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Ohio Agricultural Research and Development Center

WOOSTER, OHIO
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GRASS MIXTURES FOR LAWNS AND GOLF COURSES

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Department of Agronomy

Why Mixtures?

It is common knowledge that a good sod of a single grass is more uniform and thus usually more attractive than a sod composed of several species. Then why are mixtures used? Some of the "reasons," real or imaginary, are discussed below.

1. "A mixture has a wider adaptation to soil and climate conditions than a single grass." This is a legitimate reason for mixtures if local conditions aren't known and if there is no means of modifying the climate, as with irrigation. With additional information about the capabilities of the grass, soil characteristics, fertilizer requirements, and a good irrigation system, this reason for using a mixture largely disappears.

2. "A mixture has more tolerance to pests--diseases, insects, weeds." There is no doubt that varieties of Kentucky bluegrass and other species have different reactions to diseases caused by fungi.

Merion Kentucky bluegrass is well known for its resistance to melting out (Helminthosporium vagans) and its susceptibility to stripe smut, rust, and powdery mildew. Common Kentucky bluegrass and many named varieties have a reverse reaction to these diseases. A pure stand of Merion is not recommended in Ohio because of the stripe smut problem. However, Merion blended with other varieties of bluegrass can make a very valuable contribution to the sod. Merion's aggressive nature makes it inclined to "take over" but other bluegrasses appear to remain in the sod where only 10-15 percent Merion is used in the seed mixture.

Red fescue is often used with bluegrass and the two are inclined to mask each other's weaknesses. The problem here may be too much aggression on the part of the red fescue. This point will be discussed later.

Any problem which weakens the sod is an invitation to weeds. In this indirect manner, a mixture or blend may be more resistant to seed invasion.

3. "A mixture makes a good sod sooner after seeding." It is no secret that Kentucky bluegrass is slower in emergence and seedling growth than the ryegrasses, fescues, and redtop. This is particularly true with a spring seeding.

There are at least two reasons other than impatience for wanting a quick cover: (a) to beat the summer annual weeds which are sure to come and/or (b) to lessen the danger of erosion on steep slopes. The introduction of siduron (Tupersan) makes it possible to eliminate the summer annual weed problem at reasonable cost when making spring
seedings. With late summer and fall seedings, annual weeds are not a serious problem. Both mechanical and chemical aids for erosion control can be used to hold the soil until grass appears if judgement dictates that the fast growing grasses should not be used.

"Seed cost is less when using a mixture." Large grass seed, i.e. ryegrass, tall fescue, and red fescue, costs less per pound than Kentucky bluegrass or bentgrass. Cost per unit area is another matter since less weight of the small seed is needed for a stand. At any rate, selecting grasses based on seed cost is poor economy which can be very expensive in the long run.

Some Experimental Results with Mixtures

When a mixture is seeded, the goal is usually a good sod of one or two species. For example, in a lawn situation, perhaps eventually Kentucky bluegrass (including blends) is wanted in the sunny areas and some red fescue is wanted with the bluegrass in shaded areas. Can this be obtained with a mixture? In a golf course fairway situation, perhaps a good sod of colonial bentgrass is wanted. Can this be obtained by seeding a mixture? Experiments with mixtures for the past 15 years at Wooster, Ohio provide some answers.

Bentgrass quickly dominates any grass commonly seeded with it if given water, fertilizer, and short mowing. When mowed 2 inches high, bentgrass moves slower against the other grasses but it still dominates. Unfortunately, it is not able to keep Poa annua out of fairways and greens without skillful management. Packagers of lawn seed have heeded experimental results and the practice of putting a small percentage of bentgrass in lawn mixtures is largely history. However, many home owners in Ohio must live with past mistakes.

Ryegrass starts most rapidly of the grasses commonly used in mixtures. It seriously competes with the slower grasses in the mixture and, with high percentage of ryegrass seed, may nearly eliminate them. Annual or domestic ryegrass is usually short lived and may leave the sod very thin when it suddenly goes. The thin sod is an open invitation for a weed invasion. There are usually enough perennial types in ryegrass seed lots to leave a few unsightly clumps which remain for years. Their coarse texture and the whitish cast (due to the inability of the mower to cut the tough fiber cleanly) are constant eyesores.

Redtop is almost a universal component of packaged lawn mixtures. It starts rapidly and the appearance is not objectionable during the seeding year. As the sod gets older, the coarse, stemmy nature of redtop becomes apparent. Redtop is a perennial which lasts indefinitely at Wooster. It generally becomes more prominent in the sod with time, particularly when not irrigated. The mowing and fertilizer program which favors bluegrass also favors redtop.
TABLE 1.--Percentage Bluegrass in Sod as Influenced by Ryegrass 1 Year After Seeding, Oct. 1959.

<table>
<thead>
<tr>
<th>Seeded Grass</th>
<th>High N</th>
<th>Low N</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Merion Kentucky bluegrass</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>100% common Kentucky bluegrass</td>
<td>93</td>
<td>92</td>
<td>93</td>
</tr>
<tr>
<td>50% perennial ryegrass</td>
<td>93</td>
<td>90</td>
<td>91</td>
</tr>
<tr>
<td>50% Kentucky bluegrass</td>
<td>99</td>
<td>97</td>
<td>98</td>
</tr>
<tr>
<td>50% perennial ryegrass</td>
<td>86</td>
<td>92</td>
<td>89</td>
</tr>
<tr>
<td>50% Merion bluegrass</td>
<td>98</td>
<td>96</td>
<td>97</td>
</tr>
<tr>
<td>50% domestic ryegrass</td>
<td>55</td>
<td>82</td>
<td>68</td>
</tr>
<tr>
<td>25% red fescue</td>
<td>75</td>
<td>13</td>
<td>26</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Seed Mixture</th>
<th>Irrigated</th>
<th>Not Irrigated</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>85% Kentucky bluegrass</td>
<td>15</td>
<td>30</td>
<td>22</td>
</tr>
<tr>
<td>15% redtop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90% Kentucky bluegrass</td>
<td>9</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>10% redtop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95% Kentucky bluegrass</td>
<td>12</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>5% redtop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70% Kentucky bluegrass</td>
<td>9</td>
<td>21</td>
<td>14</td>
</tr>
<tr>
<td>25% red fescue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5% redtop</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 3.—Change in Redtop Content of Sod, 1965-66. Seeded Sept. 1964.

<table>
<thead>
<tr>
<th>Seed Mixture</th>
<th>Percent Redtop in Sod</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1965</td>
</tr>
<tr>
<td>85% Kentucky bluegrass</td>
<td>10</td>
</tr>
<tr>
<td>15% redtop</td>
<td></td>
</tr>
<tr>
<td>90% Kentucky bluegrass</td>
<td>9</td>
</tr>
<tr>
<td>10% redtop</td>
<td></td>
</tr>
<tr>
<td>95% Kentucky bluegrass</td>
<td>6</td>
</tr>
<tr>
<td>5% redtop</td>
<td></td>
</tr>
<tr>
<td>70% Kentucky bluegrass</td>
<td>4</td>
</tr>
<tr>
<td>25% red fescue</td>
<td></td>
</tr>
<tr>
<td>5% redtop</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 4.—Influence of Mixture and Nitrogen on Redtop 4 years After Seeding, Oct. 1962.

<table>
<thead>
<tr>
<th>Seeded Grass</th>
<th>Percent Redtop in Sod</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High N</td>
</tr>
<tr>
<td>85% Kentucky bluegrass</td>
<td>24</td>
</tr>
<tr>
<td>15% redtop</td>
<td></td>
</tr>
<tr>
<td>50% domestic ryegrass</td>
<td></td>
</tr>
<tr>
<td>25% red fescue</td>
<td></td>
</tr>
<tr>
<td>15% Kentucky bluegrass</td>
<td>18</td>
</tr>
<tr>
<td>10% redtop</td>
<td></td>
</tr>
<tr>
<td>70% domestic ryegrass</td>
<td>9</td>
</tr>
<tr>
<td>20% Kentucky bluegrass</td>
<td></td>
</tr>
<tr>
<td>10% redtop</td>
<td></td>
</tr>
<tr>
<td>85% Merion bluegrass</td>
<td>3</td>
</tr>
<tr>
<td>15% redtop</td>
<td></td>
</tr>
</tbody>
</table>
Red fescue starts more rapidly than bluegrass and is usually considered a desirable fine-leaved perennial. It is adapted to shade too dense for bluegrass. In the open, Kentucky bluegrass presents a better appearance than solid fescue except for spring and fall. The summer color of red fescue is gray-green and it is tough to mow. Hopefully, then, bluegrass will dominate the mixture in open areas when used with red fescue. Recent experiments at Wooster have cast some doubt that this is actually the case.


<table>
<thead>
<tr>
<th>Seeded Grass</th>
<th>Percent Fescue in Sod</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1965</td>
</tr>
<tr>
<td>100% creeping red fescue</td>
<td>90</td>
</tr>
<tr>
<td>90% Kentucky bluegrass 10% red fescue</td>
<td>14</td>
</tr>
<tr>
<td>70% Kentucky bluegrass 30% red fescue</td>
<td>28</td>
</tr>
<tr>
<td>10% Kentucky bluegrass 60% red fescue</td>
<td>57</td>
</tr>
<tr>
<td>10% Kentucky bluegrass 90% red fescue</td>
<td>83</td>
</tr>
</tbody>
</table>

TABLE 6.—Influence of Irrigation and Mixture on Red Fescue Content of 2-Year-Old Sod.

<table>
<thead>
<tr>
<th>Seeded Grass</th>
<th>Percent Fescue in Sod, Nov. 1966</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Irrigated</td>
</tr>
<tr>
<td>100% creeping red fescue</td>
<td>92</td>
</tr>
<tr>
<td>90% Kentucky bluegrass 10% red fescue</td>
<td>16</td>
</tr>
<tr>
<td>70% Kentucky bluegrass 30% red fescue</td>
<td>41</td>
</tr>
<tr>
<td>10% Kentucky bluegrass 60% red fescue</td>
<td>70</td>
</tr>
<tr>
<td>10% Kentucky bluegrass 90% red fescue</td>
<td>83</td>
</tr>
</tbody>
</table>
TABLE 7.—Influence of Nitrogen Rate on Fescue Content of Sod 4 Years After Seeding, Oct. 1962.

<table>
<thead>
<tr>
<th>Seeded Grass</th>
<th>High N</th>
<th>Low N</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Pennlawn fescue</td>
<td>72</td>
<td>91</td>
<td>81</td>
</tr>
<tr>
<td>100% creeping red fescue</td>
<td>62</td>
<td>90</td>
<td>76</td>
</tr>
<tr>
<td>60% Pennlawn fescue</td>
<td>32</td>
<td>68</td>
<td>50</td>
</tr>
<tr>
<td>40% Merion bluegrass</td>
<td>21</td>
<td>31</td>
<td>26</td>
</tr>
<tr>
<td>40% creeping red fescue</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It has been shown that red fescue is generally better able to compete with no irrigation and a low nitrogen rate. This does not mean, however, that Kentucky bluegrass is favored by the reverse. In a mixture study from 1958-1963, percentage of bluegrass in the sod was not significantly affected by nitrogen either year. In a continuing study, Poa annua and other weeds have increased with irrigation but percent bluegrass in the sod has not increased.

Table 8 gives one of the best arguments for using mixtures. The combination of bluegrass and fescue makes a higher percentage of the sod than either does alone. More attention to controlling pests and supplying water could eliminate some of this advantage.

Bluegrass blends well chosen and managed offer some hope for a lasting sod without adding other species. A current experiment is not far enough along to make positive statements about the outcome. Bluegrass resistant to a wider spectrum of disease will undoubtedly be developed and these new grasses will require rethinking the whole problem of mixtures.

TABLE 8.--Composition of a 5-Year-Old Sod (Not Irrigated) as Influenced by Mixture and Mowing Height.

<table>
<thead>
<tr>
<th>Seeded Grass</th>
<th>% bluegrass</th>
<th>% fescue</th>
<th>bluegrass &amp; fescue</th>
<th>% crabgrass</th>
<th>% bentgrass</th>
<th>% other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1&quot;</td>
<td>2&quot;</td>
<td>1&quot;</td>
<td>2&quot;</td>
<td>1&quot;</td>
<td>2&quot;</td>
</tr>
<tr>
<td>Merion bluegrass</td>
<td>34</td>
<td>69</td>
<td>--</td>
<td>--</td>
<td>34</td>
<td>69</td>
</tr>
<tr>
<td>common bluegrass</td>
<td>31</td>
<td>55</td>
<td>--</td>
<td>--</td>
<td>31</td>
<td>55</td>
</tr>
<tr>
<td>Pennlawn fescue</td>
<td>--</td>
<td>--</td>
<td>39</td>
<td>70</td>
<td>39</td>
<td>70</td>
</tr>
<tr>
<td>creeping red fescue</td>
<td>--</td>
<td>--</td>
<td>40</td>
<td>62</td>
<td>40</td>
<td>62</td>
</tr>
<tr>
<td>60% Pennlawn</td>
<td>20</td>
<td>20</td>
<td>28</td>
<td>74</td>
<td>48</td>
<td>94</td>
</tr>
<tr>
<td>40% bluegrass</td>
<td>20</td>
<td>20</td>
<td>28</td>
<td>74</td>
<td>48</td>
<td>94</td>
</tr>
<tr>
<td>60% red fescue</td>
<td>22</td>
<td>52</td>
<td>24</td>
<td>29</td>
<td>46</td>
<td>81</td>
</tr>
<tr>
<td>40% Merion</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
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The Kentucky bluegrass variety trial is now 3 years old and varietal differences not present in young stands are beginning to appear. Large differences due to mowing height are also now apparent on some but not all varieties.

The trial is fertilized at optimum rates with ammonium nitrate and a complete fertilizer. Nitrogen is applied several times per season with a relatively low amount for any given application. The plots are not irrigated regularly but have been watered during excessively long droughts. Half of each plot is mowed at 1½ inches and half at 2 inches.

Stripe and/or flag smut are beginning to appear in Merion and a few other varieties but have not yet caused significant damage. Some varieties have been severely damaged by Helminthosporium leaf spot but recovery has been relatively good.

Outstanding varieties as they appeared in July 1967 are Merion, Pa. K-5, Windsor, Nl-51, Prato, N3-1, and A-20. Of these, only Merion, Windsor, Prato, and A-20 are being marketed. The others are experimentals which may be available at a later date. All of these varieties are nearly weed free, which indicates their resistance to weed invasion and the weed-free condition of the seed used for planting.

Varieties which were considered to be average in overall appearance are Cougar, N0-10, Kentucky grown common (not a variety), Newport, and Delft. Of these, only N0-10 is experimental.

Varieties with poor general appearance are Delta, Denmark grown common (not a variety), Nudwarf, Campus, and Park. All are being marketed. It should be noted that although a variety is being marketed, it is not necessarily available in Ohio.

Most of the varieties rated medium or poor are susceptible to leaf spot. This has caused the stands to become thin and has permitted weeds to invade. In the case of the Denmark grown common, it is believed that seeds of undesirable bluegrass species were present in the seed used for planting. This may be true of other varieties as well.

As the stands become older, other problems are likely to become apparent. Other trials at Wooster indicate Merion probably will be severely damaged by smut. Smut has also been found on Windsor but the extent of possible damage is not known.

As mentioned before, mowing height can be an important factor in the successful management of a variety. All varieties in the outstanding class were nearly weed free at both cutting heights. Most of the other varieties had weeds with approximately five times as many in the area cut at 1½ inches as in the area cut at 2 inches.
None of the varieties under test is a perfect grass. They all have weaknesses but their weaknesses are not the same. This indicates that a blend of varieties may be more desirable than any single variety, especially if varieties with complementary strong points are blended.

Common Kentucky bluegrass is a natural blend of many strains and that which is grown in Kentucky is an acceptable lawn grass. It should be noted that "common" grown on the west coast is probably a named variety which is in surplus and is not necessarily adapted to Ohio. "Common" imported from Europe is not an acceptable lawn grass because it contains weed seed and has high susceptibility to leaf spot. Unfortunately, the majority of "common" sold in Ohio is not Kentucky grown.
DEVELOPMENT OF NEW BLUEGRASS VARIETIES

M. H. Niehaus
Department of Agronomy

A bluegrass breeding project was initiated in 1965. The objectives are to develop superior strains or mixtures of bluegrass specifically for Ohio conditions.

At present there are a limited number of improved bluegrass varieties adapted to Ohio. All of them have weaknesses and, although several are superior to common Kentucky bluegrass, none is the ideal grass.

The genetics of Kentucky bluegrass are complicated and improvement is slow. Most Kentucky bluegrass plants produce seed by a process known as apomixis. This means that seed is produced without fertilization and that all the offspring of a plant are exactly like the parent plant. To obtain variability necessary for breeding progress, some way of overcoming apomixis is necessary. Fortunately, there are occasional plants in all strains which are not apomictic and a few strains have been isolated which are low in frequency of apomixis. Crosses between these plants and apomictic plants occur naturally and can be made artificially. Variations resulting from such crosses provide material for the breeding program.

Other sources of variability are introductions from other areas of the world and artificially created mutants. About 100 such introductions are being tested for possible use in Ohio. Artificially created mutants are obtained by treating seed with chemical mutagens or radiation. Both methods are being used and a high degree of variability has been obtained. Unfortunately, the majority of such changes are not useful.

The material obtained from the crossing, introduction, and artificial mutation program is planted in spaced plant nurseries where superior plants are selected. These selections are then planted in small turf plots. If they still appear promising, larger plots are planted and seed is distributed to other testing locations. Several years are required for the testing necessary before a variety can be released. It will be a minimum of 10 years before a variety can result from this program.

It is becoming increasingly obvious that a pure strain of Kentucky bluegrass may not be desirable. This means that further testing of mixtures of strains may be necessary. Mixtures have built-in insurance against disease because all plants are not likely to be susceptible to the same disease. Such insurance is needed because diseases do not remain stable and are known to change so that they attack pure strains of grass which were previously resistant. While such an approach complicates evaluation, it may provide varieties which have tolerance to more adverse conditions than any single strain could have.


11
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THE EFFECTS OF CERTAIN MANAGEMENT PRACTICES ON THE
BOTANICAL COMPOSITION AND WINTER INJURY TO TURF CONTAINING
A MIXTURE OF KENTUCKY BLUEGRASS AND TALL FESCUE

Robert W. Miller
Department of Agronomy

The experience with a mixture of tall fescue and Kentucky bluegrass on the football field of The Ohio State University Stadium stimulated this research project.

In 1961 the OSU Athletic Department decided that a renovation program was necessary for the football field. At that time the turf consisted of a poor common Kentucky bluegrass sod which was heavily infested with bentgrass, yellow nutsedge, and various other obnoxious weeds. It was decided that a complete renovation program was necessary.

After the last game of the 1961 season, the existing sod was removed with a sod cutter. This was followed by the establishment of a new set of drainage lines over the field. A soil was constructed, graded to the proper contour, and fumigated to destroy weeds and weed seeds.

In early April 1962, the field was seeded to 90 percent tall fescue (Festuca arundinacea, Schreb.) and 10 percent Kentucky bluegrass (Foa pratensis, L.) by approximate seed count. The actual seeding rate was 9 lb. of tall fescue and 0.25 lb. of Kentucky bluegrass mixture per 1000 square feet. The Kentucky bluegrass consisted of a mixture of Delta, Newport, and Merion.

Good sod cover was present by June 8, 1962. During the first playing season, tall fescue dominated the turf. Careful analysis indicated 80 to 90 percent was tall fescue. Tall fescue was seeded previous to each football game and cleated in by the players. Less than 25 percent of the turf was tall fescue during the 1963 season. By the 1964 season, almost all of the turf was Kentucky bluegrass. Now there is no tall fescue in the turf except for isolated plants around the edge of the track which surrounds the field.

In 1962 a study had been established to evaluate management practices for tall fescue - Kentucky bluegrass turf. This study was modified in an attempt to determine why the tall fescue was eliminated from the turf on the football field.

The study included five grasses or grass mixtures. Merion, Delta, Newport, and a mixture of the three varieties were each seeded with tall fescue. Tall fescue alone was the fifth treatment. Seeding rates were the same as for the football field. Other variables included in the study were three fertility levels, two mowing heights, supplementary water, and no supplementary water.

During the 1962 and 1963 seasons, the fertility variable consisted of nitrogen levels of 0, 2, and 4 lb. per 1000 square feet. In 1964, nitrogen rates were changed to 0, 4, and 8 lb. to represent a wider
nitrogen variation. All plots received equal applications of phosphorus and potassium. At establishment, the entire experimental area received fertilizer, including nitrogen, according to soil test recommendations.

The mowing variables were 2 and 3-inch cutting heights with a rotary mower. Plots receiving supplementary water were irrigated about 24 hours after the plants began to show stress. No supplementary water was needed in 1965 and 1966 because of abundant rainfall during normal critical periods. Differences between irrigated and non-irrigated plots were inconclusive and will not be discussed in this paper.

**Effects of Nitrogen Level on Grass Composition**

There were no clear cut differences among the nitrogen levels in the amount of bluegrass or tall fescue in the turf during the first growing season. It was believed that residual nitrogen from the application at establishment was sufficient to mask differences which might have occurred.

By 1963, the second growing season, differences among nitrogen levels in the amount of tall fescue and bluegrass present in the turf were evident. Plots treated with either the 2 or 4 lb. rate of nitrogen contained more bluegrass and less tall fescue than plots receiving no nitrogen. No differences existed, however, between the 2 and the 4 lb. rates.

The amount of Kentucky bluegrass present in the turf was small in 1962 and 1963. In 1963, plots receiving 0, 2, and 4 lb. of nitrogen per 1000 square feet contained 0.73, 1.41, and 1.76 percent bluegrass, respectively. The tall fescue component made up the remaining percentage except for an insignificant weed content.

In October 1966, a critical examination was made of the amount of Kentucky bluegrass and tall fescue present by taking a core with a golf cup cutter and counting the shoots of each species. It should be remembered that the nitrogen rates were altered in 1964. The 0 rate remained the same, the 2 became 4, and the 4 was changed to 8 lb. per 1000 square feet.

The bluegrass percentage greatly increased in all plots. Even though plots which had received no nitrogen since establishment in the fall of 1961 appeared to be mostly tall fescue, bud counts revealed 24 percent bluegrass in 1966. It should be pointed out that a shoot of bluegrass does not cover as much area as a shoot of tall fescue. Therefore, less than 24 percent of the ground was covered by bluegrass in these plots.

Plots which had received 4 lb. of nitrogen per 1000 square feet since 1964 contained 52 percent bluegrass by bud count and plots which had received 8 lb. contained 60 percent. Figure 1 summarizes the relationships between nitrogen fertility, mowing height, and bluegrass and tall fescue composition of the turf. As nitrogen fertility increased, the bluegrass portion of the sod increased and the tall fescue component decreased.
Effects of Seeding Mixture on Grass Composition

During the first growing season, the bluegrass component of plots containing Delta Kentucky bluegrass was greater than plots containing Merion, Newport, or a mixture of the three bluegrass varieties. The fact that Delta germinates quicker than most bluegrass varieties may explain the initial advantage for that variety. By the second year, the advantage was no longer present.

In October 1966, the only difference among the bluegrass varieties in the number of bluegrass shoots per unit area was a reduction in shoots of Newport compared to other varieties. As expected, Newport plots, which contained less bluegrass, also had more tall fescue than plots containing other bluegrass varieties (Table 1).

![Graph showing the effects of nitrogen and mowing height on shoot number in a mixture of tall fescue-Kentucky bluegrass turf.](image)

**Fig. 1.** The effects of nitrogen and mowing height on shoot number in a mixture of tall fescue-Kentucky bluegrass turf.
TABLE 1.—The Effects of Seeding Mixture on the Number of Tall Fescue and Kentucky Bluegrass Shoots. Counts Made October 1966.

<table>
<thead>
<tr>
<th>Seeding Mixture</th>
<th>Tall Fescue-Merion</th>
<th>Tall Fescue-Delta</th>
<th>Tall Fescue-Newport</th>
<th>Tall Fescue-Merion, Delta, Newport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass</td>
<td>Shoots per 4-inch Core</td>
<td>Shoots per 4-inch Core</td>
<td>Shoots per 4-inch Core</td>
<td>Shoots per 4-inch Core</td>
</tr>
<tr>
<td>Kentucky Bluegrass</td>
<td>40</td>
<td>36</td>
<td>32</td>
<td>40</td>
</tr>
<tr>
<td>Tall Fescue</td>
<td>30</td>
<td>26</td>
<td>35</td>
<td>29</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>64</td>
<td>67</td>
<td>69</td>
</tr>
</tbody>
</table>

Effects of Mowing Height on Grass Composition

The number of shoots of Kentucky bluegrass and tall fescue increased as the mowing height was decreased from 3 to 2 inches. The increase was greater if either 4 or 8 lb. of nitrogen were applied than if no nitrogen was used. Although a small increase in shoot number occurred if no nitrogen was applied and if the mowing height was reduced from 3 to 2 inches, the difference was not significant. Table 2 illustrates the effects of mowing height.

Relationship between Management Factors and Winter Injury

Why did Kentucky bluegrass increase and tall fescue decrease? Observation led to the belief that tall fescue was more susceptible to winter injury than Kentucky bluegrass. The differential effect also appeared to be greater under the management regime consisting of lower mowing and higher nitrogen fertilization.

TABLE 2.—The Effects of Mowing Height on the Number of Tall Fescue and Kentucky Bluegrass Shoots. Counts Made October 1966.

<table>
<thead>
<tr>
<th>Mowing Height</th>
<th>Tall Fescue</th>
<th>Kentucky Bluegrass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoots per 4-inch Core</td>
<td>Shoots per 4-inch Core</td>
<td></td>
</tr>
<tr>
<td>2 Inches</td>
<td>31</td>
<td>42</td>
</tr>
<tr>
<td>3 Inches</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>Average</td>
<td>30</td>
<td>38</td>
</tr>
</tbody>
</table>
To examine some of the management and temperature factors which affect the winter injury of turfgrasses, a 2-year study was initiated. Four-inch cores were taken from plots containing Marion bluegrass. Before sampling, the plants were allowed to harden naturally in the field.

The samples were placed in a Sherer-Gillett low temperature growth chamber. The photoperiod, controlled by a timer, was set at 10 hours' light and 14 hours' darkness. Four cold treatments were used in the 1964-65 study:

A. 30 days at 10° F.
B. Treatment A plus 7 days at 40° F.
C. Treatment B plus 30 days at 10° F.
D. Treatment C plus 7 days at 40° F.

After the samples from each treatment were removed from the cold chamber, they were placed in a greenhouse for regrowth.

The temperature regimes of this study proved to be too severe for the bluegrass-tall fescue mixture and resulted in severe injury. The tall fescue was essentially killed by treatment A and therefore was not statistically analyzed. There were a few tall fescue plants surviving after treatment A and these were nearly always found in the low fertility samples. None were found in the high fertility samples.

Even though the bluegrass was more resistant to the cold treatment than the tall fescue, it was completely killed by treatment C.

Cold treatments were modified in 1966. Since it was believed that severe injury in the 1965 study may have resulted from abrupt temperature changes, temperatures were raised and lowered at a rate of 1/4 degrees per hour for this study. Treatments in 1966 were as follows:

AA. 13 days at 12° F.
BB. Treatment AA plus 14 days at 40° F.
CC. Treatment BB plus 14 days at 12° F.
DD. Treatment CC plus 14 days at 40° F.

The temperature conditions of this study were found to have no differential effects on the bluegrass. Neither the bluegrass crowns nor shoots changed among cold treatments at any fertility level.

**Effects of Cutting Height on Cold Injury**

Cutting height was found to affect both shoots and crowns of tall fescue and bluegrass at the 4 and 8 lb. rates of nitrogen. At these fertility levels, bluegrass shoots and crowns were injured more at the 3-inch than at the 2-inch cutting height (Table 3).
TABLE 3.—Effects of Two Cutting Heights on Bluegrass Crown and Shoot Survival at Three Nitrogen Levels in 1966.

<table>
<thead>
<tr>
<th>Nitrogen Level</th>
<th>Cutting Height</th>
<th>Low (0 Nitrogen)</th>
<th>Medium (1± Lb. Nitrogen)</th>
<th>High (8 Lb. Nitrogen)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 Inches</td>
<td>14</td>
<td>57</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>3 Inches</td>
<td>10</td>
<td>25</td>
<td>24</td>
</tr>
</tbody>
</table>

Number of Crowns Surviving

| 2 Inches | 19 | 83 | 74 |
| 3 Inches | 14 | 26 | 34 |

L.S.D. for number of crowns surviving:
Cutting heights at medium fertility level (.05) = 8
(.01) = 11
Cutting heights at high fertility level (.05) = 14
(.01) = 20

L.S.D. for number of shoots surviving:
Cutting height at medium fertility level (.05) = 13
(.01) = 18
Cutting height at high fertility level (.05) = 19
(.01) = 25

TABLE 4.—Effects of Two Cutting Heights on Tall Fescue Crown and Shoot Survival at Three Nitrogen Levels in 1966.

<table>
<thead>
<tr>
<th>Nitrogen Level</th>
<th>Cutting Height</th>
<th>Low (0 Nitrogen)</th>
<th>Medium (4 Lb. Nitrogen)</th>
<th>High (8 Lb. Nitrogen)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 Inches</td>
<td>22</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3 Inches</td>
<td>16</td>
<td>11</td>
<td>1</td>
</tr>
</tbody>
</table>

Number of Crowns Surviving

| 2 Inches | 27 | 6  | 2  |
| 3 Inches | 20 | 13 | 1  |

L.S.D. for number of crowns surviving:
Cutting heights at medium fertility levels (.05) = 4
(.01) = 5

L.S.D. for number of shoots surviving:
Cutting height at medium fertility level (.05) = 5
On tall fescue, cutting height had an opposite effect than on bluegrass. The difference due to cutting height was significant only at the 4 lb. nitrogen rate for tall fescue. More shoots and crowns survived the 3-inch than the 2-inch cutting height (Table 4).

The results of these data suggest that for maximum winter survival, bluegrass should be cut at 2 inches if either 4 or 8 lb. of nitrogen per 1000 square feet is applied. Tall fescue should be cut at 3 inches if the 4 lb. rate is used. If neither grass receives any supplementary nitrogen, the cutting height appears to be insignificant. There also was no difference in winter survival of tall fescue at the 2 or 3-inch cutting height if 8 lb. of nitrogen were applied.

**Effect of Nitrogen Fertilization on Cold Injury**

The level of nitrogen fertilization affected the response of bluegrass and tall fescue to the cold treatments. Tall fescue was reduced at all three fertility levels. The treatments receiving no nitrogen showed the least reduction, with about three times more reduction occurring at the 4 and 8 lb. per 1000 square feet rates. There were no differences in reduction of tall fescue between the 4 and 8 lb. rates (Table 5).

The bluegrass increased in percent of composition after treatment at all three levels (Table 5). There was the least increase if nitrogen was not applied, with a higher increase at the 4 and 8 lb. rates. Again, there was no difference between the 4 and 8 lb. treatments.

**TABLE 5.**—Effects of Fertility on the Percent Change in Bluegrass and Tall Fescue Composing the Samples After Cold Treatments in 1966.

<table>
<thead>
<tr>
<th>Fertility Level</th>
<th>Percent Increase (+) or Decrease (-)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bluegrass</td>
</tr>
<tr>
<td>Low (0 Nitrogen)</td>
<td>+20 a</td>
</tr>
<tr>
<td>Medium (4 Lb. Nitrogen)</td>
<td>+34 b</td>
</tr>
<tr>
<td>High (8 Lb. Nitrogen)</td>
<td>+46 b</td>
</tr>
</tbody>
</table>

*Means within a column followed by a different letter are significantly different at the 5 percent level using Duncan's Multiple Range Test.
Some conclusions which may be drawn from this study are:

1. A turfgrass consisting of a mixture of tall fescue and Kentucky bluegrass will gradually change to bluegrass when highly managed in a climate similar to that of Central Ohio.

2. The increase in bluegrass and decrease in tall fescue results, at least in part, from differential winter injury to the two species.

3. To maintain a bluegrass-tall fescue mixture with a minimum shift to bluegrass, no more than 4 lb. of nitrogen per 1000 square feet per year should be used. If the 4 lb. rate is applied, the mowing height should be 3 inches.
Water is often the most limiting factor in the proper growth of plants. Soil acts as a reservoir to absorb, store, and release water to plants. It is important, therefore, to understand soil properties and properly manage soil in order to make the most efficient use of water applied or stored in the soil.

Soil Properties Affecting Water Management

Two important properties of soils affecting their water management are: (1) the infiltration rate or rate of water intake through the soil surface during a rain or irrigation and (2) the available water-holding capacity. These properties are closely related to the number and size of pores in the soil.

An average productive soil will contain about 50 percent open pore space. Pores range in size from fine capillary pores to large aeration pores. Much of the available water retained in the soil is held in the capillary pores. The larger aeration pores drain rapidly and have an important effect on infiltration rates, water movement, drainage, and aeration in the soil. The proper proportion of capillary and aeration pores in a soil are necessary for the optimum water infiltration rate and available water-holding capacity.

Soils differ greatly in their ratio of large to small pores due to differences in soil texture, structure, and management. Fine-textured soils such as clays have mostly fine pores and coarse-textured soils such as sands have mainly large pores. A soil with a well-aggregated structure also contains many larger pores. The management of a soil can also greatly alter the percentage of larger pores and affect the soil's ability to absorb, transmit, and store water for use by growing plants.

Infiltration Rate

The infiltration rate of a soil is determined largely by the amount of larger pores in its surface and is greatly influenced by management. To maintain a high capacity to absorb water falling or applied on the soil, the surface should be kept as open and porous as possible.

Compaction by heavy traffic or use can reduce the porosity and infiltration rate drastically. A compacted soil should be loosened or aerated to increase water intake. Bare soil surfaces can be compacted by raindrop impact, causing surface sealing and crust formation which greatly reduce the infiltration rate. Mulches should be used on newly-seeded bare soil to prevent raindrop impact from sealing the surface.
The infiltration rate of a soil determines how fast water can be applied without causing runoff. Infiltration capacities have been determined on a number of Ohio soils to determine the rate at which they can take in water after the surface is wet. Rates for several typical Ohio soils are given in Table 1. Generally, flood infiltration rates of a soil surface are considered high if more than 5.00 inches per hour, medium from 0.20 to 5.00 inches per hour, and low if less than 0.20 inches per hour.

Available Water-Holding Capacity

The amount of available water which a soil can store for plant use is determined by its percentage of smaller pores, since they retain water from drainage by gravity. Fine-textured soils high in clay hold large amounts of water but much of it is held too tightly to be removed by plant roots. Coarser sandy soils, on the other hand, have too few fine pores, retain too little water, and are often droughty. Silt loam soils, with a good balance of sand, silt, and clay, usually have the highest available water-holding capacity. Organic matter also increases a soil's water-holding capacity.

The available water-holding capacity of a soil determines how often water must be applied to maintain good plant growth. Those with low capacities, such as sandy soils, must have water applied more frequently than those with higher capacities. Sands often hold less

<table>
<thead>
<tr>
<th>Soil</th>
<th>Texture</th>
<th>Infiltration capacity (In./hr.)</th>
<th>Available water-holding capacity (In./ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brookston</td>
<td>Silty clay loam</td>
<td>5.00</td>
<td>1.5</td>
</tr>
<tr>
<td>Canfield</td>
<td>Silt loam</td>
<td>0.60</td>
<td>2.0</td>
</tr>
<tr>
<td>Crosby</td>
<td>Silt loam</td>
<td>0.63</td>
<td>2.1</td>
</tr>
<tr>
<td>Hoytville</td>
<td>Silty clay</td>
<td>2.40</td>
<td>2.4</td>
</tr>
<tr>
<td>Miami</td>
<td>Silt loam</td>
<td>0.30</td>
<td>1.9</td>
</tr>
<tr>
<td>Napanee</td>
<td>Silt loam</td>
<td>1.53</td>
<td>1.3</td>
</tr>
<tr>
<td>Russell</td>
<td>Silt loam</td>
<td>1.31</td>
<td>2.2</td>
</tr>
<tr>
<td>Toledo</td>
<td>Silty clay</td>
<td>0.21</td>
<td>1.6</td>
</tr>
</tbody>
</table>

1Data from Div. of Lands and Soils, Ohio Dept. Natural Resources. Flood infiltration rates at end of five hours run on wet soil.
than 0.5 inch per foot of available water, clays up to 1 inch per foot, and some silt loams 2 or more inches per foot. Table 1 indicates available water-holding capacities of a few major Ohio soils.

**Principles of Turfgrass Irrigation**

To plan a proper irrigation schedule or system for lawns or turfgrass areas, it is important to first understand and consider the type of soil involved, including its texture, infiltration rate, water-holding capacity, and internal drainage. The soil should be managed to maintain a high infiltration rate by mulching bare, newly seeded areas, keeping the surface porous and open, and reducing compaction. Water should be applied before the plants become permanently wilted.

There are several methods for determining soil moisture contents. The standard method is to oven dry field samples and determine the difference between wet and dry weights. Newer methods such as neutron soil moisture probes are being used experimentally. Tensiometers, commonly used for irrigation control, measure the water tension in the soil as water moves in and out of porous cups buried in the soil and give direct readings of soil moisture content. Electrical resistance blocks of several types are also available for determining soil moisture changes through the growing season.

Simple visual or hand tests can be used by the average home owner to give a rough estimate of soil moisture content and determine when water should be applied. An inexpensive soil probe or auger can be used to take soil samples to depths of 2 to 3 feet. A medium-textured silt loam soil contains adequate amounts of available moisture if it can be squeezed into a ball with the fist and retains this shape until pressed gently. If the soil feels dry and hard and cannot be formed into a ball by squeezing, it is near the wilting point and should be watered.

The depth of wetting can also be checked visually with the soil probe. Moist soil appears darker than when dry and, by noting the color change of the soil with depth, the depth to which water has penetrated can be estimated. Visual symptoms of the grass, such as wilting which is often observed as a bluish cast to the grass, are also clues that water stress is present in the soil and irrigation is probably needed.

Water should be applied to turfgrass areas to encourage deep rooting. New seedings are shallow-rooted and require frequent light sprinklings. Established seedings should be irrigated less frequently and with enough water to replenish the entire root zone to a depth of 5 to 8 inches. Most grasses require 1 inch or more per week. On sandy soils with low water-holding capacities, this may require 0.5 inch applied two or three times a week. A clay soil may require slow applications of 1 inch only once each week or 10 days because of its limited infiltration capacity.

Frequent light applications of water should be avoided on established turfgrass areas. They encourage shallow root growth,
which is more susceptible to damage and drought, and do not wet the soil profile deeply enough to replenish the root zone. As shown by the water-holding capacities in Table 1, most medium-textured soils require at least 1.5 to 2.0 inches to wet the soil just to 12 inches. Light applications wet only a small surface layer of the soil and most of the water applied is rapidly lost by evaporation and is wasted.

It is important to measure the amount of water applied to insure adequate amounts to wet the rooting depth according to the soil type. This can be done with straight-sided cans or containers set on the ground surface. The rate of application should not be greater than the soil's infiltration rate, or runoff will occur and water will be wasted. Many sprinklers apply water at the rate of 0.5 to 2 inches per hour. At the higher rates, runoff can often occur quickly, especially on fine-textured or compacted soils.

Several problems occur in soils which affect their water management. Thatch accumulated on the soil surface often acts as a waterproof barrier and reduces movement of rainfall or applied water into the soil. It should be removed to make water use more efficient.

Layers or local accumulations of coarse sand, gravel, or debris just under the soil surface can cause wilted or brown spots in turf areas. This is due to the soil's low water-holding capacity, causing it to be droughty. These layers should be removed and replaced with medium-textured silt loam soil with adequate organic matter. Compaction of the soil surface, which reduces the infiltration rate and increases runoff, should be prevented or corrected for most efficient water management.

For the most efficient water management for turfgrasses: know the infiltration rate and available water-holding capacity of the soil, manage the soil surface to maintain a high infiltration rate, and apply water when needed in large enough amounts to wet the entire root zone and encourage deep rooting but at a rate low enough to prevent runoff losses.
CONTROLLING WEEDS IN TURF

Edward W. Stroube
Department of Agronomy

Producing a dense healthy stand of turfgrass is the most satisfactory method of controlling many lawn weeds. Weeds will not be a serious problem if good turf management recommendations are followed. However, herbicides must be used to have a completely weed-free lawn. Herbicides are chemicals which kill or reduce plant growth. They do not eliminate the need for good lawn management but if properly used they are another tool for obtaining a good lawn.

Herbicides are sold commercially under various trade names in several package sizes. It is more important to consider the proper active ingredient in the herbicide than to consider the specific trade name.

Herbicides are manufactured in different forms or formulations. Granules are designed to be applied in the dry form. Wettable powders and liquids are designed to be mixed with water and applied as a spray. The label on the herbicide container gives directions for mixing and applying the various formulations.

Many types of commercial equipment are available for applying turf herbicides. It is important to get uniform distribution of the correct amounts of herbicide. One of the best sprayers for home use is the hand-operated, compressed-air sprayer with a capacity of 1 to 3 gallons.

The simplest way to apply the desired amount of material as a spray is to add the amount required for a specific area to a relatively large quantity of water (1 gal. per 200 to 300 sq. ft.). Then the measured lawn area should be covered repeatedly until all of the solution is used. After the first coverage, it is best to go crosswise to the previous spray pattern each time.

Hand-operated push-type spreaders are satisfactory for applying granular herbicides. The calibration directions furnished with the spreader or the directions on the herbicide label should be followed. The setting with one of the smallest openings is often required for applying granular herbicides. To be sure the setting is correct, apply a given amount of granules to a small measured area before treating the entire lawn.

Lawn herbicides are useful and relatively safe but must be handled with respect. Keep them away from children and out of eyes and food. Avoid drift while spraying. ALWAYS READ DIRECTIONS AND PRECAUTIONS ON THE LABEL AND FOLLOW THEM CAREFULLY.

Broadleaf Weeds

For control purposes, weeds in lawns may be divided into two general classes—broadleaf weeds and undesirable grasses. Dandelions,
Plantains (common and buckhorn), and many other broadleaf weeds in lawns can be eliminated with 2,4-D (2,4-dichlorophenoxyacetic acid). To be most effective, 2,4-D should be applied to the foliage of weeds. It works best if applied during periods of ample moisture when the weeds are growing well.

Fall is the best time for general treatment with 2,4-D. When the weeds are killed in the fall, lawn grasses will fill the vacant spaces before crabgrass germinates the following spring. Desirable plants susceptible to 2,4-D injury (most flowers, vegetables, shrubs, and trees) are less likely to be injured in the fall than in spring or summer. However, care must be used to prevent 2,4-D injury, regardless of when the weeds are treated.

When using a spray, use the amine, not ester, formulations since esters are more volatile. Spray only when the wind is quiet. Avoid direct contact with all flowers, vegetables, shrubs, or trees.

All 2,4-D lawn products do not contain the same quantity of 2,4-D per unit of the concentrate. Follow the directions on the label of the product. A standard lawn solution is 1 tablespoon of 4 lb. per gallon amine formulation in 1 gallon of water. Apply this to wet the weeds to a point of runoff. On large bluegrass or fescue lawns, use 1 lb. of 2,4-D per acre in enough water to cover the area. Use 1/2 lb. per acre on lawns containing bentgrass.

Mixtures of 2,4-D and fertilizer are available for use on lawns. Granular forms of 2,4-D on inert carriers are also available. These do a good job when properly used.

Sprays may be more effective than dry materials on hard to kill weeds. Formulations for spraying are generally less expensive than those for spreader application. Shaker cans or "canses" containing 2,4-D are convenient for spot treating a few weeds missed by the general treatment. Wax bars containing 2,4-D are effective on some of the more susceptible broadleaf weeds.

2,4-D will not kill some broadleaf weeds commonly found in lawns. Ground ivy, common chickweed, meadow chickweed, mouse-ear chickweed, white clover, wood sorrel, and yarrow all appear to be more sensitive to Silvex [2-(2,4,5-trichlorophenoxy) propionic acid] than to 2,4-D. Silvex is suggested for trial on any broadleaf weed not killed with a careful application of 2,4-D. Silvex and 2,4-D are ineffective on grass weeds.

Use the rate suggested on the label. For large areas, use 1.5 lb. of Silvex per acre in enough water to cover the foliage. Repeat applications will likely be needed on some stubborn weeds. This rate will not harm bluegrass but may seriously injure bentgrass.

Do not use a sprayer used for silvex or 2,4-D for other spraying. If you must use the sprayer for other purposes, clean it thoroughly with strong ammonia or trisodium phosphate solution (2/3 ounce to the gallon). When silvex has been used, rinse the sprayer with gasoline or kerosene before using the cleaning solution. (Caution--gasoline and kerosene can be explosive.)
**KNOTWEED (Polygonum aviculare)** 1. entire plant; 2. seed; 3. portion of stem and leaves; 4. angle leaf; 5. distribution. Annual, reproducing by seed. Stems bluish-green, leafy, wiry, extending 4 inches to 3 feet in all directions from the small taproot and forming a dense mass. Each plant or mass covered with a thin papery sheath. Leaves bluish-green, alternate, oblong, narrowed at base, pointed at tip. Flowers very small, white or yellow, borne in clusters in the leaf axils. Seeds small, clavate, reddish-brown, triangular. Found in hard triangular areas in yards, lawns, waste places, and along roadways or paths.

**ERECT KNOTWEED (Polygonum aviculare)** 6. branch of plant; 7. portion of stem and leaf; 8. leaf; 9. distribution. Annual, reproducing by seed. Stem erect. 6 inches to 2 feet high, branched near top, smooth, yellowish-green, slightly rigid. Leaves light green, oval, alternate, 1/2 to 1 inch long, sometimes covered with mites. Flowers and seed similar to those above. Found in same areas as knottweed.

**COMMON CHICKWEED (Stellaria media)** 1. plant in flower; 2. flower; 3. seed pod; 4. seed. Winter annual or evergreen, reproducing by seed and creeping stems, rooting at the nodes. Root system fibrous, shallow. Stems are smooth, branched, creeping or sprawling, rooting in low spreading plants 4 to 12 inches high. Leaves small, opposite, simple, broadly ovate, pointed at the tip, smooth; pedicels have a line of hairs on one side. Flowers small, white, with 5 deeply notched petals. Seed pod cylindrical, breaking into 5 segments at maturity, containing single seeds. Seed small, dull reddish-brown, somewhat heart-shaped but nearly round, roughened by curved rows of minute tubercles. Found in lawns, gardens, fields, strawberry beds, meadows.

**GROUND IVY (Cephalis herba-virosa)** 1. vegetative growth of stems and leaves; 2. flower section; 3. seeds. Perennial, with slender roots, spreading by seeds and by creeping stems. Stems 15 to 30 inches long, purplish, 4-sided, rooting at the nodes. Leaves almost round or kidney-shaped, with round-toothed edges, bright green, 1/4 to 1/2 inches in diameter, hairy, opposite, borne on long petioles, with a many-ovate edge. Flowers small, bluish-purple, funnel-shaped, 1/8 to 1/4 inches long, borne in small clusters in the axils of the leaves. Seeds rough, dark brown, in groups of 4, fan on 2 sides and round on the third side, with a white aril at the tip. Found in lawns, fields, and waste places, especially shady areas with damp rich soil.

**RED SORREL (Oxalis acetosella)** 1. young plant; 2. seed; 3. entire plant. Perennial, reproducing by creeping rhizomes and seeds. Roots and rhizomes extensive but rather shallow. Stems 6 to 18 inches high, slender, upright, branched at top. Several stems may arise from 1 crown. Leaves are arrow-shaped, 1 to 3 inches long, thick, smooth, acid to the taste. Early growth consists of a cluster of heart leaves. Flowers yellow to red, borne on a raceme near top of plant. Male and female flowers borne on different plants. Seals podded, reddish-brown, shiny. Root reddish-brown, tough, often adhering to the seeds. Found mainly in pastures and meadows, scattered in lawns. Prefers in areas of poor drainage, low soil fertility, and late composting.
GUACOGRASS, Coughgrass (Agropyron repens). 1. spike; 2. stem, leaves, and flowering stems; 3. seed and seedling; 4. root on rootstock; 5. rootstocks; 6. leaves. Leaves and flowering stems vary from 2 to 3 feet tall, with smooth, thin blades and narrow, linear, pointed leaves. It requires special control methods because of its weedy habits. Although it is considered a primary noxious weed in most states, it can often be used for pasture or grass hay plant.
Dicamba has given good control of knotweed and red sorrel as well as weeds normally controlled by 2,4-D in tests at the Ohio Agricultural Research and Development Center. It is available in a mixture with 2,4-D. There is danger of it harming shrubs and trees and extreme precautions should be used.

MCPP will control most weeds commonly controlled by 2,4-D and Silvex but has a greater margin of safety on the bentgrasses than 2,4-D or Silvex.

**Grass Weeds**

Annual grasses are those which must grow from seed each year. Crabgrass, foxtail, barnyardgrass, and goosegrass are annual grasses found in lawns. Crabgrass is the most common. Herbicides which control crabgrass usually give some control of the other annual grasses.

There are two basic ways of controlling crabgrass with herbicides. One method is to treat the lawn in the winter or spring before crabgrass seeds germinate (pre-emergence). The other method is to apply herbicides after the crabgrass is growing (post-emergence).

Pre-emergence herbicides should be applied before crabgrass first germinates. To be sure you apply the materials in time, apply them before April 1 in Southern Ohio and before April 15 in Northern Ohio.

Many crabgrass pre-emergence herbicides are available. Some of them give more consistent crabgrass control than others. Materials containing Dacthal, Benefin, Tupersan, Bandane, and others have resulted in excellent control in several years of studies at the Ohio Agricultural Research and Development Center. Products containing calcium arsenate, lead arsenate, chlordane, calcium propyl arsenate, and diphenatrile have given erratic crabgrass control.

Post-emergence crabgrass herbicides should be applied as soon as the crabgrass is seen in the turf. In Ohio studies, at least two and sometimes as many as six applications have been needed to control crabgrass for the summer. Make applications about a week apart until the crabgrass is killed. If additional crabgrass germinates after the application, apply another series of treatments.

The two most effective and widely used post-emergence herbicides are DMA (disodium methylarsenate) and AMA (octyl-dodecyl ammonium-methylarsenate). Kentucky bluegrass may be slightly discolored with these materials but no serious injury should result if used at the recommended rates. Several experimental organic arsenicals have given results equal to DMA and AMA but not better.

Perennial grasses are those which come back from roots or stems each year. Most lawn grasses are perennials but several perennial grasses are objectionable in lawns. Nimblewill is a summer grass which is quite troublesome in central and southern Ohio. This grass is brown and dead appearing from October through April. So spots of it give a bare appearance to the lawn in the fall, winter, and spring. In summer it is much like bentgrass.
<table>
<thead>
<tr>
<th>Weeds</th>
<th>Annual or Perennial</th>
<th>Chemical to Use</th>
<th>Time of Application</th>
<th>Degree of Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black medic</td>
<td>annual</td>
<td>silvex</td>
<td>early spring</td>
<td>good</td>
</tr>
<tr>
<td>Carpetweed</td>
<td>annual</td>
<td>2,4-D</td>
<td>spring</td>
<td>good</td>
</tr>
<tr>
<td>Carrot, wild</td>
<td>biennial</td>
<td>2,4-D</td>
<td>spring</td>
<td>good</td>
</tr>
<tr>
<td>Chickweed, common</td>
<td>annual</td>
<td>silvex</td>
<td>spring or fall</td>
<td>good</td>
</tr>
<tr>
<td>Chickweed, mouse-ear</td>
<td>perennial</td>
<td>silvex</td>
<td>fall or spring</td>
<td>good</td>
</tr>
<tr>
<td>Chicory</td>
<td>perennial</td>
<td>2,4-D</td>
<td>spring</td>
<td>good</td>
</tr>
<tr>
<td>Cinquefoil</td>
<td>perennial</td>
<td>2,4-D</td>
<td>fall or spring</td>
<td>good</td>
</tr>
<tr>
<td>Dandelion</td>
<td>perennial</td>
<td>2,4-D</td>
<td>fall or spring</td>
<td>good</td>
</tr>
<tr>
<td>Dock, curly</td>
<td>perennial</td>
<td>2,4-D</td>
<td>fall or spring</td>
<td>good</td>
</tr>
<tr>
<td>Garlic or onion</td>
<td>perennial</td>
<td>2,4-D ester</td>
<td>late fall-early spring</td>
<td>fair</td>
</tr>
<tr>
<td>Ground ivy</td>
<td>perennial</td>
<td>silvex</td>
<td>summer, fall or spring</td>
<td>fair to good</td>
</tr>
<tr>
<td>Heal-all</td>
<td>perennial</td>
<td>2,4-D</td>
<td>spring</td>
<td>good</td>
</tr>
<tr>
<td>Henbit</td>
<td>annual</td>
<td>silvex</td>
<td>spring</td>
<td>good</td>
</tr>
<tr>
<td>Knotweed</td>
<td>annual</td>
<td>dicamba</td>
<td></td>
<td>good</td>
</tr>
<tr>
<td>Mallow roundleaf</td>
<td>annual</td>
<td>silvex</td>
<td>spring</td>
<td>fair</td>
</tr>
<tr>
<td>Pigweed</td>
<td>annual</td>
<td>2,4-D</td>
<td>summer</td>
<td>good</td>
</tr>
<tr>
<td>Plantain, buckhorn</td>
<td>perennial</td>
<td>2,4-D</td>
<td>fall or spring</td>
<td>good</td>
</tr>
<tr>
<td>Plantain, common</td>
<td>perennial</td>
<td>2,4-D</td>
<td>fall or spring</td>
<td>good</td>
</tr>
<tr>
<td>Poison ivy</td>
<td>perennial</td>
<td>2,4,5-T or silvex</td>
<td>spring or summer</td>
<td>good</td>
</tr>
<tr>
<td>Red sorrel</td>
<td>perennial</td>
<td>dicamba</td>
<td>spring, summer or fall</td>
<td>good</td>
</tr>
<tr>
<td>Speedwell, thyme-leaved</td>
<td>perennial</td>
<td>endothal or silvex</td>
<td>fall or spring</td>
<td>poor to fair</td>
</tr>
<tr>
<td>Speedwell, annual</td>
<td>annual</td>
<td>endothal or silvex</td>
<td>spring or fall</td>
<td>fair to good</td>
</tr>
<tr>
<td>Spurge, spotted</td>
<td>annual</td>
<td>silvex</td>
<td>SPRING</td>
<td>good</td>
</tr>
<tr>
<td>Thistle</td>
<td>perennial or biennial</td>
<td>2,4-D or dicamba</td>
<td>spring and fall</td>
<td>fair to good</td>
</tr>
<tr>
<td>White clover</td>
<td>perennial</td>
<td>silvex</td>
<td>spring, summer or fall</td>
<td>good</td>
</tr>
<tr>
<td>Wood sorrel</td>
<td>annual</td>
<td>silvex</td>
<td>spring</td>
<td>fair to good</td>
</tr>
<tr>
<td>Yarrow</td>
<td>perennial</td>
<td>silvex</td>
<td>spring</td>
<td>fair</td>
</tr>
</tbody>
</table>
Sparse infestations of nimblewill can be fairly well controlled by hand removal. Nimblewill can be killed by spot treating with the herbicides suggested below for other perennial grasses but the lawn grasses will also be killed.

Tall fescue, velvetgrass, orchardgrass, quackgrass, and other undesirable perennial grasses are often found in lawns. Spot treatment with chemicals on the crown of each clump of these grasses may be practical for moderately infested lawns. Chemicals such as kerosene, dalapon, ammonium sulfamate (Ammate), amitrole, and amitrole-T may be used if applied at rather high concentrations. All of these materials, except Ammate, will permit growth of lawn grasses into spaces left by the weeds within a few weeks after treatment.
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RESEEDING WEEDY TURF

G. B. Triplett and R. R. Davis
Department of Agronomy

Destroying existing vegetation and reseeding desirable lawn grasses is sometimes the best solution for grassy weed problems. Spot treatment with herbicides can be used to kill a few tall fescue or orchardgrass plants in bluegrass but this can be quite time consuming for extensive infestations. Re-seeding is a must if extensive areas of bentgrass are removed from bluegrass sod.

Bare spots 6 inches or less in diameter in a bluegrass lawn do not need reseeding. Bluegrass spreads by rhizomes or underground stems and in time will fill in small bare areas. Spread of bluegrass, however, into bare areas 1 foot or more in diameter is slow enough to warrant reseeding.

Undesirable vegetation must be killed and the dead material disturbed for satisfactory reseeding. Desirable perennial grasses cannot be established satisfactorily in a live sod. The following information is based on numerous experiments and is intended to serve as a guide for reseeding operations.

Killing Weedy Grasses

Several herbicides which may be used to destroy undesirable grasses are listed in Table 1. Some of these remain in the soil for a short period of time and must be applied several weeks before reseeding. Rates of dry material are for level tablespoons.

Vapam is a liquid soil sterilant which can be diluted to aid in proper coverage and sprayed on the soil or applied with a watering can. The treated area should be watered immediately after application. A vertical mower, roto-tiller, or aerator should be used on the turf prior to application and the treated area should be covered with burlap after irrigation.

The turf should be watered and fertilized, if necessary, to insure active growth before using the dalapon and amitrole combination or amitrole alone. These materials should be dissolved in sufficient water to insure proper coverage of the treated area. Two gallons of water per thousand feet of treated area should be adequate for a spray application.

Paraquat and cacodylic acid kill the plant tops. Under some conditions, these may eradicate grassy weeds but neither material provides as effective control as systemic herbicides under all conditions. These materials do not remain in the soil for long periods of time and reseeding can be made 1 week after application.

Since amitrole, paraquat, and cacodylic acid all require good leaf contact for good kill, sprinkler can application will likely be unsatisfactory.
Site Preparation

Good seed to soil contact is necessary for satisfactory establishment of grass seedlings. The mat of dead sod must be removed or disturbed sufficiently to insure grass seed contact with the soil.

1. Rotary tillage or discing may be used to loosen the layer of dead sod. Care should be taken to insure that the tools penetrate the organic layer and loosen the soil to a depth of 1/2 to 1 inch. If the turf formed a thick mat, part of the loosened organic material should be removed.

2. A vertical mower, aerator, or a combination of both tools can be used quite effectively to prepare killed sod for reseeding. These machines make holes or grooves through the organic layer into the soil. Seed planted in these openings have an ideal media for germination and growth. If a vertical mower is used, the loose grass should be removed before reseeding.

3. The dead sod can be removed. Either a manual or mechanized sod cutter can be used to cut the sod below the soil surface and remove the sod as a layer. The soil surface should be tilled before seeding.

Mid-August to mid-September is the best time for establishing lawn grasses. The herbicide should be applied early enough so the waiting period will be completed by this time.

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate/100 ft.</th>
<th>Waiting Period</th>
<th>Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMDC (Vapam)</td>
<td>20 oz.</td>
<td>3 Weeks</td>
<td>Excellent</td>
</tr>
<tr>
<td>Dalapon + Amitrole</td>
<td>4 Tablespoons</td>
<td>4-6 Weeks</td>
<td>Excellent</td>
</tr>
<tr>
<td>Amitrole</td>
<td>4 Tablespoons</td>
<td>2-3 Weeks</td>
<td>Not as effective as mixture with Dalapon</td>
</tr>
<tr>
<td>Paraquat</td>
<td>2 Tablespoons</td>
<td>1 Week</td>
<td>Fair/good</td>
</tr>
<tr>
<td>Cacodylic acid</td>
<td>See directions on container</td>
<td>1 Week</td>
<td>Fair/good</td>
</tr>
</tbody>
</table>
Before planting, the site should be fertilized according to recommendations in Extension Bulletin 271, Your Lawn, and lime applied if needed. Copies of the bulletin are available from county offices of the Cooperative Extension Service. The soil surface should be dragged or raked lightly after seeding. If the sod is completely removed, a light mulch after seeding will be necessary for best results.


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TURF FUNGICIDE TRIALS

H. A. Runnels
Department of Plant Pathology

Helminthosporium Leaf Spot (1967)

The single varieties and mixtures of lawn grasses in the experimental turfgrass planting at the Research Center were given a series of fungicidal applications from April 19 to July 1. The first four treatments were made weekly and the last four at 2-week intervals.

The fungicide was Daconil 2787 at the rate of 1 oz. in 5 gal. water on 1,000 sq. ft. A wheelbarrow-type sprayer equipped with a 4-nozzle boom was used.

The incidence of leaf spot on two bluegrass varieties and a blend of three varieties was determined approximately 2 weeks after the final application. As in 1966 when another fungicide was used, a distinct reduction in the occurrence of leaf spot on the non-irrigated sprayed bluegrass turf was evident. This year there was no apparent benefit from spraying irrigated bluegrass turf in contrast to results obtained in 1966.

Sclerotinia Dollar Spot (1966)

As curative treatments for an established outbreak of dollar spot on a uniform stand of Old Orchard bentgrass, three applications of the following materials at weekly intervals from August 19 to 19 provided better than 90% control of the disease when compared with untreated turf. The fungicides were Daconil 2787 (0.5 oz./10 gal. water/1,000 sq. ft.); Mercurem (3 or 5 oz.); Niagara Lawn & Turf Fungicide (8 oz.); Dyrene (8 oz.); 2-1 Fungicide (2 oz.); Memni (1 oz.); Kromad (2 oz.) + Calo-Clor (½ oz.); Tersan 75 (3 oz.) + 2-1 Fungicide (1 oz.); Spotrete (3 oz.) + PMAS (½ oz.); MF-296 (3 oz.); EF-336 (3 oz.); and Calo-Gran (3 lb.). Niagara Lawn & Turf Fungicide (6 oz.) and EF-296 (2.5 lb.) were only slightly less effective. Calo-Gran and EF-296 were dry treatments.

<table>
<thead>
<tr>
<th>Percent of Grass Leaves with Leaf Spot</th>
<th>Not Irrigated</th>
<th>Irrigated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not Sprayed</td>
<td>Sprayed</td>
</tr>
<tr>
<td>Common Kentucky</td>
<td>62.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Merion Kentucky</td>
<td>13.5</td>
<td>8.0</td>
</tr>
<tr>
<td>Blend of Park, Delta and Newport</td>
<td>59.0</td>
<td>7.5</td>
</tr>
</tbody>
</table>
A long-range research project is underway at the Ohio Agricultural Research and Development Center with extensive plantings of ornamental trees in the Secrest Arboretum. This is a cooperative project sponsored by several Ohio utility companies, Ohio Chapter of International Shade Tree Conference, and the Ohio Nurserymen's Association. It is designed to determine characteristics and adaptations of species and cultivars of shade and ornamental trees, with emphasis on street and highway use.

Because of increased emphasis on landscape planting of streets and highways, many new types of shade and ornamental trees are being selected and introduced for specific use in this area. These cultivars have application for this type of landscape planting because of attributes such as size or habit which minimize interference with overhead and underground utility lines, branching which does not interfere with foot or vehicular traffic, superior rooting habits, tolerance of unfavorable environmental conditions, and lack of fruit or ornamental fruit which does not create maintenance and nuisance problems.

Many of these new selections have been evaluated by the producer and, on an individual basis, by arboretums and similar agencies. However, no program had been developed in the North Central region to make an intensive comparative evaluation in one location. As more miles of streets and highways are added, the need for these new cultivars will continue to increase. An unbiased, scientific evaluation of morphological characteristics and ecological adaptations is essential to provide useful information to utility companies, municipalities, other public agencies, landscape architects, landscape horticulturists, and home owners. Urban renewal, expansion of park development, increased construction of recreation areas such as golf courses, and landscape planting of public and commercial buildings are additional factors justifying the need for a study such as this to gain more knowledge of the trees to be used in these areas.

In addition to the need for a comparative evaluation of tree cultivars, it is also necessary to obtain information on the ecological performance of selected types in various planting sites throughout the state. A later phase of the project will include this type of study.

The trees in the Secrest Arboretum plots will be periodically evaluated for numerous factors. These include growth habit and rate, branching characteristics, height and spread, density, type and extent of root growth, ornamental features, and other characteristics.

Another phase of the project includes the evaluation of similar trees in established plantings in various locations throughout Ohio. The final phase of the study will begin after 5 or 6 years of research. At this time, the trees rated highest in the evaluations will be planted in specific locations in different cities and studied for a period of years.
A number of species and cultivars are already growing in the Secrest Arboretum plots. By the end of 1967, there will be 8 replicated plantings each of 30 maple species and cultivars, 20 hawthorn species and cultivars, and 18 linden species and cultivars. The replicated plants are completely randomized in the plots to permit meaningful statistical analyses of the evaluation data.
Properly selected shade and ornamental trees along streets and highways and in yards are important assets which help make rural and urban living enjoyable. Trees not only provide pleasant shade during hot summer days but have an important effect in muffling noise on busy roads and streets.

Since shade trees are long-term investments, it is important to select trees which are suitable for the site conditions in which they will be planted and which will provide maximum benefit with minimum care. One of the most serious mistakes which is made too frequently is the planting of cheap trees such as soft maples and Chinese elms. Proper choice of shade trees is essential not only from the aesthetic viewpoint but also from the standpoint of maintenance costs over a long period of time. This is especially important in new developments in urban areas.

A growing number of municipalities are beautifying their streets according to plans which have been proven to be sound. Some of the more progressive cities have a well rounded shade tree program which is financed by a modest assessment of only a few cents per front foot. This is included in the property owner's real estate taxes and provides revenues for tree planting and care and emergency measures which may be necessary to combat damages caused by wind, insects, or disease.

The photographs which follow illustrate some of the species which have been planted in the city of Wooster, Ohio during the past 15 years. Wooster does not have a shade tree assessment fund but it has had a Shade Tree Commission since 1953. This commission serves as an advisory body in recommending a program for the removal of diseased and unsafe trees, spraying and pruning of certain species, removal of stumps, and planting of new trees.

A few local examples have been selected to illustrate some general principles which apply statewide as guidelines in selecting trees for planting.
Armstrong Red Maple  
(*Acer rubrum 'Armstrong*)

Width of tree lawn: 8 feet
Planted about 1960
Photo taken July 1967
Tree height: 15 feet
Crown width: 4 feet

Sweetgum  
(*Liquidambar styraciflua*)

Width of tree lawn: 8 feet
Planted in 1963
Photo taken July 1967
Tree height: 14 feet
Crown spread: 7 feet

This short street has sweetgums planted at 50-foot spacing on both sides of the street.
Random mixture of red and pin oaks

Width of tree lawn: 8 feet

Width of pavement: 26 feet

Distance from sidewalk to front of houses: 60 feet

Distance between major trees: 85 feet

Utility wires are at back of lots. Light poles in tree lawn are spaced 340 feet apart.

This is nearly a model residential street.

Red oak (Quercus rubra) (Second tree on left in above photograph)

Age: About 25 years from seed

Tree height: 45 feet

Crown spread: 40 feet

Diameter at breast height:
16 inches

Photo taken July 1967
Kwanzan Japanese Flowering Cherry

(Prunus serrulata 'Kwanzan')

Grafted on 6-foot understock for pedestrian and vehicular clearance

Width of tree lawn: 5 feet

Planted in 1961

Photo taken July 1967

Crown spread: 8 feet

Tree height: 13 feet

Washington Hawthorn

(Crataegus phaenopyrum)

Width of tree lawn: 9 feet

Tree planted in 1956

Photo taken July 1967

Tree height: 18 feet

Crown spread: 16 feet

Pruned up to 6 feet for pedestrian and vehicular clearance

Overhead wires
Globe Norway Maple
(Acer platanoides 'Globosum')
Width of tree lawn: 4\(\frac{1}{2}\) feet
Planted about 1960
Photo taken July 1967
Tree height: 11 feet
Crown spread: 8 feet
Overhead wires

Lavalle Hawthorn
(Crataegus lavallei)
Width of tree lawn: 7 feet
Planted about 1962
Photo taken July 1967
Tree height: 13 feet
Crown spread: 8 feet
Overhead wires
Four Pin Oaks

(*Quercus palustris*)

Planted about 1960

Photo taken July 1967

Width of tree lawn: 6 feet

(too narrow for pin oak)

Av. tree height: 25 feet

Av. crown spread: 20 feet

Distance between trees: 25 feet

Pin oak is not recommended as a street tree because it becomes too large for most streets.

Four Little-leaf Lindens

(*Tilia cordata*)

Planted about 1960

Photo taken July 1967

Width of tree lawn: 6 feet

Av. tree height: 21 feet

Av. crown spread: 16 feet

Distance between trees: 36 feet
Trees on both sides of street were planted at 45-foot spacing in 1954.

Photo taken July 1967

Width of tree lawn: 5 feet

Sidewalk to tree: 7 feet

Sidewalk to front of residences: 37 feet

Tree height: 25 feet

Crown spread: 24 feet

A short street with uniform planting of Norway maples (Acer platanoides).

Columnar Norway Maple

(Acer platanoides 'Columnar')

Width of tree lawn: 10 feet

Trees planted in 1961

Photo taken July 1967

Tree height: 16 feet

Crown spread: 6 feet
Two Little-leaf Lindens (Tilia cordata) in front of Wooster Municipal Building

Width of tree lawn: 12 feet

Trees planted in 1961

Photo taken July 1967

Av. tree height: 12 feet

Av. crown spread: 10 feet

Imperial Honey Locusts on south side of Municipal Building

Width of tree lawn: 11 feet

Trees planted in 1961

Photo taken July 1967

Av. tree height: 20 feet

Av. crown spread: 20 feet
Amur Cork Tree

(*Phellodendron amurense*)

Planted about 1962

Photo taken July 1967

Width of tree lawn: 10 feet

Av. tree height: 13 feet

Av. crown spread: 9 feet

Overhead wires

---

Cleveland Norway Maple

(*Acer platanoides 'Cleveland*)

Width of tree lawn: 10 feet

Planted in 1956

Photo taken July 1967

Av. tree height: 20 feet

Av. crown spread: 15 feet
CONCLUSIONS

1. The main objectives of street and yard tree planting are: shade, beauty, architectural enhancement, noise softening, and wind reduction. Major benefits are cool shade on hot summer days and an improved landscape.

2. Proper tree selection can help avoid future problems such as broken sidewalks, over-population of one species, poor street lighting, excessive pruning for power line clearance, breakage by wind and sleet storms, and damage to water and gas shut-off valves.

3. If possible, trees selected for planting should be cultivars which will not need to be topped at some future date for line clearance or safety.

4. To permit shade trees to grow normally, they should be spaced at least 35 to 50 feet apart. Spacing along streets may be varied to avoid planting in front of driveways. The architectural beauty of houses or other buildings should be enhanced whenever trees are planted.

5. It is more important to "plant the right tree in the right place" than to adhere strictly to a uniform planting.

6. New trees should be planted in such a manner that they will not impede the free use of sidewalks and streets.

7. Streets with narrow tree lawns and those where the planting area is in close proximity to buildings should not be by-passed in a city street tree planting program. Trees suitable for such areas are available. However, a tree lawn should be at least 4 feet wide if a tree is to be planted.

8. Short-lived and untried species of unknown endurance and trees requiring frequent spraying should be avoided.

9. A wide range of species should be used in a city tree planting program. This is necessary in order to use the best trees for each location. When several kinds of trees are planted, the risk of a serious disease or insect pest attacking all of them is very remote. If uniformity is important, alternate plantings may be made in one, two, or three blocks.

10. In new developments, utility lines should either be underground or at the back of the lots if feasible. Then trees which will mature at 50 feet or more may be planted in front yards or in tree lawns.


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THE MAPLES

K. W. Reisch
Department of Horticulture

The genus *Acer* (maple) includes some of the most valuable and popular trees used in Ohio landscape plantings. There are numerous cultivars which offer great diversity of form and size to fill specific landscape needs. More than 125 forms are produced in U. S. nurseries, with approximately 250 types growing in arboreta and botanical gardens in the country. The common large forms such as sugar and silver maple are native in the United States. A few species such as Norway maple originated in Europe and numerous forms such as Japanese maple are native in Asia.

The genus has many merits, including size variation (from less than 20 feet to more than 100 feet in height), attractive and diverse growth habits, excellent foliage varying from dark green to bright red, impressive fall coloration, and attractive bark and branching habits. A few forms are also valued for showy flowers and fruit.

Taxonomically, the maples have distinctive characteristics which aid in identification. The leaves are deciduous and always arranged opposite on the twigs. In general, the leaves are simple and lobed. However, some types have compound leaves and others have toothed or nearly entire leaves.

Buds of most types have several imbricate scales and a few have two valvate bud scales. There are different types of inflorescences or flowers and most, except those of *Acer rubrum* and *A. platanoides*, are not considered to be too ornamental. The fruit is described as being composed of two long-winged compressed samaras or keys. Samara is the ancient Latin name for maple. The fruit of most forms, although interesting, is not ornamental but the red fruit of *A. tataricum* is effective in mid-summer.

The wide variations in form and size provide maples for virtually any landscape use ranging from the shade of large forms such as sugar maple to the attractive color and texture of Japanese maple in plantings around the house. New cultivars are constantly being introduced and some narrow upright forms are available for use as street trees, in large-scale plantings, or where the design calls for this distinctive formal habit. The introduction and production of numerous small types under 30 feet in height have proven valuable where space is limited such as under power lines and on small properties.

The foliage is excellent, with variations in color and texture. In addition to different shades of green, there are forms with distinctive leaf coloration such as crimson king Norway maple (maroon), Japanese maple cultivars (red, yellow, green), and some with white and cream variegation. The brilliant autumn leaf color adds another dimension of beauty to these trees. This includes the yellow of Norway maple, the red of trident and red maple, and the outstanding orange, scarlet, and yellow of sugar maple. It should be noted that
Acer Leaf Patterns
Scale-One Inch Squares

Acer Leaf Patterns
Scale-One Inch Squares

Acer (Maple) Leaf Patterns. Photo by F. C. Galle and E. E. Nank.

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the autumn color of red maple leaves varies from red to yellow, depending on plant source and location.

The size and texture of the leaves are important aesthetic and functional features. Some are large and coarse as on Norway maple and others, such as on threadleaf Japanese maple, are very fine and delicate. The density of shade is somewhat dependent on leaf size and spacing. For example, the heaviest shade, which often is detrimental to the growth of other plants, is cast by Norway maple. The broad rounded habit of this tree also adds to the problem. In contrast, sugar maple, which grows taller, has smaller leaves, is less dense and more upright, and seldom creates any problems with heavy shade. The time of leaf emergence in the spring is also important in the landscape. Red, Norway, and silver maple leaf out early while sugar maple remains dormant much later and adds less color to the early spring landscape.

Another ornamental feature is the attractive bark on some species. This includes the silver color of red maple, the shredded cinnamon colored bark of paperbark maple, and the white striped bark of striped maple.

Most maples grown by Ohio nurserymen are reliably hardy even during severe winters. One exception is the popular Japanese maple which has been damaged during unusually severe cold weather or when it is located on a windswept exposed site. This should not, however, limit the use of Japanese maple because it will grow well in most parts of Ohio with reasonable care. Culturally, maples can be planted in either light or heavy soils if the soil is well drained. As with most plants, good soil with ample organic matter will give the most satisfactory results.

Diseases and insects create a few problems on maples but, in general, there are few critical pests. In recent years there have been reports of older maple trees declining and dying. In a few instances, this has been traced to a disease such as verticillium wilt. However, in most cases the only causes appeared to be severe drought over a period of years, coupled with some extremely cold winters.

Some diseases and insects which may infect maple are:

Maple bladder gall is caused by a tiny mite stinging the leaves of silver maple as they unfold from the bud. This results in the formation of red and green warty-appearing growths on the leaves which, other than being unsightly, do not usually harm the tree. Control is gained by spraying the branches of silver maple with Malathion after leaf drop in the fall or before bud opening in the spring.

Leaf scorch, which results in marginal browning of leaves, is due to a lack of water reaching the foliage. This is a physiological disorder and not a disease. It usually occurs during dry weather or on trees where root growth is restricted.

Verticillium wilt is a serious fungus disease which fortunately has not become extensive enough to limit the planting of maples. When
this disease is present, there is sudden wilting of leaves and individual branches and the tree may die. There is a gradual decline in the tree and dead leaves remain attached to the branches. There is no chemical spray to combat this disease. However, infected branches should be removed and the tree watered and fertilized to increase vigor.

A number of maple species and cultivars are located on the campus of the Ohio Agricultural Research and Development Center and in the Secrest Arboretum. Several forms are included in a research project relating to street tree selection.

The following includes a brief description of important maple species for use in Ohio landscape plantings:

**Acer buergerianum** - Trident Maple: Excellent small tree to 20 feet height with a round head. Attractive, small shiny three-lobed leaves with good red fall color. Occasionally grown with multiple stems from the base. Native - E. China, Japan.

**Acer campestre** - Hedge Maple: Medium size tree to 35 feet height with a round head. The small three-lobed leaves are very dense and this tree can be used for shade or as a hedge or screen. Fall color is yellow. Native - Europe, W. Asia.

**Acer ginnala** - Amur Maple: Small vase-shaped tree to 20 feet height. The dark glossy green, three-lobed leaves become bright red in the fall. This type is also valued for its fragrant creamy-white flowers. Native - Central and W. China, Manchuria, Japan.

**Acer griseum** - Paperbark Maple: This oval to rounded tree grows to 25 feet height and is valued for excellent cinnamon colored exfoliating bark. The leaves are compound with three small leaflets. This is noted for winter character of the bark. Native - W. China.

**Acer palmatum** - Japanese Maple: A small tree or shrub 10 to 20 feet in height. The habit is broader than high or rounded and the branching is fine textured and attractive. There are 80 or more cultivars with varying characteristics such as red, green, yellow, and variegated foliage and deeply cut and fern-like leaves. There are also selections with a weeping habit. This species should be planted in rich well-drained soil and a somewhat protected site where severe winters are common. This is one of the few maples small enough for effective landscape use in plantings close to the house.

**Acer platanoides** - Norway Maple: A round-headed broad tree to 40-45 feet in height. The leaves are dark green and broad with five lobes. These leaves can be easily distinguished from those of similar maples by the milky sap found at the petiole base when the leaf is broken off. This tree gives very dense shade and has attractive yellow-green flowers and excellent yellow fall color. There are many cultivars, some with red leaves such as crimson king, and narrow upright and oval shaped forms such as columnar and Cleveland. Native - Europe, Caucasus.
Acer rubrum - Red Maple: An oval tree to 40-45 feet height. The three-lobed leaves are toothed on the margin of the lobes and turn yellow or red in the fall. The light gray bark, attractive red flowers, fall color, and medium size make this a good lawn tree. There are many cultivars of this species with variant growth habits and most are better than types collected from the wild. Native - North America.

Acer saccharinum - Silver Maple: This is one of the largest and fastest growing maples, reaching a height of 80 feet or more. The rapid growth results in weak branches which often break during wind storms or under a heavy load of ice and snow. In many situations they become hazardous with age. Other than fast growth, there is nothing noteworthy about this species. Native - North America.

Acer saccharum - Sugar Maple: This also grows large, to 60 feet or more in height, but its slower growth rate results in an attractive sturdy tree. The leaves are large with five lobes but do not have the milky sap in the petiole as on Norway maple. The habit is usually upright-oval and it serves as an excellent large shade tree. The beautiful fall color of scarlet, orange, and yellow is outstanding. There are cultivars with varying habits. Native - North America.

Acer tataricum - Tatarian Maple: A small oval tree to 20 feet in height. The leaves are coarsely toothed with a yellow to red fall color. An outstanding feature is the red fruit which becomes colored in mid-summer. Native - S. E. Europe, W. Asia.

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PRUNING IN LANDSCAPE MAINTENANCE

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The objective in maintenance of established evergreens and shrubs in landscape planting should be towards a gradual renewal-type of pruning. By gradual renewal pruning, considerable growth can be removed to reduce height and spread of older plants without changing the plant's appearance.

The plant's habit of growth provides a clue as to the best method of pruning. Most broad-leaved evergreens, deciduous shrubs, and narrow-leaved evergreens such as Taxus and juniper used in the landscape respond best to the "thinning-out" method of pruning rather than shearing. By thinning out, short individual branches are cut completely off the branch from where they arise or are cut to a lateral or side branch. Plant growth continues in the lateral branch or stem from which the branch was removed.

Deciduous shrubs normally increase and grow from new stems which arise from the base of the plant. Shrubs may be maintained to a desired height by merely removing up to one-third of the older stems at the base of the plant. Exceptions would be budded or grafted shrubs such as hybrid lilac.

Most evergreens and trees increase in size from the terminal buds of stems. Upright narrow-leaved evergreens are best pruned to eliminate multiple stems. The spreading evergreens can be pruned to create a shingled effect from top to bottom where the top of the plant is narrower than the base.

Hand pruning shears are the ideal pruning tool for deciduous shrubs, narrow-leaved, and broad-leaved evergreens in established landscape plantings. Hedge shears should be avoided except for hedges and formal plantings.

The outstanding adverse effect of shearing plants is to concentrate vigorous regrowth at the terminal end of the cut stems. An intact terminal bud appears to have an inhibiting effect upon the growth of dormant lateral buds located below the terminal bud. This effect is greater on some plants than others. When the bud is cut off as in shearing, regrowth primarily starts from a number of dormant lateral buds in the area below the cut. The type of growth which results is frequently quite upright, vigorous, unnatural, or flat with a candelabra-like appearance. Plants which are sheared lose their natural beauty or branching habit and form and appear as boxes, rectangles, or cones.

There are several beneficial effects of pruning by the thinning-out method. Landscape plants can be maintained at a desired height and spread by this gradual renewal-type pruning. More light will reach the inner branches and encourage growth of the inner twigs.
Considerable growth can be pruned off to reduce height and spread without changing the plant's appearance or branching habit. Thinning out spreads the regrowth effect throughout the entire plant.

Ohio's major soil types and climatic conditions are represented at the Research Center's 11 locations. Thus, Center scientists can make field tests under conditions similar to those encountered by Ohio farmers.

Research is conducted by 13 departments on more than 6000 acres at Center headquarters in Wooster, nine branches, and The Ohio State University.

Center Headquarters, Wooster, Wayne County: 1918 acres
Eastern Ohio Resource Development Center, Caldwell, Noble County: 2053 acres
Mahoning County Experiment Farm, Canfield: 275 acres

Muck Crops Branch, Willard, Huron County: 15 acres
North Central Branch, Vickery, Erie County: 335 acres
Northwestern Branch, Hoytville, Wood County: 247 acres
Southeastern Branch, Carpenter, Meigs County: 390 acres
Southern Branch, Ripley, Brown County: 275 acres
Vegetable Crops Branch, Marietta, Washington County: 20 acres
Western Branch, South Charleston, Clark County: 428 acres