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BLUEGRASS VARIETIES

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Changes are taking place in bluegrass varieties. Several new varieties are or soon will be on the market. Some of these have been tested in Ohio by the Ohio Agricultural Research and Development Center; others have been tested in nearby states but not at the Research Center.

Among the new varieties are Kenblue, A-20, Fylking, and Pennstar. Kenblue is quite similar to Kentucky grown "common" which has been tested and shown to be an acceptable turf grass in Ohio. A-20 has proven to be a superior bluegrass in Ohio tests. It is resistant to the major diseases and produces a dense, weed-free turf. It will be marketed only as sod. Fylking, which was developed in Sweden, has not been tested by the Research Center but has performed well in nearby states. It is reported to be resistant to the major diseases and is available as seed or sod. Pennstar is a Pennsylvania release which has shown superiority in most of the bluegrass growing area of the U. S. It is resistant to stripe smut and Helminthosporium leafspot, the two most destructive diseases of bluegrass at the present time.

Among the varieties which have been available for some time, Merion, Windsor, and Prato continue to be outstanding. Unfortunately, Merion is susceptible to stripe smut and does not perform well where this disease is present. The disease causes the leaves to shred and discharge black spores. Infected plants usually do not recover. No practical control measure is available at present.

Windsor is also susceptible to stripe smut but apparently to a lesser degree than Merion. Prato is resistant to smut and its performance has been above average.

Other varieties under test include Cougar, Campus, Newport, Park, Nudwarf, Delft, and Delta. All of these have been damaged by Helminthosporium leafspot and show little if any superiority over common Kentucky bluegrass.

Many bluegrasses can be and no doubt are sold as "common" in Ohio. The best "common" for Ohio is that which is grown in Kentucky. "Common" grown on the West Coast or in Europe is frequently not adapted to Ohio conditions and types vary from one seed lot to another. It is best to insist on Kentucky grown "common" or, when available, to buy Kenblue which is a Kentucky grown variety having the same characteristics as Kentucky grown "common".

Since most varieties have weaknesses, the possibility of using blends is being investigated. A blend would contain mixtures of varieties having different strong points. Such a blend should survive many adverse conditions which might destroy a pure variety. The chief difficulty is finding suitable varieties which are compatible with
### Characteristics of Some Kentucky Bluegrass Varieties

<table>
<thead>
<tr>
<th>Variety</th>
<th>Leafspot</th>
<th>Stripe</th>
<th>Smut</th>
<th>Weed Invasion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merion</td>
<td>E</td>
<td>P</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Common (Ky. grown)</td>
<td>P</td>
<td>E</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Windsor</td>
<td>G-E</td>
<td>P</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Pennstar</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Newport</td>
<td>P-F</td>
<td>G</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Prato</td>
<td>E</td>
<td>E</td>
<td>G-E</td>
<td>G</td>
</tr>
<tr>
<td>Delta</td>
<td>P</td>
<td>E</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Park</td>
<td>P</td>
<td>E</td>
<td>P</td>
<td>F</td>
</tr>
<tr>
<td>A-20</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Cougar</td>
<td>P</td>
<td>E</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

E = Excellent, G = Good, F = Fair, P = Poor

Earlier tests have shown that some blends do not persist as blends because one of the varieties tends to dominate the mixture. This problem hopefully can be solved by blending varieties of equal vigor which are compatible.

The above table lists several bluegrass varieties and some of their characteristics. The information was collected from Research Center tests.
CONTROLLING WEEDS IN TURF

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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 2,4-D in 1 gallon of water. Use 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. They 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 "canes" 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 weed killers 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 diesel fuel or kerosene before using the cleaning solution. (Caution—diesel fuel and kerosene can be explosive.)
KNOTWEED, Downy (Polygonum aviculare), 1. entire plant; 2. seeds; 3. portion of stem and leaves; 4. single leaf; 5. distribution. Annual, reproducing by seed. Stems bluish-green, leafy, wiry, extending 4 inches to 2 feet tall from four small, matted roots. Each leaf or node covered with a thin papery sheath. Leaves bluish-green, alternate, oblong, carried on short, pointed at tip. Flowers very small, yellow or white, borne in clusters in the leaf axils. Seeds small, slender, reddish-brown, triangular. Found in beds, swamps, low places, and along roadsides or paths.

GREAT KNOTWEED (Polygonum arvense), 4. branch of plant; 7. portion of stem and leaf; 8. leaf; 9. stems. Annual, reproducing by seed. Stems erect, 8 inches to 2 feet high, branched near top, smooth, yellowish-green, slightly rigid. Leaves light green, oval, alternate, 1 by 1 inch long, sometimes covered with mildew. Flowers and seed similar to those above. Found in same areas as knotweed.

COMMON CROWWEED (Glechoma hederacea), 1. plant in flower; 2. flower; 3. seed pod; 4. seed. Winter annual or perennial, reproducing by seed and creeping stolons rooting at the nodes. Root system fibrous, shallow. Stems much branched, creeping or ascending, growing to 2 feet high. Leaves small, opposite, simple, broad, ovate, pointed at the tip, smooth; petals have a line of hairs on each side. Flowers small, white, with 5 deeply notched petals. Seed pod cylindrical, breaking into 5 segments at maturity, containing many seeds. Seed small, dull reddish-brown, somewhat heart-shaped but nearly round, strengthened by curved rows of minute tubercules. Found in lawns, gardens, fields, strawberry beds, nurseries.

GROUND IVY, Creeping Charlie (Glechoma hederacea), 1. vegetative growth of stems and leaves; 2. flower section; 3. seeds. Perennial, with slender roots, spreading by rhizomes and creeping stems. Stems 15 to 30 inches long, prostrate, 4-sided, rooting at the nodes. Leaves almost stemless or kidney-shaped, with smooth edges, green, 1/4 to 1 inch wide in diameter, hairy, opposite, borne on long petioles, with a milky odor. Flowers small, bluish-purple, funnel-shaped, bearing 8-stamened, borne in small clusters in the axils of the leaves. Seeds rough, dark brown, in groups of 4, flat on 2 sides and round on the third side, with a white scar at the tip. Found in lawns, orchards, and waste places, especially shady areas with damp rich soil.

RED SORREL, Sheep sorrel (Rumex acetosella), 1. young plant; 2. seeds; 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 tip. Several stems may arise from a crown. Leaves are arrow-shaped, 1 to 2 inches long, thick, smooth, held to the stem. Early growth consists of a rosette of basal leaves. Flowers yellow to red, borne on a stem near the top of the plant. Male and female flowers borne on different plants. Seeds 3-sided, reddish-brown, shiny. Hull reddish-brown, rough, often adhering to the seed. Found mainly in pastures and meadows, sometimes in lawns. Tolerant of areas of poor drainage, low fertility, and little competition.
**Nimblewill** *(Distichlis spicata)*: 1. plant showing rooting at lower nodes; 2. spikelet. Perennial, reproducing by seed and numerous fine stolons. Stems not hairy, very slender, spreading, branching, decumbent at base and rooting at lower nodes, forming dense patches 1 foot or more in diameter from a single plant. Leaf blades flat, slender (1/2 to 1 inch), not hairy except for occasional marginal hairs at the base; ligules short, membranous; collars not hairy, leaf sheaths loose, not hairy, inferior ovary 3 to 6 slender panicules, 2 to 6 inches long, appearing in September. Seeds very small, about size of a mustard. Found generally in lawns, dense rows, and unsown cultivated areas. Often confused with cranesgrass and Bernarda grass in lawns.

**Large Crabgrass** *(Digitaria sanguinalis)*: 1. plant; 2. section of spike showing spikelets; 3. seed; 4. distribution. Annual, reproducing by seed. Stems stout, smooth, up to 3 feet long; when growing, rooting at the joints. Leaf blades usually at least somewhat hairy, 4 to 14 inches long; leaf sheaths, especially the lower ones, densely long-haired. Inflorescence has 3 to 10 segments, in whorls at top of stem (finger grass arrangement); 6 to 9.5 inches long, chartreuse on the branches of the inflorescence. Found in lawns, gardens, and fields. The most serious lawn weed in the southern part of the region. Bursa late, when ground is quite warm; grows well under dry, hot conditions; flowers August-September.

**Small Crabgrass** *(Digitaria ischaemum)*: 1. distribution. Similar to above but not as coarse or tall, without hairs, more purplish or bluish. Found in same places as large crabgrass, but most commonly in lawns.

**Quackgrass** *(Agropyron repens)*: 1. spikelet; 2. stems, leaves, and inflorescence; 3. starchy and ligule; 4. seed; 5. spikelet; 6. buds on node; 7. new shoots; 8. origin of new shoots; 9. roots and rootlets. Perennial, reproducing by seed and underground rootstocks. Rootstocks vary from 2 to 6 inches in depth, depending on soil type and soil treatment. Individual rootstocks live only two summers and one winter but new ones develop from buds in the aulds of reduced leaves. Roots arise only at nodes. Stems 15 to 3 feet tall, with smooth collars and 3 to 6 points. Leaves have starchy ligule 1/4 inch long, hairy lower sheaths, upper sheaths glabrous or nearly so. Spikelet has 3 to 7 short-exposed florets in a spikelet. Found in open areas, plains, pastures, and more cropped areas. It escapes special control methods because of its weedy habits. Although it is considered a primary nuisance 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 and with fertilizer. 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. Dicamba can also be used on bentgrass.

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, Betasan, 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 diphenetrile 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.
## Some Common Lawn Weeds and Chemical Control

<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>silver or dicamba</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>silver or dicamba</td>
<td>spring or fall</td>
<td>good</td>
</tr>
<tr>
<td>Chickweed, mouse-eat</td>
<td>perennial</td>
<td>silver or dicamba</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>silver</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>Honbit</td>
<td>annual</td>
<td>silver</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>silver</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 silver</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 silver</td>
<td>fall or spring</td>
<td>poor to fair</td>
</tr>
<tr>
<td>Speedwell, annual</td>
<td>annual</td>
<td>endothal or silver</td>
<td>spring or fall</td>
<td>fair to good</td>
</tr>
<tr>
<td>Spurge, spotted</td>
<td>annual</td>
<td>silver</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>silver or dicamba</td>
<td>spring, summer or fall</td>
<td>good</td>
</tr>
<tr>
<td>Wood sorrel</td>
<td>annual</td>
<td>silver</td>
<td>spring</td>
<td>fair to good</td>
</tr>
<tr>
<td>Yarrow</td>
<td>perennial</td>
<td>silver</td>
<td>spring</td>
<td>fair</td>
</tr>
</tbody>
</table>
Tall fescue, velvetgrass, orchardgrass, quackgrass, and other undesirable perennial grasses are often found in lawns. In lawns with sparse infestations, where these perennials are in scattered clumps, the best solution is to remove each clump with a spade and replace it with a similar amount of desirable sod taken from a less noticeable place in the lawn. An alternative procedure would be to fill the dug-out area with soil and then seed a desired turf species. In lawns with heavier infestations where hand removal of the clumps is not practical or where the undesirable perennial grass is not in definite clumps (usually the case with quackgrass), a complete renovation may be the only solution.

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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GROUND COVER PLANTS OFFER MANY ADVANTAGES

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Low growing "ground cover" plants, used in place of grass or surfacing materials, are valuable assets to good landscape design and will reduce maintenance. Many areas of the landscape can be made more attractive by use of these plants which offer variations in color, texture, and seasonal effect. The functional aspect is probably more important since ground covers are effective in reducing lawn maintenance when used against buildings or fences, around tree trunks, and between shrubs where grass would be difficult to maintain in a desirable manner. They also make a good grass substitute in problem areas such as on steep slopes, over rough ground, in heavy shade, or in dry locations. Weeds are virtually eliminated after the plants have formed a solid cover.

Plants should be spaced 6 to 18 inches apart, depending on the rate of spread. For most types, planting on 8 to 12-inch centers in the bed should result in complete coverage by the second season after planting. Good, well drained soil is desirable, particularly when broadleaf evergreen forms are planted. In most situations, the planting area should be prepared by incorporating 1 to 2 inches of peat moss or similar organic matter with the soil.

If sod is present, it should be removed to prevent excessive grass growth in the ground cover beds since this is difficult to eliminate. Competition from weeds can be further reduced by treating the soil with a chemical sterilant or recommended herbicide prior to planting. Mulching after planting is recommended to reduce water loss, reduce erosion on slopes, and enhance the spread of the plants.

Once established, ground cover plants require relatively little care except the annual addition of a complete fertilizer and an occasional mulching with an organic material. In contrast to grass, ground cover plants should not be used in traffic areas.

From the standpoint of landscape design and aesthetics, ground cover planting add low horizontal lines, help tie the entire planting together, and give a finished appearance to the area.

Ground cover plantings have been used extensively for beautification and reduced maintenance on the grounds of the Ohio Agricultural Research and Development Center. A newly established ground cover display area on the south side of Williams Road illustrates the use of several types on a slope.

The following list includes some of the recommended ground cover plants for use in Ohio.

-11-
<table>
<thead>
<tr>
<th>PLANT</th>
<th>ORNAMENTAL FEATURES</th>
<th>REMARKS</th>
</tr>
</thead>
</table>
| Cotoneaster adpressa 'Praecox'  
Early Cotoneaster | Glossy green leaves, red autumn fruit | Dense habit with attractive winter character. C. spiculate also effective. |
| Hypericum patulum henryi  
Henry St. Johnswort | Yellow flowers, summer | Ascending branches. Edging hedge or ground cover. |
| Lonicera japonica halliana  
Hall's Japanese Honeysuckle | Semi-evergreen | Rank, may become pest. Use on steep slopes or rough areas. |
| Rosa wichuriana  
Wichura Rose | White flowers, June-July | Dense cover, sun. May have winter damage. |

**NARROWLEAF EVERGREENS**

<table>
<thead>
<tr>
<th>PLANT</th>
<th>ORNAMENTAL FEATURES</th>
<th>REMARKS</th>
</tr>
</thead>
</table>
| Juniperus chinensis sargentii  
Sargent Juniper | Blue-green foliage | Best low Juniper, mounded in center. Dry site. |
| Juniperus horizontalis cultivars  
Creeping Juniper | Pine texture, blue to gray foliage | Many forms, all subject to Juniper blight. Best in sunny exposure, can be used on dry site. |

**BROADLEAF EVERGREENS**

<table>
<thead>
<tr>
<th>PLANT</th>
<th>ORNAMENTAL FEATURES</th>
<th>REMARKS</th>
</tr>
</thead>
</table>
| Euonymus fortunei  
Wintercreeper Euonymus | Green foliage | Moderate growth with small leaves. Sun or shade. |
| Euonymus fortunei 'Coloratus'  
Purple Wintercreeper Euonymus | Purple in winter | Rank growth with larger leaves. Use for covering large areas. Sun or shade. Subject to scale. |
| Hedera helix cultivars  
English Ivy | Green foliage | Use only hardy recommended types—Wilson and Thorndale best. Plant on north or east side, out of winter sun. |
| Hypericum calycinum  
Aarosbeard St. Johnswort | Yellow flowers, summer | Semi-evergreen, gray-green foliage, upright branches. |
| Liriope graminifolia  
Lily Turf | Grass-like leaf | Provides variation in texture. Flowers purple but not outstanding (Kondo similar). |
| Pachystima canbyi  
Canby Pachystima | Fine texture | Plant in well drained, moist, acid soil. |
| Pachysandra terminalis  
Japanese Pachysandra | Shiny, leathery leaves | Upright branches. Plant in shade in good moist soil. Subject to scale. |
| Vinca minor  
Periwinkle or Myrtle | Glossy dark green leaves, blue flowers | Native and excellent for sun or shade. Bowles form is superior. |
| Teucrium chamaedrys  
Chamaedrys Germander | Blue-green foliage | Good low edging plant. |
<table>
<thead>
<tr>
<th>PLANT</th>
<th>ORNAMENTAL FEATURES</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PERENNIALS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ajuga reptans</td>
<td>Dark green leaves, blue flowers, May-June</td>
<td>Very low. May get out of bounds. Bronze leaved form also.</td>
</tr>
<tr>
<td>Carpet Bugle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arabia procurrens</td>
<td>White flowers in April-May</td>
<td>Low evergreen. Best in sun.</td>
</tr>
<tr>
<td>Rockcress</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceratostigma plumbaginoides</td>
<td>Blue flowers in late summer</td>
<td>Sun or shade in average soil. Rank.</td>
</tr>
<tr>
<td>Blue Leadwort</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convallaria majalis</td>
<td>White flowers in May</td>
<td>Good for shade.</td>
</tr>
<tr>
<td>Lily of the Valley</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronilla</td>
<td>Purplish pink flowers in summer</td>
<td>Slow to establish. Use on banks and in large areas.</td>
</tr>
<tr>
<td>Crownvetch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epimedium species</td>
<td>Flowers in April</td>
<td>Best in partial shade. White, red, yellow flowering cultivars.</td>
</tr>
<tr>
<td>Epimedium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phlox subulata</td>
<td>Fine texture, blue, pink or white flowers in May</td>
<td>Moist or dry areas and sun exposure.</td>
</tr>
<tr>
<td>Moss Pink</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedum species</td>
<td>Yellow, red, pink flowers. Green to gray foliage</td>
<td>Sun or shade but more flowers in sun. Good in dry areas.</td>
</tr>
<tr>
<td>Sedum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thymus serpyllum</td>
<td>White, purple flowers in June and July.</td>
<td>Low mat-like growth.</td>
</tr>
<tr>
<td>Thyme</td>
<td>Gray-green leaves</td>
<td></td>
</tr>
</tbody>
</table>

DWARFING METHODS USED FOR BONSAI TREES

Makoto Kawase

Department of Horticulture

Ohio Agricultural Research and Development Center

Bonsai, a method of producing artificially dwarfed trees in pots, has been increasing in popularity in the United States. At present there are more than 23 Bonsai clubs throughout the country, including at least one in Ohio.

Bonsai started in China and was introduced into Japan sometime before the beginning of the 12th century where it was developed as an art. Bonsai became popular among all classes of Japanese society since the middle of the 17th century.

Bonsai is an art creating a miniature form of a majestic old tree. It is more greatly appreciated when it represents an advanced age of the tree. The age must be expressed in an aesthetic sense to enable man to visualize a tree standing in nature. It should have a beautiful shape, an attractive trunk texture, a graceful balance among branches, fresh green leaves, autumn tints, colorful flowers and fruits, or sensible balance of color and size between the plant and the pot.

The idea that a Bonsai tree is a small, sick plant is a misconception. Bonsai is a healthy plant. One plant of Eddo Spruce Bonsai is believed to be 700 years old and it still receives admiration for its magnificent beauty and health. Except for size, a Bonsai tree is healthy enough to undergo the same stages and phases of growth and development as naturally growing trees.

There is an interesting correlation between dwarfing and maturation of a tree. Bonsaimen use many means to dwarf trees such as using small pots, pinching young shoots, pruning branches, and coiling branches with wires. Such dwarfing methods drastically restrain the vegetative growth of trees and this in turn shifts the physiological age of trees towards maturation. Thus, Bonsai dwarfing methods achieve aging and dwarfing of trees at the same time.

Most Bonsai plants are raised in small, shallow, clay or glazed pots. The amount of soil from which plants obtain mineral nutrition and water is limited by such small containers, thus affecting development of the root system and plant growth. Nutrient application is regulated for controlled growth. Rich chemical fertilizers induce too vigorous shoot growth which may destroy the already established tree shape or cause burning or killing of the plant. Only slow working, organic fertilizers are recommended. One which is widely used is rape cake, the residual material after oil is extracted from rape seeds. A diluted liquid formulation obtained from the fermentation of rape cake is preferred.

To support a plant with a limited root system, every inch of root must function well. The use of porous soil of good drainage is one of the important requirements to stimulate root activity. This kind of medium tends to hold less water and minerals. The success in Bonsai
culture is accomplished by frequent applications of water and nutrients. Failure to water for a few days may cause serious damage to the Bonsai plant.

Ratio of top growth to root growth (T/R) depends on each species. When the normal T/R ratio is extremely altered, survival of the tree is uncertain. To maintain the health of the tree, the T/R ratio must be maintained as closely as possible to the natural T/R ratio. When root growth is limited by the methods described above, top growth must also be controlled to approximately the same extent.

Top growth is controlled by elimination of part of a branch or the entire branch and also by a coiling of branches with wires. Because the top is the only visible part of a Bonsai tree, every operation must be exercised artistically. Eventual goal is to induce the dwarf form by reduction of branches and leaves while establishing the desired shape.

One of the most important points is the elimination of apical dominance. When a Bonsai tree is left unpruned, terminal shoot growth sustains the growth of lower branches, causing a leggy appearance. Younger shoot tips should be removed early in the growing season to force development of lower side branches. Pinching of young shoots may have to be exercised more than once for such vigorous trees as Sargent Juniper and Zelkova. The adventitious shoot which often stands up from the main trunk must be removed as soon as it appears unless it is to be used for the replacement of an old branch or for formation of a new feature of the tree.

In vigorous trees like Japanese maple, Pomegranate, and Zelkova, leaves sometimes are pinched off in July. Such treatment causes development of new shoots from buds which normally develop the following spring. This results in formation of denser small branches characteristic of the old tree and also in shortening the time required for maturation. If necessary, drastic pruning, such as removal of big branches, is done during the dormant season.

One of the most interesting techniques used in Bonsai is coiling branches by wire. This was invented early in this century by a Japanese Bonsaiman and has become the most effective Bonsai method. Copper wire is used to coil and bend branches in the desired shape. The coil must be just strong enough to hold the branches in the shape. Coiling should be done in the early part of the growing season and should not be too tight or too loose. As soon as the plant is able to hold the shape without the coil, the wire must be removed. Time required for coiling varies from a few months to several years. Conifers are most resistant to coiling, often requiring several years to achieve the desired shape. Care must be taken when bending the branches. Some trees, such as Eddo spruce and Kurume azalea, are easily damaged during manipulation.

Best use of coiling is for the main trunk. Growth of the trunk tends to be too vigorous. If coiling is done when the tree is relatively young, the main trunk can be bent at any angle. When branches are bent or slanted from the straight upright position, the growth is retarded.
Disturbance of translocation in vascular bundles is one of the reasons for growth retardation. Coiling of a branch also slows down the movement of photosynthates in phloem by mechanically pressing the phloem. In extreme cases, such an operation may kill the plant. However, coiling is generally safe to use on trees which are healthy and vigorous.

Coiling is a simple and effective method to establish a desired shape of the tree and also to dwarf it.

**KINDS OF PLANTS USED FOR BONSAI**

**Evergreen Conifers**

- Cedrus atlantica (Atlas cedar)
- Chamaecyparis obtusa (Hinoki cypress)
- C. pisifera (Sawara cypress)
- Cryptomeria japonica (Cryptomeria)
- Juniperus chinensis Sargentii (Sargent juniper)
- J. horizontalis 'Bar Harbor'
- J. rigida (Needle juniper)
- J. squamata prostrata (Prostrate juniper)
- Picea abies Maxwellii (Dwarf Norway spruce)
- P. glauca conica (Dwarf white spruce)
- P. jezoensis (Yeddo spruce)
- Pinus densiflora (Japanese red pine)
- P. parviflora pentaphylla (Japanese white pine)
- P. Thunbergii (Japanese black pine)
- Taxus cuspidata (Japanese yew)
- Tsuga Sieboldii

**Broadleaf Evergreens**

- Buxus microphylla compacta (Kingsville dwarf box)
- Ilex crenata Helleri (Heller Japanese holly)
- I. crenata microphylla (Little-leaf Japanese holly)
- Pieris japonica (Japanese andromeda)
- Rhododendron racemosum (Mayflower rhododendron)

**Flowering Type**

- Chaenomeles lagenaria (Flowering quince)
- Malus micromalus (Midget crabapple)
- Punica Granatum (Pomegranate)
- Prunus donarium
- P. incisa
- P. Mume (Japanese apricot)
- Rhododendron obtusum (Kurume azalea)

**Fruiting Type**

- Akebia trifoliata (Akebia)
- Carpinus carpinoides
- Chaenomeles sinensis
- Crataegus cuneata
Diospyros Kaki (Persimmon)
Elaeagnus multiflora
E. umbellata
Euonymus alata (Winged spindle tree)
E. Sieboldiana
E. oxyphylla
Fortunella japonica (Kumquat)
Ginkgo biloba (Ginkgo)
Ilex serrata
Kadsura japonica (Scarlet kadsura)
Lonicera gracilipes (Spangle honeysuckle)
L. Morrowii (Morrow honeysuckle)
Lycium chinense (Chinese Matrimony-vine)
Malus pumila (Apple)
Punica granatum (Pomegranate)
Pyracantha coccinea (Scarlet firethorn)
Ficus Simonii (Japanese pear)
Stauntonia hexaphylla

Miscellaneous

Acer palmatum (Japanese maple)
Carpinus laxiflora
Fagus crenata
Parthenocissus tricuspidata (Boston ivy)
Rhus sylyvestris
Salix spp. (Willow)
Zelkova serrata (Japanese zelkova)

REFERENCES


Several new plant growth regulators both of endogenous and synthetic origin have been discovered recently. These substances, when applied to plants, have exhibited such interesting and varied properties as accelerating, retarding, inhibiting, or selectively killing vegetative growth. In addition, they have been found to induce or inhibit flower bud initiation and to increase or decrease fruit formation.

Plant growth regulators are active in minute concentrations, making the timing and concentration of treatment a critical factor. Since these substances are largely untested on woody plants, preliminary tests have been conducted to evaluate old and new plant growth regulators for potential commercial application.

Research is underway in several areas. One study involves the use of herbicides on container-grown plant material. In this study, the following plants were used: Rhododendron, Pieris, Weigela, Pachysandra, Juniper, Cotoneaster, Taxus, and Viburnum. The plants were placed in 1-gallon containers containing an unsterilized 1-soil, 2-peat, 2-perlite soil medium to assure ample weed development. The following herbicides were applied to the plants 1 week after planting: Dymid (120 lb./A.), Treflan (20 lb./A.), Simazine (75 lb./A.), Casoron (150 lb./A.), and a new cellulose based pad with 150 lb./A. Casoron impregnated in it. The pad is a new product and is designed in two sizes to fit exactly either 1 or 2-gallon containers.

Results 1 month after treatment indicated that Simazine and the Casoron pad provided excellent weed control with no apparent plant damage. Dymid was a close second in effectiveness, providing very good weed control.

The Casoron pad is of special interest because of its ease of application and excellent safety factor. It is simply placed around a plant, with no measuring, no distribution problems, no calculating, and thus no means for potential error. Even an untrained worker can apply an herbicide at exactly the right rate to thousands of containers per day. Research is continuing to determine any possible toxicity symptoms which may arise from this revolutionary means of herbicide application.

The problem of adequate flower bud initiation on Rhododendron is also being investigated. The variety being tested is Rhododendron roseum 'Eleagans', which usually does not produce profuse flower buds until the fourth season after propagation. Plants 2 and 3 years old which ordinarily would not flower heavily were treated with the growth retardant Phosfon at several concentrations. The treatments were applied to the soil at the time of planting the Rhododendrons in either 1 or 2-gallon containers. The ease of the one step operation of
transplanting and treating the plants to induce flowering makes this type of operation economically desirable. Results will not be available until the fall of 1968.

The problem of how to develop well-branched compact plants without bearing the cost of excessive pruning was reported by several nurserymen. Two plants were used in this study—1-year liners of Rhododendron roseum 'Elegans' and Ilex opaca, both of which require considerable pruning to develop into compact plants. Two different types of chemical were applied to the new growth of both plant species when it was about 2 inches long. One chemical was Off-Shoot-0, a chemical pruning agent. It selectively kills just the terminal apex of stems, allowing the lateral branches to develop. Results on Rhododendron have been excellent at several concentrations but results on Ilex have been poor. Perhaps the thick cuticle on the leaf of Ilex prevented absorption of the Off-Shoot-0 or the timing of the spray application was wrong. Ilex plants will be treated again this year to investigate this problem further.

A second type of chemical applied to Rhododendron and Ilex was a class of three compounds known as "morphactins." These substances, produced in Germany, overcome apical dominance and promote lateral branching without killing any plant tissue. In the case of morphactins results have been excellent on Ilex and quite poor on Rhododendron. On Ilex, a particular morphactin has induced many lateral buds to develop, resulting in potentially very compact plants. Rhododendron so far shows moderate to severe leaf curl at all morphactin concentrations tested. However, effects on branching may not become apparent until flushes of growth occur later in the season.

Morphactins have been reported to severely retard terminal growth of plants at high concentrations (about 1,000 ppm). Forsythia and honeysuckle have been treated with high concentrations and results look very encouraging for future study. Commercial application might be possible for utility companies wanting to retard tree growth after pruning operations.

A new compound with considerable promise is one called Amchem 66-329. At low concentrations it is reported to increase rooting of woody plants if it is sprayed on plants 1 week prior to the time cuttings are to be taken. Investigations of this aspect are underway.

Amchem 66-329, used at higher concentrations, also is an excellent defoliant. The following actively growing plants have been defoliated in the time indicated: Privet (3 days), Rose (5 days), Cotoneaster (5 days), Bittersweet (5 days), Tall Hedge Buckthorn (5 days), Maple (7 days), and Elm (6 days). This material will be tested on shade trees in the fall of 1968 in an attempt to facilitate digging operations.

Pruning is an annual maintenance requirement for most plants in the landscape except trees. Plants are abused by improper pruning and this results in more maintenance rather than less. The proper selection of the right plant for height and spread at maturity would eliminate much of the need for pruning.

There are many examples where the wrong plant is used and excessive pruning is required to keep the plant within bounds. Maintenance is a never ending job. Without maintenance, everything built soon deteriorates. The same applies to landscape plantings. It would be well for the maintenance requirements to be included in a landscape design or plan. By this method, the idea of the landscape designer can be kept intact.

Proper methods of pruning reduce work, keep the plant within bounds, and lengthen the useful life of the plant. The objective in pruning established or recently planted evergreens and shrubs in the landscape is the gradual renewal method of pruning.

By gradual renewal pruning, considerable growth can be removed to reduce height and spread of an older plant without changing the plant's appearance. A plant continues to grow each year from the ends of branches, as do most evergreens and trees, or from new shoots which arise from the base of the plant, as is true of many woody shrubs. The plant's habit of growth provides a clue 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 by shearing. By thinning out, short individual branches are cut completely off the branch from where they begin to grow or are cut to a lateral or side branch. Plant growth continues in the lateral stem from which the branch was removed.

Ornamental plants for landscape design are selected for their particular growth habit and branching characteristic. Incorrect pruning methods such as heading back or shearing cut off and remove these branching characteristics. In shearing, a stem is cut back anywhere along the length of the branch. The cut may be above or below a bud but more often a stub is left. The effect of pruning by shearing with hedge shears is to concentrate vigorous new growth of stems below the cut. The resulting growth is often quite upright, unnatural, or flat with a candelabra-like appearance.

The basic difference between the two types of pruning is that in thinning out, new growth continues in the lateral or stem from which the branch was removed. In heading back or shearing, the new growth begins to grow from a number of dormant lateral buds which suddenly start to grow directly below the cut.
In most woody plants, the terminal bud inhibits the growth of lateral buds because of a concentration of growth regulators in the terminal bud. When the terminal bud is cut off as in shearing, this inhibiting effect is lost and buds directly below the cut begin to grow. This effect occurs more in some species than others and in woody plants which form true terminal buds.

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

Deciduous shrubs can be pruned by thinning out and removing up to one-third of the older stems at the base of the plant. Exceptions would be budded or grafted plants such as hybrid lilac. The upright narrow-leaved evergreens can be pruned by thinning out and elimination of multiple stems. Spreading evergreens can be pruned to form a shingled effect from top to bottom where the top is narrower than the base by the thinning out method.

Plant pruning is often called an art. Certain basic pruning principles are important to know. Pruning can best be learned by actual experience and observation of the plant's response to pruning.

TIP PRUNING OF ORNAMENTAL PLANTS

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It may soon be possible for the homeowner to tip prune or "pinch" the stem tips of outdoor chrysanthemums, azaleas, rhododendrons, taxus, pyracanthas, and cotoneasters with chemical sprays from an aerosol can. The resulting plants would be bushier and, in the case of chrysanthemums, have more flowers.

Even now, under exact experimental conditions, it is possible to obtain more flowers per plant by chemical pinching than by hand pinching (Table 1 and Figure 1). Year-round tests from January 1967-January 1968 have confirmed this trend.

The concentration of these chemicals, methyl esters of fatty acids of 6 to 12 carbons chain length, together with a spreader-sticker, is still too exact for usage by the homeowner on chrysanthemums. Research is underway to develop chemicals with a greater margin of application error.

Results on many azalea cultivars have been extremely promising (Figure 2). Nurseries in the southern states as well as in Ohio are using these chemical pruning agents with azaleas on a trial basis and reporting desirable results. Commercial application with other nursery crops will necessitate further research. Chemicals will have to be specifically formulated for taxus, pyracanthas, and cotoneasters which will be capable of penetrating the thicker, waxy cuticle layers of these types of plants.

There is a possibility of saving time and labor by spraying large numbers of plants in a short time with these compounds.

TABLE 1.—Golden Yellow Princess Ann pot chrysanthemums planted Jan. 15, 1968 and chemically pruned Jan. 29, 1968. There were 45 plants per treatment.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Flowers/Pot*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual Pinch</td>
<td>27.5 a</td>
</tr>
<tr>
<td>Procter and Gamble No. 2, 2.5%</td>
<td>31.8 b</td>
</tr>
<tr>
<td>Emery 2%</td>
<td>32.5 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.
Fig. 1.—Golden Yellow Princess Anne pot chrysanthemums. The plant on the left was sprayed with Procter and Gamble No. 2 at 2.5%, the plant in the middle was manually pruned, and the plant on the right was sprayed with Emery at 2.0%.

Fig. 2.—Valentine azaleas which, after rooting of the cuttings, were chemically pruned four times. A. Emery 3%; B. Procter and Gamble No. 2, 3%; C. Emery 5%; D. Procter and Gamble No. 2, 5%.

Weeds in the nursery reduce crop growth by competing for light, moisture, and nutrient elements. In addition, weeds harbor insects, diseases, and viruses and, in the dormant stage, present a fire hazard.

The usual method of weed control by cultivation and hoeing several times a year is expensive, with costs ranging from $100 to $600 per acre annually. Careless hoeing or cultivating can result in considerable damage to roots. Significant numbers of nursery trees and shrubs are injured or killed each year when equipment debarks, runs over, or uproots plants, particularly at the ends of rows.

Chemical herbicides have the capability of nearly eliminating most weeds in nursery areas for extended periods of time and reducing the cost of weed control and root and mechanical damage. Misuse of chemicals by the operator, however, can lead to problems. Sound judgement must be exercised during calculation, distribution, and cultivation practices.

The results of research in field plots in nurseries throughout Ohio during the spring and summer of 1968 have indicated that several chemicals perform consistently well when used at rates suggested by the manufacturers.

Excellent weed control was achieved for several months with the use of granular Casoron (6 lb. active ingredient per acre—a.i.a.) and granular Simazine (3 lb. a.i.a.). The combination of wettable Simazine (1 lb. a.i.a.) and wettable Enide (4 lb. a.i.a.) eliminated weeds in a very satisfactory manner in most cases, although not as consistently as Casoron or Simazine. The advantages of using the combination are less chance of soil residue buildup, possibly a wider spectrum of weeds controlled, and less toxicity to Simazine-susceptible crops.

Satisfactory weed control was obtained with granular Treflan (1 lb. a.i.a.) incorporated, wettable Enide (8 lb. a.i.a.), and granular Dymid (6 lb. a.i.a.).

Poor results were achieved with granular Treflan (4 lb. a.i.a.) applied to the soil surface and not incorporated.

In a limited trial, Herban (5 lb. a.i.a.) yielded very satisfactory weed control. The length of time Herban effectively controls weeds is unknown at present.

For periods of 1 or 2 months, the treatments of granular Treflan (1 lb. a.i.a.) incorporated and wettable Enide (8 lb. a.i.a.) are equally effective. In these studies, the above herbicides lost effectiveness after 2 months.
Most annual weeds were controlled with the majority of herbicide tested; the perennial weeds, in most cases, were not. Gasoron was more effective than the other herbicides against perennial weeds including Canada thistle, bindweed, and quackgrass. Nutgrass, prevalent this year, was not effectively suppressed by the herbicides used in these studies.

Suggested autumn treatments to control weeds from now through next spring are: 1) on newly planted liners--A) Treflan incorporated prior to planting. Treflan is recommended due to its safety factor on young plants. 2) On established plants, A) Gasoron, B) Simazine, C) Simazine and Enide in combination, and D) Enide or Dymid.

None of the above herbicides can be safely used on all plants. Therefore, refer to the label for crop tolerances.

Some herbicides, as indicated on the labels, are more effective if incorporated or irrigated into the soil, depending on soil temperature and moisture conditions. Sprayers and distributors must be accurately calibrated prior to application.

The success of pre-emergence weed control in the nursery depends on the efficiency of the operator because the chemicals have been found to be effective if applied properly.


-26-
Conifers commonly used in ornamental plantings are sometimes injured by insects or mites. Recent work in Ohio has shown that materials are available to control many of these pests. Selected examples of this work are presented here, along with some notes on the biology and habits of each pest.

**Gooley Spruce Gall Aphid on Douglas Fir**

This aphid does not cause gall formations on Douglas fir as it does on Colorado blue spruce. Instead, the aphids are found on the foliage where their feeding causes the needles to be deformed and restricts the growth of new shoots. Infestations are usually detected when the masses of white cottony wax produced by mature females are observed on the needles. These cottony masses appear in early May and again in late June.

Under this protective cover, each female lays a group of eggs over a period of several days. It is common to find a mature female, eggs, and newly hatched nymphs under one mass. Needles which are attacked become crooked or twisted and develop chlorotic spots.

The results of some insecticide trials are shown in Table 1.

**TABLE 1.--Evaluation of Materials for Control of Gooley Spruce Gall Aphid on Douglas Fir.**

<table>
<thead>
<tr>
<th>Material</th>
<th>Rate Lb. Act./100 Gal.</th>
<th>Date Treated</th>
<th>Date Evaluated</th>
<th>Percent Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jygon 2E</td>
<td>.5</td>
<td>5/8</td>
<td>5/15</td>
<td>0</td>
</tr>
<tr>
<td>Meta-Systox-R</td>
<td>.25</td>
<td>5/8</td>
<td>5/15</td>
<td>31</td>
</tr>
<tr>
<td>Malathion</td>
<td>1.0</td>
<td>5/8</td>
<td>5/15</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/22</td>
<td>5/24</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/22</td>
<td>7/1</td>
<td>0</td>
</tr>
<tr>
<td>Sevin</td>
<td>1.0</td>
<td>5/8</td>
<td>5/15</td>
<td>0</td>
</tr>
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<td></td>
<td></td>
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<td>5/24</td>
<td>75</td>
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<td>7/1</td>
<td>90</td>
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<td></td>
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<td>6/20</td>
<td>6/27</td>
<td>100</td>
</tr>
<tr>
<td>Lindane</td>
<td>.5</td>
<td>5/8</td>
<td>5/15</td>
<td>0</td>
</tr>
<tr>
<td>Parathion</td>
<td>.5</td>
<td>6/20</td>
<td>6/27</td>
<td>44</td>
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</tbody>
</table>
Evidently the only material which can be relied upon to provide control of Cooley spruce gall aphid on Douglas fir is Sevin. These tests also suggest that later applications are more effective than early ones. However, the late treatment date will allow some damage to the first needles formed in the spring.

**Pine Needle Scale on Norway Spruce**

Heavy infestations of this pest cause plants to appear as if splashed with whitewash. As a result of the scales' feeding, needles turn yellow and drop prematurely. Young trees and limbs of larger trees can be killed back.

The usual practice in attempting control is to treat when the immature scales are present in late May. When this optimum period has passed, the scales are harder to control.

The data in Table 2 are from a trial designed to evaluate materials for effectiveness in controlling the overwintering scales. Treatments were applied Nov. 22.

These data show that the population of adult females was reduced substantially by Meta-Systox-R and by ethion and oil and that eggs survived on all trees. Immatures failed to become established on trees treated with Meta-Systox-R, oil, or oil plus ethion. Evidently a dormant application of any of these materials will give satisfactory control of pine needle scale on spruce.

**Grape Mealybug on Taxus (Yew)**

Taxus plants which are not healthy may, upon inspection, prove to be infested with this insect. This is another sucking insect which causes generally poor vigor in infested plants. If it is present, one can find white cottony material in the interior of the plant during summer and masses consisting of dead needles and white cottony wax during the dormant season.

| TABLE 2.—Evaluation of Materials for Control of Overwintering Pine Needle Scale on Norway Spruce. |
|----------------------------------------------------------|-----------------|-------------|-------------|
| **Material** | **Rate** | **Percent Reduction** | | | |
| | **Formulation/ 100 Gal.** | **12/6** | **2/19** | **6/6** |
| | | **Adults** | **Eggs** | **Immatures** |
| Cygon 2E | 1 quart | 54 | 33 | 25 |
| 70 sec. oil | 2 gal. | 56 | 83 | 100 |
| Meta-Systox-R 2 EC | 1 quart | 80 | 42 | 100 |
| Ethion + oil (.15, 70 sec.) | 2 gal. | 97 | 42 | 100 |

-28-
TABLE 3.--Evaluation of Materials for Control of Grape Mealybug on Taxus.

<table>
<thead>
<tr>
<th>Material</th>
<th>Rate Act. Lb./ 100 Gal.</th>
<th>Percent Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malathion</td>
<td>1.0</td>
<td>100</td>
</tr>
<tr>
<td>Sevin</td>
<td>1.0</td>
<td>100</td>
</tr>
<tr>
<td>Diazinon</td>
<td>.5</td>
<td>90</td>
</tr>
<tr>
<td>Lindane</td>
<td>.5</td>
<td>71</td>
</tr>
<tr>
<td>Ethion + oil</td>
<td>.5 (ethion)</td>
<td>97</td>
</tr>
<tr>
<td>Cygon 2E</td>
<td>.5</td>
<td>98</td>
</tr>
<tr>
<td>Meta-Systox-R</td>
<td>.5</td>
<td>76</td>
</tr>
</tbody>
</table>

Treatment is most effective when young nymphs are present. Sufficient spray mixture to wet the entire plant, especially the interior, must be applied for good results. Several materials will provide good control (Table 3).

**Tip Dwarf Mite on Arborvitae**

Much damage is done by this tiny creature but it is not generally recognized. When the new growth of arborvitae or juniper does not develop normally and the plants appear to be somewhat ragged and growth is slow, this mite may be the reason. The mites live and feed beneath the scale-like needles of these plants.

Control measures can be applied whenever the weather is warm but are most effective in early summer. Table 4 shows the results of a trial initiated Sept. 14 and evaluated Sept. 22.

**Spotted Pine Aphid on Scotch Pine**

Damage caused by this pest has been increasing in recent years. The aphids feed on 2nd and 3rd year needles, causing premature needle fall. The result can be defoliation of all except the current year's needles, causing the tree to appear thin and unattractive. Population levels of this pest are typically moderate in spring, low in summer, and high in autumn.

Table 5 shows the results of an evaluation of the effectiveness of several materials in controlling the aphid. The treatments were applied May 16 and were evaluated Sept. 19. Table 6 shows the results of another trial where treatments were applied August 21 and evaluated Sept. 20.
TABLE 4.--Evaluation of Materials for Control of Tip Dwarf Mite on Arborvitae.

<table>
<thead>
<tr>
<th>Material</th>
<th>Rate Act. Lb./100 Gal.</th>
<th>Percent Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kelthane</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>Malathion</td>
<td>1.0</td>
<td>0</td>
</tr>
<tr>
<td>Galecron</td>
<td>0.75</td>
<td>78</td>
</tr>
<tr>
<td>Meta-Systox-R</td>
<td>0.50</td>
<td>17</td>
</tr>
<tr>
<td>Morestan</td>
<td>0.50</td>
<td>83</td>
</tr>
<tr>
<td>Tedion</td>
<td>0.50</td>
<td>49</td>
</tr>
<tr>
<td>Acaralate</td>
<td>1.00</td>
<td>92</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Material</th>
<th>Rate Act. Lb./100 Gal.</th>
<th>Percent Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meta-Systox-R</td>
<td>.5</td>
<td>99</td>
</tr>
<tr>
<td>Meta-Systox-R</td>
<td>.25</td>
<td>96</td>
</tr>
<tr>
<td>Cygon 2E</td>
<td>.5</td>
<td>28</td>
</tr>
<tr>
<td>Diazinon</td>
<td>.5</td>
<td>0</td>
</tr>
<tr>
<td>Sevin</td>
<td>1.0</td>
<td>0</td>
</tr>
<tr>
<td>Malathion</td>
<td>1.0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th>Rate Act. Lb./100 Gal.</th>
<th>Percent Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meta-Systox-R</td>
<td>.5</td>
<td>100</td>
</tr>
<tr>
<td>Cygon 2E</td>
<td>.5</td>
<td>98</td>
</tr>
<tr>
<td>Meta-Systox-R</td>
<td>.25</td>
<td>96</td>
</tr>
<tr>
<td>Sevin</td>
<td>1.00</td>
<td>85</td>
</tr>
<tr>
<td>Lindane</td>
<td>1.00</td>
<td>64</td>
</tr>
<tr>
<td>Malathion</td>
<td>1.00</td>
<td>47</td>
</tr>
<tr>
<td>Diazinon</td>
<td>1.00</td>
<td>43</td>
</tr>
</tbody>
</table>

Season-long control was obtained with Meta-Systox-R applied in May. This material or Cygon will reduce the high autumn population if applied in August.

NEW FINDINGS ON THE FACTORS CONTROLLING ROOTING OF CUTTINGS

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Ohio Agricultural Research and Development Center

Centrifugation Promotes Rooting of Softwood Cuttings

When cuttings are placed in propagation media, it is believed that native hormones and root-promoting substances move down, accumulate at the basal cut ends, and then promote rooting. This downward movement of the hormones and rooting substance is called polar movement. Is there any means of enhancing this polarity to obtain better rooting? Experimental results suggest that this may be possible.

Softwood cuttings obtained from willows and some other woody species were carefully inserted in a centrifuge tube containing a little water, with the basal cut ends down. The force applied to the cuttings during the centrifugation was directed from the top to the base of the cuttings. Thus the centrifugation boosted the natural polarity. The force applied ranged from 160 to 2540 times that of gravitational force. After 1 hour of this treatment, cuttings were placed in sand in the mist-propagation frame or in water in the growth cabinets and the rootings were compared with non-centrifuged ones. The numbers of roots per cutting increased with the increase of the centrifugal force.

A major interest is to determine what kind of substance is moving downwards in the cuttings. After centrifugation, the water in the centrifuge tube was collected. This water, collected from tests with cuttings of mung bean and willow, contained a strong root-forming activity. Some kind of rooting substance must have come from the cuttings into the water during the centrifugation. The stronger rooting activity in the extract was obtained by the higher centrifugal force.

The substance is not likely any known plant hormone but has a kind of hormone-like activity. Does the existence of this substance decide whether cuttings are easy to root or hard to root? This is of keen interest. Purification of the substance is underway and the substance will be applied to various cuttings to learn whether this could induce rooting in slow-rooting cuttings. Centrifugation has been applied to many species, including easy-to-root and hard-to-root cuttings, to determine the most practical use of this method.

Etiolation and Rooting in Cuttings

Plants are commonly propagated by inserting cuttings into a rooting bed which etiolates or darkens their basal ends. Is this darkening of the cuttings important for rooting? Does the cutting ed only provide moisture and anchoring effect or perhaps something else to the cuttings? Research has been underway to find an answer to these questions.
Fig. 1.---Effect of centrifugation on rooting of willow cuttings. Cuttings were centrifuged for 1 hour with speeds of 0, 1000, 2000, and 4000 rpm or with gravitational forces of 0, 160, 640, and 2540 g.

Fig. 2.---Inhibitory effect of light on rooting of mung bean cuttings. Bases of the cuttings were etiolated for the first 0, 1, 2, 3, 4, or 10 days respectively for the treatments of 0D, 1D, 2D, 3D, 4D, and 10D. Photo was taken after 10 days.
When willow cuttings were inserted into a glass container filled with water only, seven roots appeared from the base of the cuttings. However, when the glass container, together with the basal parts of the cuttings, was covered with aluminum foil for 2 days, 11 roots were formed. Eighteen roots appeared when the covering was extended to 4 days. Etiolation therefore certainly promoted rooting of the cuttings. Similar results were obtained with many other cuttings, including those of poplar and mung bean.

According to the results of this study, the etiolation treatment had an important role in preserving plant hormone in the cuttings. The plant hormone is produced in plants, mostly in the growing points, and distributed in the plants. Every cutting contains some of this hormone when severed from the mother plant. Although this is the hormone which participates in root formation in the cuttings, it gradually disappears after the cuttings are set in the rooting bed. However, the disappearance of the hormone is prevented quite well by the etiolation treatment. Further research will be conducted to learn whether etiolation prevents destruction of the hormone or prevents its diffusion from the cuttings.
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SHADE TREE EVALUATION

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Ohio Agricultural Research and Development Center

As reported previously, eight Ohio utility companies, the Ohio chapter of the International Shade Tree Conference, and the Ohio nurserymen's Association have established a shade tree evaluation study in the Secrest Arboretum at the Research Center. Because many new tree cultivars are being introduced by nurserymen, with little to no comparative evaluation, the study was designed to observe different types under similar conditions.

The planting was begun in the spring of 1966 and at present includes the following species and cultivars: 30 Acer (Maple), 16 Tilia (Linden), 20 Crataegus (Hawthorn), and 6 miscellaneous genera. Data are taken at the time of planting and throughout each year. Results will be reported after the plants have grown for a period of time.

A second phase of the project involves the evaluation of existing street trees in various Ohio cities. At present 52 different tree species and cultivars are being evaluated in four cities—Cincinnati, Columbus, Wooster, and the greater Cleveland area. The trees are observed each year to determine the effect of site on rate of growth, condition of foliage, branching character, and other factors.

Several problems are evident in many of the street tree plantings. Crataegus oxyacantha 'Paul's Scarlet' has been used extensively as a street tree and has usually been found to be infested with aphids or scale, thus limiting its value from a maintenance and appearance standpoint. The bark on the southwest side of another tree, Prunus serrulata 'Kwanzan', was observed to be cracked when located so it was exposed to extreme weather conditions. Problems such as these may often be more severe in street plantings because of a weakened condition caused by a restricted root system, air pollution, or traffic usage.

Two undesirable design and cultural practices often followed by ties are: 1) planting a tree with too large or too small a mature size in an area not in scale and 2) planting in too narrow a tree lawn or too small a planting area. The latter situation results in interference with traffic and power lines and often results in the need for excessive maintenance. Where tree lawns are too narrow, a simple solution is to plant the trees in the lawn area on the property line of the sidewalk.

Trees planted in tree lawns often have a different growth rate than the same trees planted in a more open area. Several Acer stanoides, planted by the city in a homeowner's lawn in 1954, were feet taller and had a 4-inch larger trunk diameter than the same species planted 3 years later in a 5-feet-wide tree lawn.
Several tree species and cultivars were observed growing well in tree lawns of varying widths in Cleveland and other Ohio cities. These were observed in residential areas where air pollution was slight to moderate. Those in tree lawns 12 feet or more in width were: Acer buergerianum, Tilia cordata, Zelkova serrata, Gleditsia triacanthos 'Moraine', and Fraxinus subintegerrima 'Marshall Seedless'. Those growing well in a tree lawn of 6 to 12 feet width were: Gleditsia triacanthos 'Skyline', Pyrus calleryana, Aesculus carnea, Acer pseudoplatanus, Acer platanoides 'Globosum', Eucommia ulmoides, Acer platanoides 'Fassens Black', Sorbus aucuparia, Cercidiphyllum japonicum, and Crataegus lavaliei. In tree lawns of 5 feet width or less, the following were observed to be growing well: Acer pseudoplatanus, Acer platanoides 'Globosum', Acer rubrum 'Scanlon', Sorbus aucuparia, Cercidiphyllum japonicum, and Crataegus phaenopyrum.

These and additional plantings will be observed for a 5-to-10 year period to establish long range case histories which will provide information to provide better trees for Ohio streets and highways.
Beauty helps make life and work enjoyable. Nearly 170 years ago Thomas Jefferson observed that communities "should be planned with an eye to the effect made upon the human spirit by being continuously surrounded with a maximum of beauty." We have inherited a beautiful and it is our responsibility not only to preserve it but also to create new beauty for the enjoyment of future generations.

Well cared-for trees of the proper varieties make downtown areas and shopping centers much more attractive and pleasant than the drab situations which are all too common in many American cities. This article deals with two types of urban planting areas: business districts and parking lots.

Business Districts. Downtown areas usually provide at least three options for tree planting: prefabricated planters, shallow planters without bottoms, and curbside excavations. These are illustrated in Figures 1-3. Experience has shown that, where possible, curbside excavations are much preferred because they usually provide a better environment for root development.

Curbside excavations may vary in size, depending upon the size and species of tree to be planted. Tree pit openings may range in size from 5 x 5 feet to small circles 2 feet in diameter. The holes are usually 3½ to 4 feet deep, depending on subsoil conditions. As shown in Figure 1, a pit surface of coarse gravel kept even with the sidewalk encourages infiltration of water into the soil and does not present a hazard to pedestrians.

Shallow planters without bottoms (Figure 2) require less depth of the planting hole because of their curbed sides. They have the further advantage of preventing salt injury resulting from snow removal. Although they may appear more attractive, initial cost of installation and maintenance of ground cover are factors to consider. Raised pit borders may present a hazard to pedestrians, so municipalities contemplating shallow planters should investigate the associated legal responsibilities.

Above ground containers (Figure 3) seldom are as successful as excavated planters. The failures of container plantings are usually due to inadequate size tubs and extreme summer and winter temperatures. High summer temperatures often result in very dry soil conditions and low winter temperatures are injurious to tree roots. However, there often is a place for large prefabricated containers in business districts when curbside excavations are not possible.

Parking Lots. Modern suburban shopping centers in many cities are beautifully landscaped and provide a delightful environment for shopping. Unfortunately, there are also examples of large black-capped parking areas without a single shade tree (Figure 4).
Fig. 1.--A satisfactory curb-side excavation with brick border and gravel maintained at same level as sidewalk.

Fig. 2.--Shallow planters without bottoms. Attractive but expensive in construction and maintenance.
Fig. 3.--Prefabricated cement planter. Such containers may be used in situations where it is not possible to plant trees in curbside excavations.

Fig. 4.--A few shade trees would make this a much more pleasant parking lot.
Many of the same principles which should be considered in planting trees in parking lots are similar to those which apply to business districts. The illustration of the pin oak in Figure 5 is probably the most practical solution to providing shade in a large parking lot. Here 9 x 15-foot parking spaces have been curbed at 75 to 100-foot intervals. The effect is generally pleasing and is certainly an improvement over large treeless areas, which are all too common in our urban landscape.

Species Selection. The difficult site conditions for tree growth under city conditions limit the number of species which can be recommended. The list below is subject to discussion because of variations in soil and climate in different localities but the following are suggested.

**Business Districts**

- *Acer platanoides columnare*. Columnar Norway Maple
- *Crataegus phaenopyrum*. Washington hawthorn
- *Crataegus laevigata*. Lavalle hawthorn
- *Carpinus betulus fastigiata*. Columnar European hornbeam
- *Gleditsia triacanthos inermis*. Thornless honey locust (selected cultivars)
- *Fraxinus pennsylvanica lanceolata*. Green ash
- *Ginkgo biloba fastigiata*. Columnar ginkgo
- *Malus*. (Upright forms of crabapple)
- *Pyrus calleryana "Bradford"*. Bradford pear
- *Quercus shumardii var. texana*. Texas red oak
- *Robinia pseudoacacia*. Black locust
- *Tilia cordata 'Greenspire*'. Greenspire little leaf linden

**Parking Lots**

- *Celtis occidentalis*. Hackberry (selected forms)
- *Fraxinus pennsylvanica lanceolata 'Marshall'. Marshall's ash
- *Gleditsia triacanthos inermis*. Thornless honey locust (selected cultivars)
- *Phellodendron amurense*. Amur corktree
- *Tilia cordata*. Little leaf linden
- *Tilia euchlora*. Crimean linden
- *Quercus shumardii var. texana*. Texas red oak
- *Quercus borealis* (rubra). Northern red oak
- *Quercus palustris*. Pin oak

**Factors to Consider in Business District Tree Planting**

1. Advance planning is important. Site locations should be predetermined prior to starting tree planting projects in business districts. Trees should not create hazards or interfere with street lighting, traffic signals, or overhead wires. Check on location of underground utilities.

2. Spacing may vary. Trees need not be spaced at exact intervals, although minimum spacing between 50 and 70 feet is usually most acceptable.
Fig. 5.--Pin oaks were planted in 9 x 15-foot parking spaces at 100-foot intervals.

Fig. 6.--Two prefabricated curbs provide protection for this tree. Remaining space accommodates a compact car on either side.
3. Use good top soil in back fill and provide adequate drainage.

4. Diversify species. Diversified planting is much safer than setting out too many trees of one species in a long street.

5. Provide adequate maintenance. Trees need regular watering during hot dry periods of the growing season. Trees in poor condition and planting pits filled with litter become a prominent detraction.
Oak trees have long instilled in people an image of strength, stability, and magnificence. What greater majesty exists than the sight of a mature oak with its large massive trunk and branch spread of up to 100 feet? A man standing next to such a specimen realizes his insignificant stature and can not help but wonder at one of nature's giant creations.

Perhaps because of their size, oaks have historically been considered sacred to the Hebrews, Greeks, and Romans. Today the wood of oak trees is highly valued for its strength and for centuries its acorns were prized as a food source for man or beast. As recently as World War II, acorns were ground up and used as a flour supplement in the war-ravaged countries of Europe.

Several uncommon oaks were prized for other characteristics. Kermes Oak (Quercus coccifera), for example, is host to the Kermes insect which produces galls on the leaves which yield a brilliant red dye upon extraction. The Turkish Oak (Quercus aegelops) was prized for its acorns, used in the tanning of leather. The fishermen of ancient Greece and Rome buoyed up their nets with cork taken from the Cork Oak (Quercus suber).

Taxonomically, the oaks belong to the Beech family (Fagaceae). The leaves are either deciduous or evergreen, alternate, simple, and stipulate. The plants are usually monoecious, the staminate and pistillate flowers appearing in catkin-like racemes, and the fruit is a one seeded nut referred to as an acorn.

Oaks are divided into two groups. One is the White Oak group, having acorns which mature in 1 year. The leaves of this group have rounded lobes, with the exception of the Live Oak (Quercus virginiana) and Post Oak (Quercus stellata), both having entire leaves. The acorns when tasted are seldom bitter.

The second group is the Black Oak group. Acorns of this group take 2 years to mature and are very bitter when tasted. The lobes of the leaves are usually sharp pointed and tipped with bristles.

The native habitat of the oaks is principally North America, although a few such as the Oriental Oak (Quercus variabilis) are from Asia and a few such as the English Oak (Quercus robur) are from Europe. Most of the oaks are deciduous but a limited number, such as the famous Live Oak (Quercus virginiana) found in the south, have evergreen foliage.

Generally oaks will do well in a wide variety of soil and environmental conditions, which adds to their attractiveness as a good ornamental plant. Four species, however, should receive special care when used in landscape plantings. Bar Oak (Quercus macrocarpa) will
Quercus Leaf Patterns
Scale - One Inch Squares

Quercus Leaf Patterns
Scale - One Inch Squares
not tolerate shady conditions. Willow Oak (Quercus phellos) does well in the southern part of Ohio but is susceptible to winter injury when it is used in unprotected areas in the northern part of the state.

Pin Oak (Quercus palustris), a very popular tree, should not be planted in alkaline soils. Iron is not available to Pin Oaks at an alkaline pH and these trees in such a situation will quickly develop yellow leaves (iron chlorosis). If uncorrected, iron chlorosis will result in a gradual decline and ultimate death of this species. Control measures for iron chlorosis are available and worthwhile where specimen plants are involved but the best control is to plant Pin Oaks in acid soils to avoid the problem. In direct contrast, the Chinkapin Oak (Quercus muehlenbergia) is found native in alkaline soils and should be planted in such for best growth and development.

Oaks are used in the landscape as either specimen plants or as large shade trees. Where space permits, as most oaks attain a height of 75 feet or more, certain species such as Willow Oak (Quercus phellos), Shingle Oak (Quercus imbricaria), and Pin Oak (Quercus palustris) have been used in street tree plantings. Many species, such as Pin Oak, Scarlet Oak (Quercus coccinea), and Eastern Red Oak (Quercus rubra maxima), have excellent red or scarlet fall color which add to their attractiveness in the landscape.

Most oaks are propagated from seed. The acorns of the White Oak group will germinate as soon as they fall from the trees and should be sown immediately. Acorns from the Black Oak group require overwintering, or cold temperature exposure, before germination will occur. A few cultivars, such as the popular Upright English Oak (Quercus robur 'Fastigiata'), are grafted.

Several insect and disease problems occur on oaks, although none are serious enough in Ohio to limit their use in landscape plantings. The most common problems are as follows:

**Anthracnose:** This disease occurs in rainy weather during either the spring or early summer. Leaves of infected trees exhibit brown blotchy areas and often drop from the trees. For control, use either Zineb or Puratized Agricultural Spray according to manufacturers' recommendations.

**Leaf-Blister:** Circular raised areas, often yellowish-white in appearance, occasionally appear on oak leaves during cool wet springs. This is an unsightly disease but one rarely causing permanent injury. For control, spray dormant trees with either Captan or Zineb at manufacturers' recommendations.

**Wilt:** Affected trees have curled, drooping, brown leaves. This disease is not a serious problem in Ohio. No good chemical control exists. Sterilization of all pruning equipment is advised after each pruning operation.

**Galls:** These appear as proliferated raised masses of leaf tissue caused by the feeding of insects and mites. Galls are unsightly but rarely cause permanent damage to trees. For control, spray dormant plants with a miscible oil and apply Sevin spray in mid-May and mid-June.
Scales: Scales vary in size from 1/16 to 1/6 of an inch in diameter, usually appear on stems, and vary in color from yellow to a dull gray. These are generally not serious but local heavy infestations have occurred in certain areas of Ohio. For control, spray with either a miscible oil when the trees are dormant or with malathion in early summer when the young scales are in the crawling stage.

**Selected Oaks for Use in Ohio**

**Quercus alba** (White Oak) 90 feet plus

Majestically, no tree can compare with a mature specimen of White Oak. It becomes quite round headed at maturity with very wide, stout spreading branches. It is a rather slow growing tree and has the characteristic of holding its leaves for most of the winter. Fall color varies from a purplish red to a violet purple. If it is used as a specimen plant, at least 80 feet should be allowed for it to mature.

**Quercus bicolor** (Swamp White Oak) 60 feet plus

This tree has a rather narrow, round topped, open headed growth habit. Swamp White Oak resembles White Oak but its leaves and the tree itself are coarser in texture. The bark of especially young branches tends to peel and give a shreddy appearance. It is especially suited for use in moist or wet soils. Fall color ranges from yellowish brown to red.

**Quercus coccinea** (Scarlet Oak) 75 feet

At maturity, Scarlet Oak tends to become a broad, rather open headed tree. The leaves have five to nine lobes, the sinuses are nearly circular, and the leaf base is often straight across. The open habit of growth permits good turf development under the tree. This tree transplants with difficulty and should be handled carefully. Fall color is a brilliant scarlet and is outstanding.

**Quercus imbricaria** (Shingle Oak)

Shingle Oak has a rather pyramidal growth habit when young, tending to be rather round topped and open at maturity. The leaves are different than those of many oaks, being long and narrow with an entire leaf margin. The leaves are dark green above and densely downy beneath. This tree is adaptable to shearing and can be pruned into excellent large hedges, windbreaks, and screens. Fall color varies from a good yellow to russet.

**Quercus palustris** (Pin Oak) 75 feet

This is a very picturesque tree with a beautiful pyramidal habit of growth. The upper branches are upright, the middle branches are horizontal, and the lower branches are pendulous. The foliage is lustrous green on the upper surface and shiny and hairless beneath, except for tufts where the veins join. It has a rather fibrous root system and transplants readily. Care should be taken not to plant Pin Oak in alkaline soils as the foliage will quickly appear chlorotic.
This is an excellent specimen plant but room must be allowed for the spread of the lower pendulous branches. Fall color is an excellent red or scarlet.

**Quercus phellos** (Willow Oak) 50 feet

Willow Oak is a medium sized tree with slender branches and a symmetrical, somewhat open, conical, round topped crown. It has fine textured foliage. The leaves are 2½ to 5 inches long, narrow, and resembling those of a willow. It is widely used as a specimen plant and also used often as a street tree. Willow Oak has a shallow root system and transplants readily. It is used mostly in southern Ohio because of its susceptibility to winter injury.

**Quercus robur** (English Oak) 75 feet plus

English Oak is a medium to large, open, wide spreading tree, with heavy limbs and a deeply furrowed trunk. Its leaves are similar in appearance to those of White Oak but are smaller and not lobed as deeply. The fastigiate form of English Oak is used more widely than the species and is similar to it except in growth habit. Like all European species, English Oak has no fall color.

**Quercus rubra maxima** (Eastern Red Oak) 75 feet plus

This is a large oval to round headed tree with a somewhat symmetrical but open branching habit. The lobes of the leaves are bristle tipped and, although the leaves resemble those of Pin and Scarlet Oak, they are less deeply indented. In general, this tree is not troubled by iron chlorosis and the dark glossy green leaves provide dense shade. Fall color is maroon to purplish red.

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