EXTENSION BULLETIN 224

# Growing Beautiful LAWNS

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MICHIGAN STATE COLLEGE
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# Growing Beautiful Lawns

*By JAMES TYSON[1] and BUFORD GRIGSBY[2]*

A beautiful lawn is the most effective setting for a home or a large building—and it is an essential feature of parks, cemeteries, recreation areas and playgrounds.

*Proper grading*—to "set-off" the buildings and to establish a suitable subsoil condition for the grass—is the first step in the development of the lawn. Next comes the *selection of a good lawn soil.* This is essential because the grass, through its roots, absorbs the water and mineral nutrients needed for growth from the soil. A good lawn soil, therefore, is one which is capable of supplying the grass plants with optimum amounts of mineral nutrients and water at all times during the growing season.

Grass roots can perform their function of absorbing water and mineral nutrients most efficiently when (1) the soil contains an available supply of free oxygen, and when (2) the reaction of the soil (the degree of acidity or alkalinity) is within the "range of tolerance" of the grass plants. Oxygen must be present in the soil air to be available to the grass roots; therefore, the physical nature of the soil must be such as to provide both small pores for the retention of needed water, and large channels—the large channels allowing the excess water to drain away freely, and fresh air to enter the soil.

Next in order is the *choice of a grass or grass mixture,* adapted to the conditions of shade and moisture supply.

Finally, and of most importance, is the *supplying of adequate plant food and water,* accompanied by regular mowing at a suitable height.

Carbon dioxide is absorbed through the openings *(stomata)* in the leaves of the grass plants. Through the action of sunlight and chlorophyll (the green coloring matter), it is combined with water in the leaves to form simple carbohydrates. These serve as a basis for the formation of more complex carbohydrates, proteins, and other compounds—which in turn form the leaves, stems, roots, and other essential parts of plants. Inasmuch as the leaves are the "factories" which produce the ingredients to induce new growth, any clipping of a lawn which removes too large a proportion of the leaves weakens the grass by forcing it to draw on the root reserves to make new leaves.

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A beautiful lawn can be made and maintained by anyone who will study the growth requirements of grass—and then apply a few, simple, fundamental principles of lawn management. Considerable time and energy will be required, but the work is enjoyable and the result is pleasing to the owner and his neighbors.

## *I. Making a New Lawn*

### GRADING

The first step in building a new lawn is shaping the soil to form the desired contours and landscape features. The most satisfactory grades slope gently away from the buildings in all directions. Terraces and steep slopes should be avoided, for it is difficult to establish and keep grass on them. Water tends to run off steep slopes, rather than to soak into the soil—and such areas are difficult to mow, rake, roll, and fertilize. A gently curving slope gives a more pleasing landscape effect and simplifies the problem of lawn maintenance.

Wherever the grading operations require the moving of enough earth to cause the surface soil to be covered with *subsoil*, it is advisable to (1) remove the surface soil, (2) establish the grade in the subsoil, and (3) replace the surface soil. The surface soil at the site on which a new building is to be constructed should be scraped to the rear of the lot, and left in a place where it won't have to be disturbed until the building is finished and the subsoil has been graded to give the desired contours. "Clayey" and clay-loam subsoils should be shaped up so that there are no pockets in which water may accumulate, thereby causing a water-logged condition in the surface soil.

### DRAINAGE

In addition to the shaping of the subsoil, in very fine-textured soils it may be necessary to install a tile system to insure good drainage. Tile lines should be installed *after* the grades have been established in the subsoil, but *before* the layer of surface soil is put in place. However, if needed, they can be installed after the lawn is established.

Use regular 4-inch agricultural tile, placed at a depth of 18 to 24 inches below the surface, in lines approximately 15 feet apart. Run the laterals into a main—which should be either 6- or 8-inch tile, depending upon the size of the lawn being drained. That line must

have an outlet, usually into a storm sewer in the cities, or an open ditch in the rural districts.

The layout of the tile lines will be controlled by the shape of the lot—and by the size, shape, and location of buildings. As a minimum, the tile lines must have a "fall" of *at least* one-tenth foot per 100 feet of line. An even greater fall is desirable, so that the surplus water is removed as quickly as possible.

In sandy soils, drainage is generally good—unless such soils are underlain with clay or hardpan, or are in a swampy location. In fact, drainage may sometimes be so good that there will not be enough water left for the grass! When that situation exists, it can be improved by adding a quantity of good topsoil; the quantity should be sufficient to provide a water-storage capacity which will be large enough to supply the requirements of the grass, and still retain the good drainage conditions.

## LAWN SOIL

**Texture—**

Dark-colored sandy loam and loam soils are ideal surface soils for lawns: they possess the capacity to retain large quantities of water and plant food while allowing surplus water to drain away readily. These are soils which contain 40 to 65 percent sand, much of which is coarse-textured; less than 20 percent clay; and from 10 to 15 percent organic matter.

Dark-colored soils usually are well-supplied with organic matter, for it is this substance which imparts the dark color to the soil. Mucks and peats may be distinguished from dark-colored loams and sandy loams by their light weight when they are dry. Mucks and peats are not suitable surface soils for lawns, although they are useful for mixing with soils to supply organic matter.

**Organic Matter**

For lawns, organic matter is a very important constituent in the surface soil. It can be supplied to those surface soils which lack it by mixing well-rotted barnyard manure, artificial manure, peat, muck, or green-plant material into the soil.

Rye, buckwheat, cowpeas, oats and peas, and other crop plants may be grown for green manure, then plowed under when still green and succulent. However, that system is used principally for large acreages—such as parks, cemeteries, golf course fairways, airports, and roadsides—where the time element is not important.

On small lawns—or even on fairly large estates—where a grass cover is desired as soon as possible, the use of well-rotted barnyard manure, peat, or muck is more practical. Peats and mucks need to be shredded and screened—if there is any coarse, woody or fibrous material present—to prepare them for mixing with the lawn soil.

They should be mixed in the proportion of one part by volume of peat or muck to two or three parts of mineral soil—For example, (1) use one bushel of peat or muck with two or three bushels of soil; or (2) one cubic yard of muck or peat with two or three cubic yards of mineral soil. Peat and muck may be purchased under various trade names, or they may be obtained from local deposits.

Wherever organic materials are added to the surface soil of a lawn, the two should be mixed until the organic matter is evenly distributed throughout the surface layer of mineral soil.

### Improving Unsatisfactory Soils

Fine clay, clay-loam, or silt-loam soils are usually undesirable for lawns since surplus water drains away too slowly. This condition results in insufficient air for the grass roots, and hence unhealthy grass. Furthermore, such soils will remain wet and soft in the spring, delaying spring care of the lawn. Lawns on these heavy soils tend to become uneven, instead of maintaining a smooth surface.

Sandy soils, on the other hand, allow water to percolate through too freely and they retain little moisture for the plants; hence the grass suffers from drouth. They act much like sieves, rather than having sponge-like qualities.

The faults of either clay or sandy soils can be corrected by adding to one particular soil sufficient quantities of soil with the opposite characteristics. Very good lawn soils may be prepared by mixing the following proportions of sandy, clay, and organic soils:

(a) 1 bushel clay soil, 1 bushel muck or peat, and 2 bushels of sandy soil.

(b) 1 bushel clay loam, 1 bushel muck or peat, and 1 bushel of sandy soil.

### Thickness of Surface Soil Needed

After the subsoil grade has been established, the lawn should be covered with a layer of the loam topsoil as has been described (see page 5). The thickness of surface soil required depends upon the type of subsoil. Use the accompanying table as a guide (Table 1).

*TABLE 1—Thickness of surface soil required for a good lawn*

| *Nature of Subsoil or Subgrade* | *Thickness of Surface Soil Required* |
|---|---|
| Sandy loam, loam, or silt loam | 4 to 6 inches |
| Sandy or clayey | 6 to 8 inches |

Initial expense often influences people to use less topsoil than the amount indicated in the table—but reduction of maintenance costs and increased lawn beauty will more than offset the extra initial costs for the full topsoil.

**Layers of Clay Damage Lawns**

In sandy areas where it is difficult to obtain good topsoil, it is *not* a good practice to cover the sand with a layer of 4 to 6 inches of clay. Whenever clay subsoil is used for that purpose it usually prevents the free downward movement of excess water—and the lawn is damaged by a poor drainage condition.

A better plan is to mix a 3-inch layer of clay soil with the top 6 to 8 inches of sandy soil. On large areas the mixing may be accomplished by repeated plowing and harrowing when the clay soil is in a friable condition, but for the average-sized lawn a small power mixer would be needed. Hand-mixing is so laborious that few people would do a thorough job. Usually the process of getting clay and mixing it with the sand is just as expensive as to use all good topsoil over the sandy soil.

## GRASSES FOR LAWNS

Many firms supply good grass seeds. Although the exact formulae of the mixtures may vary, the individual firms use the same varieties of seeds in their mixtures for the same purpose. Ready-prepared grass seed mixtures distributed by responsible seedsmen and purchased from reliable dealers are recommended for all small lawns. Special mixtures may be obtained for open, sunny lawns or for shady lawns. Michigan law requires seedsmen to label packages of grass seed with the analysis of the particular mixture.

One precaution should be taken in buying grass seeds for general lawn purposes: *Do not* buy mixtures which contain bent grass seeds,

either creeping or colonial bents, for Michigan conditions (although many reliable seedsmen add a small percentage of these to their "best" mixtures).

**Creeping and Colonial Bent**

These grasses are widely used for lawns because they produce a shorter-statured, thicker, and more velvety turf than do the usual lawn grasses. Various factors lead us to discourage most persons from attempting to grow bent grass. The reasons are the greater susceptibility of the grasses to the fungous diseases commonly called *"brownpatch," "dollar-spot," "melting-out,"* and *"snowmold;"* the necessity of more intensive care and management, including more frequent mowing at a much lower height; more frequent fertilization; more watering, and frequent topdressing with soil.

Growing such grasses might be undertaken by those growers who are willing to study their care, or who have the means to keep a gardener who understands their care. (The management of bentgrass lawns is discussed in Michigan Agricultural Experiment Station Circular Bulletin 156, "Management of Bent Grass Lawns.")

**Common Lawn Grasses Recommended**

Good lawns may be obtained by planting Kentucky bluegrass, red fescue, or rough bluegrass individually—that is, without the usual nurse grass such as redtop or domestic ryegrass. However, the average lawn-builder will get more satisfactory results if he uses one of the mixtures which have some nurse grass or white clover present.

When fescue (either Chewing's or creeping red fescue) is planted on *sandy* or *light sandy-loam soils,* better stands and healthier turf will be obtained if the fescue seed is planted alone—that is, without the addition of a nurse grass.

The proportions of different grass seeds in any mixture may be varied rather widely without materially affecting the resulting turf, for it is the *soil conditions* which will largely determine the grass which will predominate.

However, not more than 15 percent domestic ryegrass or white clover should be used in the mixtures. Redtop which is so commonly used as a nurse-grass in lawn-seed mixtures is very susceptible to injury from "brownpatch" and "snowmold," the same as are the bent grasses. "Snowmold" may kill large areas of a newly seeded redtop turf in the winter, and "brownpatch" affects newly seeded turf in the summer months.

**New Varieties of Lawn Grasses**

Research workers are constantly seeking to find and develop superior strains and species of grasses for lawn and other fine turfs. MERION BLUEGRASS, a variety of Kentucky bluegrass, originated as a single plant selection on the golf course of the Merion Country Club, Ardmore, Pennsylvania, in 1936. It has now been tested and developed by the United States Golf Association, Green Section, and the Division of Forage Crops and Diseases—Bureau of Plant Industry, Soils and Agricultural Engineering (U.S.D.A.) in the cooperative turf-research program.

The results of these workers and of turf specialists in Indiana, Pennsylvania, Rhode Island, New Jersey, and the Canadian Province of Ottawa have proven it to produce good turf under conditions that common Kentucky bluegrass has not been able to survive. Merion bluegrass is resistant to injury from *Helminthosporium* leaf-spot; is drought-tolerant; and exhibits a growth habit which enables it to withstand close mowing. It is a low-growing type, with short, fairly wide leaves and numerous vigorous rhizomes, and is as a result a rapid spreading form which produces a dense turf in a relatively short time.

Merion bluegrass grown in test plots on the College Farm at East Lansing, Michigan—where common Kentucky bluegrass has always grown very well—has produced better turf than the common strain, when mowed at heights of one-half inch and one-and-a-half inches. As long as the seed growers maintain pure supplies of Merion bluegrass seed it assures the critical lawn-grower of the finest bluegrass seed known at present.

Other new strains of Kentucky bluegrass, which are being introduced by various agencies, have not been thoroughly tested for fine-turf purposes and should be used for experimental purposes only at present.

ALTA FESCUE and KENTUCKY 31 FESCUE are two strains of tall fescue, both of which are very good grasses for turfs—where coarseness of texture is not undesirable. These grasses have coarse, broad leaves; are deep rooting; and, although they grow best under good soil and moisture conditions, they will grow well on sandy or clayey soils if fertilized generously.

These grasses grow best for turf purposes when mowed at a height of approximately 3 inches. They are desirable for turf on football fields, play fields, airports, road shoulders, and large lawns where

texture is of no particular importance. *They are not desirable for fine lawns.*

Strains of two warm-climate lawn grasses—BERMUDAS and ZOYSIAS—that are hardy in the northern humid region are being used experimentally in Michigan for turf purposes. MEYER ZOYSIA ("Z52"), a strain of Japanese lawn grass (*Zoysia japonica*), and "U3," a strain of Bermuda grass developed jointly by the United States Golf Association (Green Section) and the U.S.D.A. Plant Industry Station, Beltsville, Maryland, have been grown on the plots on the College Farm at East Lansing for two years.

These grasses make a rapid, vigorous growth during the hot summer months; but they start very slowly in the spring, and go off-color with the first frost in the fall. MEYER ZOYSIA retains a green color later in the fall than does the U3 BERMUDA, when well-supplied with nitrogen.

Although these grasses may be useful for special types of turf in the southern two or three tiers of counties, they are not being recommended for lawn purposes in Michigan at present.

They could be grown to produce a turf which is used mainly during July and August—and where the brown color in April, May, September, and October would not be objectionable. The better strains of *Zoysia japonica* produce wonderful turf in the warmer humid areas, such as in the neighborhood of Washington, D.C., the Ohio River Valley, and southern states.

Not even considering individual preferences, then—with so many natural factors influencing a proper choice, only rather broad recommendations can be offered growers here as to the right seed to produce a beautiful lawn. With that reminder, therefore, some suggestions as to suitable grass seed or seed mixtures—according to general soil conditions—are given in Table 2. The recommended rate of seeding is also indicated.

## SEEDBED PREPARATION

**To Lime or Not to Lime—**

Lime should be applied when building a new lawn *only* when tests for acidity have indicated the soil to be very strongly acid in reaction. It is possible for the individual lawn owner to make those tests by means of the "Soiltex reaction kit," which may be purchased through the local county agricultural agent or the Soil Science Department, Michigan State College, East Lansing, Michigan. Or he may send samples of soil to either of the agencies named for testing.

*TABLE 2—Lawn seed mixtures for different growing conditions*

| Soil Conditions | Grasses and Seed Mixtures | Rate of Seeding (*amount per 1,000 sq. ft.*) |
|---|---|---|
| Open, sunny, fertile, well-drained loam, sandy loam, silt loam or clay loam | Merion bluegrass*.....100% | 1 lb. |
| | Kentucky bluegrass.....100% | |
| | Kentucky bluegrass..... 90%<br>White Clover..... 10% | |
| | Kentucky bluegrass..... 85%<br>Domestic ryegrass..... 10%<br>White clover..... 5% | |
| | Kentucky bluegrass..... 85%<br>Domestic ryegrass..... 15% | |
| Shady, well-drained loam, sandy loam, or silt loam | Red fescue.....100%<br>(Either Chewings or Creeping Red) | 1½ lb. |
| | Red fescue..... 90%<br>Ryegrass..... 10% | |
| | Red fescue..... 90%<br>White Clover..... 10% | |
| Shady, clay loam | Red fescue..... 50%<br>Rough bluegrass (*Poa trivialis*).... 50% | 1½ lb. |
| | Red fescue..... 50%<br>Rough Bluegrass..... 40%<br>Domestic ryegrass..... 10% | |
| | Red fescue..... 50%<br>Rough bluegrass..... 40%<br>White clover..... 10% | |
| Sandy to sandy loam; open and sunny or shady | Red fescue.....100% | 1½ lb. |
| | Red fescue..... 90%<br>White clover..... 10% | |
| Wet, poorly drained soils | Canadian bluegrass..... 50%<br>Rough bluegrass..... 30%<br>Redtop..... 20% | 1 lb. |
| | Seaside Creeping bent.....100% | ½ lb. |

**A joint research development of the Green Section—U. S. Golf Association, and the Division of Forage Crops and Diseases—Bureau of Plant Industry, Soils and Agricultural Engineering—U. S. D. A.*

If the soil, when tested with a Soiltex kit, shows a reaction of "pH 5.5" or less—broadcast *pulverized limestone, ground limestone,* or *agricultural meal* at the rate of 100 pounds per 1,000 square feet of lawn area, mixing it thoroughly with the topsoil while preparing the seedbed. (*Hydrated lime* may also be used. But because it reacts with sulfate of ammonia in fertilizer to produce ammonia gas—which

has a severe burning effect on grass—it should be applied not less than two weeks before seed sowing or a fertilizer application.)

### Broadcast Fertilizer Before Seeding

Broadcast 10 to 15 pounds of 10-6-4 (or 12-6-6) fertilizer[3] per 1,000 square feet of lawn and mix thoroughly with the surface soil by raking, as the preparation of the seedbed is being completed. (This quantity represents approximately 400 to 600 pounds of fertilizer to the acre.)

### Special Fertilizer for White-Clover Lawns

If a lawn-seed mixture containing white clover seed is used, the fertilizer used should be one which contains no nitrogen. Phosphate and potash fertilizers, applied to soils in which the available supply is low, stimulate the growth of the white clover; while applications of available nitrogen stimulate the more aggressive grasses, retarding the growth of the clover by competition. The analysis of the fertilizer used depends upon the kind of soil on which the clover is grown, as is shown in Table 3.

*TABLE 3—Fertilizer recommendations for White-clover lawns*

| Soil | Fertilizer Analysis* | Rate of Application Per 1,000 Sq. Ft. (*in pounds*) |
|---|---|---|
| Muck soils—Sandy soil | 0- 9-27 | 20 |
| Sandy loam | 0-20-20<br>0-12-12 | 15<br>20 |
| Heavy sandy loam—Loam—Silt loam | 0-20-10 | 15 |
| Clay loam—Clayey soil | 0-20- 0 | 15 |

**Read footnote 3 at the bottom of this page.*

### Fitting the Soil

To fit the soil for the actual seeding, alternately rake and roll the lawn surface until a firm seedbed is produced. That condition may be ascertained by observing your footmarks as you walk on the soil. Your feet should not sink into the soil appreciably when the seedbed

[3]The first figure in the fertilizer "analysis" represents the percent of *available nitrogen;* the second, the percent of *available phosphoric acid;* and the third, the percent of *water-soluble potash.* Thus a "10-6-4" fertilizer contains 10% available nitrogen, 6% available phosphoric acid, and 4% available potash. Michigan law requires the analysis to be printed on each package of fertilizer offered for sale. (The above analysis recommended for general turf fertilization is to be replaced by a "12-6-6" analysis, which will undoubtedly appear on the market in the near future, although not yet available at the time of this revision.

is sufficiently firmed. The final preparation, before broadcasting the seed, is to rake the surface very lightly with a steel rake. The teeth of your rake should not penetrate the soil to a depth of more than ¼ inch.

Larger areas can be prepared for seeding by plowing and harrowing with disk, spring-tooth, and spike-tooth harrows until the soil is well-pulverized and a smooth seedbed prepared. Then go over the area with a cultipacker or a weeder for the final preparation. Cultipacking should be done at right angles to all slopes, so that the small trenches will tend to prevent washing.

## SEEDING THE LAWN

In general, the best time to seed lawns is from August 15 to September 1, in Southern Michigan, and from August 10 to 25 in the Upper Peninsula. Where facilities are available for watering, however, good results may be obtained with seedings made at any time during the growing season from April 1 to September 1.

It is a good plan to mix the seed, for each measured section of the lawn, with enough dry, screened soil to make sufficient bulk for even distribution when broadcast. It is suggested that the seed be divided into three portions. The first portion is broadcast while the operator is walking in a "north-south" direction; the second portion, while he moves in an "east-west" direction; and the third while he walks "northeast-southwest." This plan leads to even distribution of the seed. (Fig. 1.) Rake the lawn lightly after the seed has been sown—roll it once with a heavy roller to firm the soil around the seed.

### Seeding Large Acreages

When seeding large acreages, where a firm seedbed has been prepared by alternately harrowing and cultipacking, the seed may be broadcast immediately after the last cultipacking. A uniform seeding is easily obtained through the use of one of the wheelbarrow-type grass seed distributors. It is unnecessary to cover the seed by harrowing, or by any other mechanical process. With the first rain, enough soil will be washed from the ridges into the trenches to cover the seed to about the right depth.

### Care of New Seeding During Early Stages of Growth

This is your most important step in caring for a newly seeded lawn: Make certain that the surface layer of soil, in which the seed is imbedded, always contains enough moisture to keep the little seedings alive after the seeds germinate. Water the lawn, using a fine spray to

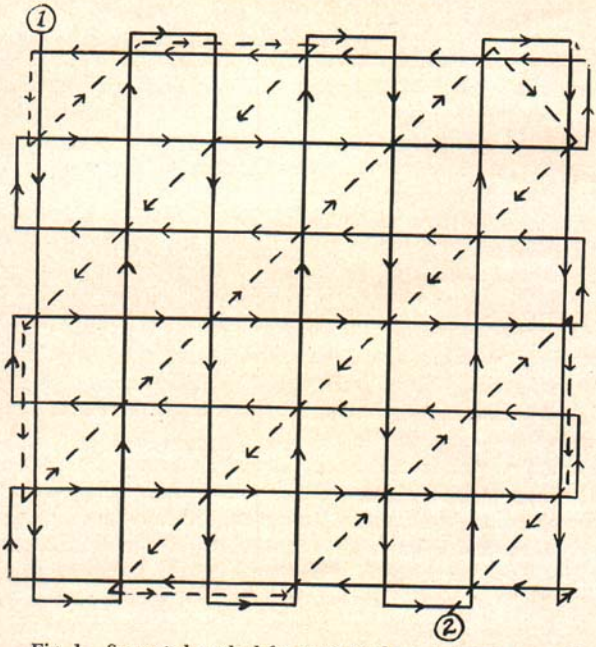


**Fig. 1. Suggested method for sowing a lawn to insure even distribution of seed. (Read the diagram like a map: Beginning at 1, this operator first sowed a straight line "south"—the full depth of the lot—then a series of "north-south" parallels, roughly even, across the fitted lawn site. From the southeast corner he repeated along on "east-west" line to cross his previous path at right angles. Finally, starting just below the northwest corner, he made a series of diagonal broadcasts "northeast-southwest," ending at 2.)**

avoid washing the soil, as often as is necessary to keep the surface moist. You may find it necessary to sprinkle the new seeding two or three times daily.

After the grass attains a height of approximately an inch the lawn may be watered as described in this bulletin under "maintenance of established turf." (See page 22.) Begin mowing the lawn as soon as the grass has reached a height of 3 inches. A sharp mower is essential for mowing any lawn, and especially for new seedings. The cutter-bar should be set to cut at a height of 2 inches, and the grass maintained at this height.

## *II. Care of an Established Lawn*

If a lawn is to give its owner lasting satisfaction—and continue to improve—it must receive constant care. Plant food and water must be supplied regularly; the grass must be mowed intelligently; and leaves, sticks, stones, and other debris removed.

### LIME ON ESTABLISHED LAWNS

As has been explained on page 11, lawn soils should not be limed unless they are very strongly acid *(pH 5.5, or below)*. The constant watering of lawns with water rich in lime—as is the case with most well water in Michigan—supplies considerable quantities of lime. As a result, it is seldom necessary to apply lime to an old lawn which has been watered artificially for a number of years.

When tests show that the soil needs lime, finely ground limestone should be broadcast at the rate of 50 pounds per 1,000 square feet, on an established turf. (Note that this rate is half that recommended on page 11 inasmuch as the lime will be held close to the surface and cannot be mixed into the soil mechanically.) If hydrated lime is to be used, 30 to 35 pounds should be ample. As already explained, hydrated lime should not be applied within two weeks before or after an application of fertilizer.

There will be very few lawn soils in the cities and larger villages of Michigan which are not alkaline in reaction—that is, that do not already have a high-lime content. The average water used for irrigation purposes from lakes, streams, or wells contains a large amount of lime. Soil tests made upon hundreds of samples of lawn soils from the cities of Michigan indicate that *at least 99 percent* are alkaline in reaction; the lime applied in the irrigation water is responsible for this condition. *Lime need be applied to lawns in Michigan only in exceptional cases.*

### LAWNS NEED FERTILIZER

Lawn fertilizers should contain a large proportion of nitrogen, the plant food element which stimulates the production of the green, leafy portion of plants. A medium amount of phosphoric acid and potash should also be included to promote a well-balanced and healthy growth of grass. The fertilizer which is recommended for all general turf growing has a "10–6–4" analysis.[4]

[4]The numerical values identifying a fertilizer are explored in footnote 3, page 12; also note the newly recommended 12-6-6 analysis.

**Fertilizing the Open Sunny Lawn**

An early spring application of 10 pounds per 1,000 square feet of lawn of the 10–6–4 fertilizer is recommended. This should be put on as early in the spring, after the snow disappears, as it is possible for man to walk on the ground without leaving footprints. In the southern half of the Lower Peninsula this is usually about April 1. For locations farther north, it will be approximately one week later for each 100 miles. The corresponding date in the Upper Peninsula, exclusive of Menominee County, is the first week in May.

A second fertilizer application, using the same amount, should be made about 6 to 8 weeks after the early spring treatment. This treatment should be broadcast between May 15 and June 1 in the vicinity of Lansing, and not later than June 15 in the Upper Peninsula.

To insure a vigorous growth in the fall, a third application of the same amount and kind of fertilizer should be made about September 1, regardless of geographical location in the state. This is one of the seasons during which grass grows to best advantage, and a vigorous growth at this time aids greatly in controlling weeds the following season.

**Fertilizing Shady Lawns**

Whenever there are shade trees and shrubs in the lawn or around the edges, tree, shrub and grass roots must of necessity get their available nutrients and water from the surface soil to a large extent. This competition of roots for the vital necessities of plant life is largely responsible for the difficult problem of producing a good lawn; it must be modified, therefore, to assist the grass to obtain its share, if a good turf is to be maintained.

The system of fertilizing a shady lawn is a simple one—but it requires the periodic application of available plant foods, in the form of fertilizers, during the entire growing season.

The first fertilizer treatment in the early spring is exactly the same as for "open, sunny lawns"—10 pounds of 10–6–4 fertilizer per 1,000 square feet, by about April 1 at Lansing, and at corresponding dates farther south and north. Thus, the entire lawn may be fertilized in one operation at this season. Beginning May 1, however, apply 10 pounds of 10–6–4 per 1,000 square feet to the shady lawn, monthly until September 1.

## ALTERNATE FERTILIZER PROGRAM

In some cases it is not advisable to follow the generally recommended fertilizer program with the 10–6–4 grade, and in others it is not procurable—or at least only with great inconvenience. To illustrate, if irrigation facilities are not at hand to wash this salt-type fertilizer (10–6–4) from the green grass leaves, immediately after applying it, the grass may be severely injured; or the local dealer may not have the recommended analysis in stock. Under such circumstances a substitute fertilizer program must be used.

As a substitute for 10–6–4, either 25 pounds of 4–12–4 or 4–12–8 may be applied per 1,000 square feet—or 20 pounds of 5–10–5 or 6–12–4, or 30 pounds of 3–12–12 or 3–18–9—for the early spring application when the grass is dormant. Any one of the above treatments will supply sufficient phosphoric acid and potash to feed the grass all season.

But follow this alternate treatment with two applications of one of the types of organic, nitrogenous fertilizers which can be broadcast on green grass (at recommended rates) without danger of burning the green foliage. The commonly used organic nitrogenous fertilizers of this type are Milorganite, Agrinite, soybean meal, processed tankage, and cottonseed meal. These materials should be applied at the rate of 20 pounds per 1,000 square feet about May 15 to June 1, and again August 15 to September 1.

Other materials which are sometimes used are sewage sludge from local sewage disposal plants, and animal manures; these should be applied at rates of 60 to 80 pounds per 1,000 square feet.

Ammonium sulfate, ammonium nitrate, and urea may be used as lawn fertilizers, where conditions are such that only nitrogen is needed. But if applied when the grass is green, they must be washed from the foliage with a coarse spray immediately after broadcasting; if not, they will "burn" the grass. Rates of application should be 5 pounds ammonium sulfate per 1,000 square feet per application; or 3½ pounds of ammonium nitrate; or 2½ pounds of urea (NuGreen or Uramon).

## SOLUBLE FERTILIZERS FOR LAWNS

Application of soluble fertilizers to lawns through the irrigation system, while watering the grass, has become very popular with many lawn owners. The fertilizer is introduced into the system by the use of some type of a "proportioner." There are many of these de-

vices on the market at the present time, ranging in price from a few dollars to as much as three hundred dollars.

A completely soluble fertilizer, formulated especially for lawn grasses under Michigan conditions, should contain the three major plant foods: nitrogen, phosphoric acid, and potash. Those three should be in about the same proportions as in the grade of regular fertilizer recommended (10–6–4). Thus the soluble lawn fertilizer should contain in proportion, approximately 5 parts nitrogen, 3 parts phosphoric acid, and 2 parts potash. Analyses of mixtures which would contain that ratio would be 10–6–4, 15–9–6, 20–12–8, and 25–15–10.

There are many common fertilizer materials which are completely soluble in water and well-suited to solution application. All common forms of *potash* fertilizers—such as muriate of potash and sulfate of potash—are soluble in water and may be used in this way. Likewise there are many soluble *nitrogenous* materials—including liquid ammonia, anhydrous ammonia, ammonium sulfate, ammonium nitrate, and urea.

The common phosphate fertilizers — superphosphate and treble superphosphate—are not completely soluble in water and are not, therefore, well-suited to such use. However, *potassium phosphate* (0–50–35) is a good source of water-soluble phosphoric acid and potash for use in making completely soluble lawn fertilizers: A mixture of *1 1/4 pounds of potassium phosphate* plus *either 5 pounds ammonium sulfate, 3 pounds of ammonium nitrate, or 2 1/4 pounds of urea,* is approximately equal to 10 pounds of 10–6–4 fertilizer.

### Suitability of Available Commercial Mixtures

There is a large number of grades of soluble, mixed fertilizers on the market at the present time—and additional analyses are appearing continually, and probably will be until some agreement on standard grades is reached. Some of these grades were formulated for application in irrigation water; others were developed for commercial vegetable growers to use as "starter solutions" when setting transplants in the field.

Few of the grades of soluble fertilizers offered for sale at present meet the nutritional requirements of turf, when applied as the sole fertilizer. The majority of them contain too low a proportion of nitrogen to phosphoric acid for continuous use as the only fertilizer.

However, they can be used with excellent results if supplemented with other forms of nitrogen and, in some cases, with potash.

The analyses of some of the completely soluble and solution fertilizers on the market at the present time are:

| *Group A* | *Group C* | *Group D* |
|---|---|---|
| 23–13–10 | 5–10– 5 | 10–52–17 |
| 10– 6– 3 | 10–20–10 | 15–52– 9 |
| | 12–31–14 | |
| *Group B* | 13–26–13 | |
| 23–21– 7 | 13–35–13 | |
| 21–25–17 | 15–30–15 | |

The two grades in Group A contain nitrogen, phosphoric acid, and potash in the approximate ratio of 5–3–2, which is suitable for continuous turf fertilization if used to supply about one pound of nitrogen per 1,000 square feet per application. The rates of application would be 5 pounds of 23–13–10—or 10 pounds of 10–6–3—per 1,000 square feet of lawn for each treatment: April 1st, May 15, and September 1st on open lawns; monthly on shady lawns.

All of the other grades listed furnish a lower proportion of nitrogen to phosphoric acid than is recommended for general turf fertilization. The proportions become increasingly lower in Groups B, C and D respectively. An application of those grades in Group B which supply enough nitrogen for grass will also furnish about twice the phosphoric acid needed; those in Group C, approximately four times the amount needed; and those in Group D, six to ten times the amount needed.

### Utilizing Soluble Commercial Fertilizers

There are two ways in which the fertilizers in Groups B, C and D can be used, since nitrogen is the only one of the three elements which needs to be applied periodically during the growing season.

FIRST METHOD—First, any one of the fertilizers in the three groups may be applied at that rate per 1,000 square feet which will supply one pound of nitrogen—early in the spring, the same as when using dry fertilizers. For future applications, soluble nitrogenous fertilizers may then be used to balance the seasonal nutrient requirements of the grass.

The rate of application for grass depending upon the amount of nitrogen in the fertilizer, there are these choices, therefore, for the first fertilization about April 1. (The first choice is from Group B; the others all from Group C):

5 pounds per 1,000 square feet of either 23–21–7 or 21–25–17
20 pounds of 5–10–5
10 pounds of 10–20–10
9 pounds of 12–31–14
8½ pounds of either 13–26–13 or 13–35–13
Or, 7½ pounds of 15–30–15.

Any one of these should be followed by supplemental applications of 5 pounds ammonium sulfate: Twice for open, sunny lawns—the first, May 15, and the second, September 1—and monthly for shady lawns.

If any of the fertilizers in Group D are used for the initial application, they should be applied at the rate of 10 pounds of 10–52–17 or 7½ pounds of 15–52–9 per 1,000 square feet. They should likewise be followed with applications of ammonium sulfate: May 15 and September 1 the first year—and April 1, May 15, and September 1 of the following year—for open sunny lawns; or monthly, April to September, on shady lawns.

SECOND METHOD—The second way in which these materials can be used is to mix them with *soluble* nitrogenous and potash materials to make suitable soluble mixtures. Any of the mixtures in Table 4 will furnish approximately the ratio and amount of nitrogen, phosphoric acid, and potash needed for grass fertilization.

*Important—Fertilizers may be broadcast on lawns in early April in southern Michigan, and early May in the Upper Peninsula, without fear of injury to the grass which will be dormant at that time.* However, care must be exercised when making application during any time of the growing season when the grass is green, because any fertilizer salt which clings to the green leaves will have a burning action. If the grass is wet with dew or rain, or by sprinkling with the hose, the injury will be more severe than if the grass is dry.

Broadcast fertilizers during the day when the grass is dry. The lawn should be divided into convenient areas of 500 square feet or less, using the walks and flower beds as boundaries. Divide the fertilizer into amounts fitted to each area. Broadcast the fertilizer on the first area as quickly and evenly as possible, and thoroughly water

*TABLE 4—Weight of various materials needed to make mixtures equivalent to 100 pounds of 10-6-4 fertilizer, and rate of application per 1,000 square feet of lawn*

| Mixture | Amount of Each Material in Mixture (*in pounds*) | Total Weight of Mixture (*in pounds*) | Rate of Application per 1,000 Sq. Ft. of Lawn (*in pounds*) |
|---|---|---|---|
| Potassium phosphate (0–50–35)<br>Ammonium sulfate (20–0–0) | 12<br>50 | 62 | 6 |
| Potassium phosphate<br>Ammonium nitrate (32–0–0) | 12<br>30 | 42 | 4 |
| Potassium phosphate<br>Urea (44–0–0) | 12<br>23 | 35 | 3½ |
| 23–21–7<br>Ammonium sulfate*<br>Muriate of potash | 30<br>15<br>4 | 49 | 5 |
| 21–25–17<br>Ammonium sulfate*<br>Muriate of Potash | 24<br>25<br>1 | 50 | 5 |
| 15–30–15<br>Ammonium sulfate* | 20<br>35 | 55 | 5½ |
| 15–52–9<br>Ammonium sulfate*<br>Muriate of potash | 12<br>41<br>6 | 59 | 6 |
| 10–52–17<br>Ammonium sulfate*<br>Muriate of potash | 12<br>44<br>4 | 60 | 6 |
| 13–35–13<br>Ammonium sulfate* | 30<br>30 | 60 | 6 |
| 13–26–13<br>Ammonium sulfate*<br>Muriate of potash | 24<br>34.5<br>2 | 60.5 | 6 |
| 12–31–14<br>Ammonium sulfate* | 20<br>38 | 58 | 6 |
| 10–20–10<br>Ammonium sulfate* | 30<br>35 | 65 | 6½ |
| 5–10–5<br>Ammonium sulfate* | 60<br>35 | 95 | 10 |

**Ammonium nitrate or urea may be substituted for ammonium sulfate in any of the above mixtures, using approximately ⅘ as much ammonium nitrate or ½ as much urea.*

it into the soil *immediately*—before applying fertilizer to the next area. If there are two workmen, one may broadcast the fertilizer and the second wash it into the soil.

Since the small bulk of fertilizer which is used may cause difficulty in getting even distribution, it is a good plan to mix it with a

considerable bulk of screened topsoil, sand, or muck. Usually about a half-bushel of soil to 10 pounds of fertilizer is a convenient amount to broadcast on 1,000 square feet. If a fertilizer distributor is used, it is needless to mix soil with the fertilizer; but care must be exercised not to miss strips or to overlap with the machine.

## WATERING THE LAWN

Water, which is absorbed by plant roots from the soil, is required in unbelievably large quantities for the growth of grass. It is essential that the soil contain sufficient water to supply the moisture required, otherwise the grass will wilt and turn brown. Likewise, grass roots (as is true of those of other land plants) need a constant supply of free oxygen if they are to function properly. Therefore, the soil must contain within its "inter-particle spaces" a suitable proportion of air and water to be furnished the plant as needed.

If the grass develops a large root system, its capacity to get needed water will be large and drought-resistance great, but if the root system is restricted its ability to obtain water will be small. Two moisture conditions tend to limit the depth of root development; these should be eliminated.

First, grass roots cannot penetrate and live in a water-logged soil. For that reason, subsoil drainage should be adequate enough to remove excess water to a depth of approximately 2 feet or more—so that the grass roots may develop downward as far as possible. Overwatering on fine-textured or clayey soils likewise should be avoided.

Second, there is a tendency for many persons in watering lawns to move the sprinklers frequently, so as to cover the entire area of lawn every evening or every morning. This results in producing a shallow, moist layer of soil on the surface; if continued, the grass roots tend to develop in this layer, producing a very shallow-rooted turf which is easily injured by adverse weather conditions or insects.

When moisture is needed, the lawn should be watered with a sprinkler which applies the water only as fast as it can be readily absorbed by the soil. There should be no free water remaining on the surface. The size of the sprinkler, its coverage, and quantity of water delivered must be governed by (1) the size of the area to be watered. (2) the water supply, and (3) the individual soil conditions on the lawn. It is usually better to use a sprinkler with as large a diameter of coverage as possible—and let it operate longer in each location—than to use a smaller sprinkler.

It is a good rule to allow the sprinkler to remain operating at a given location until the soil is moistened to a depth of approximately 6 to 8 inches. This may be determined by taking samples with a small hollow tube, which has had one side removed to facilitate observations and removal of the core of soil. The tubular steel shaft of a broken golf club can be made into a very handy sampling tool for this purpose.

After the soil has been given a thorough soaking, the time elapsed before water needs to be applied again depends largely upon the kind of soil, weather conditions, and trees. In a normal open, sunny lawn with good soil conditions, watering once a week will usually be sufficient; and under extremely dry weather conditions, twice a week should always be plenty. However, on sandy soils (which have a low water-retaining capacity) and under trees, it may be necessary to water at least every second day if a greensward is to be maintained. The practice in every case, though, should be to soak the soil slowly and thoroughly each watering to a depth of about 6 to 8 inches.

## MOWING THE LAWN

Lawn grasses such as Kentucky bluegrass, red fescue, rough bluegrass, and Canadian bluegrass should be maintained at a height of 1½ to 2 inches in open, sunny areas. Red fescue and rough bluegrass, grown in shade, should be maintained at 2 to 2½ inches. That is, the cutter-bar on the lawn mower should be set so the grass is mowed at those heights. Do not buy a lawn mower which cannot be adjusted to cut at those heights.

The grass should be cut before it has made a growth not to exceed one inch above the height at which it is maintained. Allow the clippings to fall back upon the lawn; they accumulate around the crowns of the plants, acting as a mulch—and upon decay return plant foods and add organic matter to the soil. Properly mowed turf will resist the invasion of weeds.

The turf on many lawns is ruined by too frequent and too close mowing. This is especially true of shady lawns, where the competition of trees for water and plant food is great, and on open lawns which are injured by drought in the summer.

Better turf will be produced if such lawns are mowed less frequently, and at a greater height. Keep them mowed as recommended above until about June 15, then put the lawn mower away. Bring it

out only if the summer conditions are so favorable the grass gets too long to be sightly.

If the grass is allowed to make a good growth at this time, it will produce a deeper and denser root system, which helps it to combat competition and make a better surf.

One of the most important factors in getting grass to grow in shady locations is to let it grow as much as possible, and to mow it as little as possible.

## SPRING CLEANING OF THE LAWN

Spring cleaning should be started by raking the lawn with a steel garden rake to remove sticks, stones, leaves, and other debris which has accumulated during the winter. This should be followed by rolling with a fairly heavy roller, to smooth the surface and firm the soil around the grass roots.

It is customary with many people to top-dress their lawns in the spring with barnyard manure, muck, peat, leafmold, or soil. The use of barnyard manure is *not* recommended—because it is one of the worst sources of weed seeds. Topdressing with peat, muck or leafmold has a tendency, when used liberally, to produce an organic layer at the surface of the lawn, which may become a source of trouble in the future if used continuously.

The use of clean, screened loam surface soil as a topdressing in the spring is recommended. It aids in producing a smooth surface, and its continued use year after year will add considerably to the depth of the surface soil.

## WINTER PROTECTION FOR THE LAWN

Lawn grasses should not be covered with branches, leaves, or straw for winter protection. These practices often result in severe injury by smothering the grass. This is especially true in the case of the shade-tolerant grasses under trees. It is a good practice to remove all leaves and rubbish from the lawn before it is covered with snow.

Although it is advisable to allow the grass to make some extra growth to aid in withstanding the severity of winter, the general lawn should not be allowed to attain a height of more than 3 or 4 inches. A lawn composed of rough bluegrass, *(Poa trivialis)*, should not be allowed to exceed 2½ inches.

### RESEEDING TO THICKEN THE TURF

The best time for sowing additional seed in order to thicken a thin sod is in late summer or early fall. In Michigan, that means August 15 to September 1 in the southern half of the Lower Peninsula, and August 10 to August 25 for the northern part of the Lower Peninsula and the Upper Peninsula. Rake the lawn vigorously with a steel garden rake to remove the dead grass and scar the surface of the soil. This procedure will provide sufficient loose soil to cover the seed adequately.

After sowing the seed—using about one-fourth the quantity recommended for a full seeding—sprinkle thoroughly to settle the soil around the seed. Early spring reseedings, to thicken the turf and fill bare spots, made in April are generally successful.

## *III. Controlling Weeds in Lawns*

Dense, vigorously-growing turf is the most effective weed-control measure for lawns. Such a turf can be produced and maintained by anyone who will follow the suggestions made in the preceding pages of this bulletin. However, there are many lawns in which dandelion, plantain, chickweed, crabgrass, and other weed species are making abundant growth. In these lawns it is first necessary to destroy weed plants—and then to supply the seed, fertilizer, water and care required to produce good turf.

### CHEMICAL COMPOUNDS

Prior to 1944, weed control in lawns was obtained chiefly by the slow and painful method of hand pulling or cutting. The results obtained were poor and, in some cases, cutting actually increased the number of weed plants in a unit-area of turf. The discovery of the selective herbicidal properties of 2, 4-*dichlorophenoxyacetic acid* (2, 4-D) and of certain other chemical compounds, has since given lawn owners and turf specialists more effective weapons.

#### Effective Use of 2, 4-D

"2, 4-D" is a growth-regulating substance which, when applied at suitable times and at the proper rates, will control many broad-leaved weeds. When used as recommended, 2, 4-D has but little effect on grasses—but excessive amounts of the chemical can cause severe injury to turf.

Commercial preparations of 2, 4-D may be in the form of either the *sodium salt*, a dry powder; the *amine salt*, a liquid; or the *ester* form, an oily liquid. The latter form, when mixed with water, produces a milky suspension and is probably the most active form of 2, 4-D. The other two forms are soluble in water, and produce true solutions.

Trade-name preparations may vary widely in the amount of active 2, 4-D present in a unit-volume—but all reputable manufacturers indicate on the product label the type and actual quantity of 2, 4-D (expressed in pounds per gallon or percentage composition) present in the formulation. Recommended dosages are always expressed in terms of the *actual*, 2, 4-D acid content. Table 5 indicates how the strength listed by the manufacturer can be converted in terms of ounces per gallon of water when making up a spraying solution.

*TABLE 5—Dilution table for making up herbicidal solutions for small sprayers; approximate amounts for 1 gallon of water*

| Manufactured Strength (*actual 2, 4-D in product*) | Spraying Solution Strength | | |
|---|---|---|---|
| | *0.1 percent* | *0.2 percent* | *0.4 percent* |
| 14%..... | 1 oz.* | 2 oz. | 4 oz. |
| 20%..... | ⅔ oz. | 1⅓ oz. | 3 oz. |
| 32%..... | ½ oz. | 1 oz. | 1⅔ oz. |
| 40%..... | ⅓ oz. | ⅔ oz. | 1½ oz. |

* *Fluid ounces*

## Other Herbicides

The use of 2, 4-D can bring about a great reduction in the number of broad-leaved weeds, but it is not equally effective on all species of weeds. Indeed, certain weeds appear to be highly resistant to 2, 4-D, and other herbicides may be required to control them. At present, *Ammonium dinitrophenate* (DN), *sodium pentachlorophenate* (PCP), *potassium cyanate* (KCNO), *phenyl mercuric acetate* (PMA), and herbicidal oils such as "Stoddard solvent" and refined kerosene are useful in controlling some weeds—especially chickweeds and crabgrass.

All of these materials are "contact" herbicides, and must be applied in such a way as to insure complete coverages and wetting of the weed plant foliage. Some of the contact herbicides may cause burning of the grass leaves, but when applied as recommended will not pro-

duce permanent damage to turf. Dosage recommendations are based on the actual amount of the active ingredient as shown on the manufacturer's label. (Table 6.)

*TABLE 6—Amounts of contact herbicides for 1 gallon of spray solution*

| PRODUCT | Listed Strength of Active Agent | Amount to be Used in Solution |
|---|---|---|
| DN | 13% | ¾ oz. |
| PCP | 85% | 6½ oz. |
| PMA | 10% | 3 oz. |
| KCNO | 100% | 2 oz. |

## DANDELION, PLANTAIN, CHICORY, WILD CARROT

These weeds are readily controlled in established sod by applications of 2, 4-D. The treatment can be applied either in the spring or fall, when the weeds are in active growth. Trials at East Lansing have shown that applications of 2, 4-D in September and October give excellent control of dandelion, without any apparent effect on the turf. The fall is an ideal time to treat because the new seedlings—as well as the older weed plants—start growth at this season, and their destruction by the chemical will prevent competition between weeds and grass. Fall treatment also makes it possible to re-seed in the early spring without the risk of chemical injury to young grass-seedlings.

A solution containing 0.2 percent of the amine form of 2, 4-D, applied at the rate of 1 gallon per 1,000 square feet (either in the fall, or in early spring before the weeds flower) will give almost complete control of dandelion, plantain, chicory, and wild carrot.

## CHICKWEEDS

Common and mouse-ear chickweed are almost as universal in turf as dandelion—but usually are not killed by the treatments which control dandelion. This fact leads to the impression that the former species are increasing in importance. The growth-habit of chickweed, matting among grass stems and rooting at frequent intervals, renders these plants inconspicuous when other weeds are present. The re-

moval of the larger weeds makes the small, matted chickweed visible and the lawn owner often thinks that the use of a herbicide brought about a new weed problem.

Control of chickweed is difficult; probably, it cannot be obtained without some temporary injury to turf grasses. Furthermore, infested areas will require treatment for two or more seasons, since the abundant seed crop produced by chickweed will continue to germinate for several seasons. Any of the methods outlined below will control chickweed for one season.

**Methods of Control**

1. THE ESTER FORM OF 2, 4-D, in an oil carrier, can be applied in October or April. At these times the grass is dormant and a minimum amount of grass injury will occur. A 0.2 percent solution of 2, 4-D ester in white kerosene should be applied at the rate of 1 quart per 500 square feet. *Caution:* This solution will kill woody plants; it should not be allowed to come into contact with any ornamental plants or trees.

2. STODDARD SOLVENT, applied without dilution, at the rate of 1 gallon per 1,000 square feet may be used in the fall or spring. This treatment will kill any grass leaves that are hit by the oil, but will not injure mature stems or rhizomes. On a warm day, the chickweed will be killed within a few hours; grass seed may then be planted in the treated area as soon as the oil has dried. (A common household dry-cleaning fluid, "Renuzit," is similar to weed-killing grades of Stoddard solvent, and may be substituted for it when only small areas are to be treated).

3. DN OR PCP—DN, ¾ ounce in 1 gallon of water, or PCP, 8 ounces in 1 gallon of water, may be used during the growing season. These quantities are sufficient to treat 1,000 square feet, and will cause only a temporary discoloration of grasses. The first mowing after treatment generally will remove all evidence of injury.

4. ARSENICALS—*Sodium arsenite* and *lead arsenate* have long been used for the control of chickweeds and are highly effective on these weeds. However, the newer chemicals, which are relatively non-toxic to man and domestic animals, have about replaced sodium arsenite in lawn weed control work. The danger of poisoning by arsenicals is always present when they are used on turf, and it is fortunate that we no longer need be exposed to this danger.

## CRABGRASS

Crabgrass appears to have become prevalent in Michigan lawns within the past few years. This apparent increase is due, in part, to a greater awareness on the part of lawn-owners to the growth of weeds, and to the fact that re-seeding has not been routinely practiced after weed removal by chemical sprays.

Control of crabgrass by 2, 4-D sprays cannot be expected when the application is made after the weed-grass has become established. But heavy rates of application, made at the time when crabgrass-seed germination is beginning, will prevent its growth. For this purpose, 1 gallon of a 0.4 percent solution of 2, 4-D (amine salt) per 500 square feet is recommended. This treatment should be made between May 15 and June 1 in lower Michigan. Some late germination of crabgrass seed may be expected in the treated soil if abundant moisture is available in August.

Selective control of crabgrass in turf has been made possible by the discovery of the grass toxicity of three types of compounds. All of these require careful timing of applications: overdosage may lead to considerable injury to lawn grasses. When used as recommended, these materials can give highly satisfactory control of crabgrass.

### Selective Control Materials

1. PMA—This compound is available, under a number of trade names, as a liquid to be mixed with water; or as a dry chemical, mixed with certain inert carriers, and applied as a dust or broadcast like fertilizer. Success depends upon an adequate supply of soil moisture, careful attention to rate of application, and proper spacing of two or three applications on relatively young crabgrass.

The amount of material to be applied varies with the formulation used and it is necessary to follow the manufacturer's recommendations. Turf containing a high percentage of fescue grasses is more likely to be injured by an overdose of PMA than is a bluegrass turf.

2. KCNO OR POTASSIUM CYANATE—This compound, generally supplied as a dry powder to be mixed with water, is also available under a number of trade names. KCNO, when combined with a wetting agent, produces a rapid kill of crabgrass, but may cause considerable burning of turf. This effect, confined to grass leaves or young stems, is temporary, and rapid recovery generally occurs.

KCNO is most effective on young crabgrass less than 2 inches in height, and repeated applications are required to keep the turf free.

3. OIL SPRAYS—Certain petroleum products, which are essentially highly refined kerosenes, have been found to have selective grass-killing properties. Such oils will kill crabgrass, and have but little effect on bluegrass and most fescues. From 2 to 3 applications of oil, at the rate of 1 gallon per 1,000 square feet, are required for satisfactory control. An interval of 7 to 10 days between treatments generally gives best results. (At the present time only one of the major oil refining companies is supplying a suitable product under the name "Standard Crabgrass Spray Oil".)

## MOSSY STONECROP

The plant, sometimes called "graveyard weed", is a cultivated plant in rock gardens which often escapes and becomes a serious turf weed. The dense growth of the short, upright stems crowds out grasses, and the yellow-green color of the fleshy leaves is unsightly.

Control of stonecrop can be obtained by spraying the plants with a 0.2 percent solution of 2, 4-D ester. One gallon of the herbicidal solution, to which has been added 1 teaspoonful of "Dreft," should be applied on 500 square feet of turf.

## WHITE CLOVER

Lawn herbicides which have been found useful for controlling other weeds in turf have failed to kill white clover, except in rare cases. Applications of 2, 4-D and most other lawn herbicides, except refined kerosene, may cause defoliation or delay in flowering—but seldom cause death of the clover.

The growth of white clover in turf is favored by factors which retard the growth and competition of associated grasses. These factors are (1) deficiency of available nitrogen in the soil, (2) too close mowing for the grasses, and (3) over-watering.

White clover can be effectively controlled by systematic feeding of the lawn with fertilizers containing a high proportion of available nitrogen, mowing at a height-of-cut favorable for the growth of the grass, and by watering as previously described. (See page 22.) If herbicides have defoliated the clover and reduced the stand, control through management is even more effective.

On the other hand, if the lawn-owner desires to have white clover in his lawn, use of herbicides to control unsightly weeds will generally result in a temporary injury. That can be quickly overcome by management to encourage the clover and, in extreme cases, by re-seeding.

## PRECAUTIONS

Many of the herbicides are selective so far as grasses and broad-leaved weeds are concerned—but they may not be selective where ornamental plants are concerned. Therefore, the following precautions should be carefully observed:

1. Confine spray applications to turf areas.
2. Do not spray when strong winds are present.
3. Ester forms of 2, 4-D should be used only in late fall or early spring when sensitive ornamentals are dormant.
4. Avoid reseeding for 2 to 4 weeks after application of 2, 4-D.
5. Observe manufacturer's directions for use of all products, and do not over-dose.

### REMOVAL OF WEED-KILLERS FROM SPRAY EQUIPMENT

Spray equipment used to apply 2, 4-D to the lawn for killing weeds should be washed thoroughly to remove *all* of the weed-killer, before using it to spray plants which are sensitive to the weed-killer.

**Cleaning Directions**

Fill the tank with water, either hot or cold. Add 1 ounce of household ammonia, or 2 ounces of tri-sodium phosphate, per gallon of solution (1 gallon of household ammonia, or 10 pounds of tri-sodium phosphate, per 100 gallons); agitate the mixture; run some through the spray parts. Allow to stand 24 hours or longer. Drain the sprayer. Flush out *both* tank and spray parts with fresh clean water, two or three times.

Even after this thorough cleaning it would be a good plan to test the sprayer on some highly sensitive weeds or other plants, before using it to spray a valuable rosebush or other shrub.

## RESEEDING AND FERTILIZING BARE SPOTS LEFT AFTER KILLING WEEDS

There will be a considerable supply of viable weed-seed left in your lawn after the weeds have been killed. Many of these will un-

doubtedly germinate and produce new plants, making it necessary to repeat weed-killing operations at later dates.

Then, once the weeds have been killed by means of weed-killers, steps must be taken to fill in the bare areas where the weeds formerly acted as ground cover.

Re-seed these spots with clean seed, covering the new seed with good loam topsoil. Fertilize the lawn to stimulate the grass. Set the lawn mower to cut at a height of 2 to 3 inches, to give the grass more opportunity to grow. Water the lawn thoroughly, giving the soil a good soaking when needed, but do not repeat any oftener than necessary to keep the grass healthy. Do not compact the soil by frequent rolling with heavy rollers, or by tramping over it.

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