtful that the use of MH is justified. In the urban areas, it is doubtful that the saving resulting from even five less mowings would much more than equal the cost of MH and its applications. The quality of urban turf must be high in order for the MH applications to result in a reduction in mowing. If the turf is not high quality, the retarding effect result in a more open cover, which allows annual weed seed already present to germinate. As a result, crabgrass, foxtail or ragweed infestations occur and lead to a ragged appearance which results in as many or more mowings. Thus, the addition of an herbicide to the MH is essential. If not used, a ragged appearance is apt to result even in areas of good quality turf. When MH and herbicide are used together a satisfactory appearing roadside may result without mowing. However, the use of 2,4-D can result in a pleasing roadside area.

Maleic hydrizide has a different effect on sweet clover than on grasses. With sweet clover it inhibits the terminal growing point. This may result in a release of axillary buds leading to a brooming effect.

When used at a high rate (10 pounds per acre), MH may be quite effective in reducing or eliminating mowing in hard-to-mow areas such as fence lines or under guard rails. It has the advantage of not removing all the vegetation, or not washing into areas where its effects are undesirable, and of not making the areas subject to erosion.
SOIL AMENDMENTS (Continued)

relieve compaction, coarse builders' sand is generally used. This will have particles ranging in size from .50 to 1.0 mm. The amounts used will vary with the type of soil but in general it will require proportionately large amounts of sand to alter a soil to any appreciable extent.

Animal manures if available are good sources of organic matter. Their chief value lies in the fact that they will improve the tilth of a soil as well as increase bacterial action. The nutrient value is relatively low as compared to commercial fertilizers. The major problem with manure is that its beneficial effects on the soil structure are not of a permanent nature.

Compost fits in the same category as manure. It is costly to produce in quantity and although it will improve the soil's structural qualities, the effect is not a long lasting one.

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For more information write:
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