Propagating WOODY PLANTS From CUTTINGS

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Contents

Propagating Woody Plants from Cuttings

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Propagation from cuttings is the major means of propagating most landscape shrubs at the present time. More landscape plants will be propagated from cuttings in the future as more cultivars with unique features are released. However, the propagation techniques employed by nurseries vary almost as widely as the number of nurseries in existence. This bulletin describes the techniques used in mist propagation.

The mist propagation structure

The propagation structure should be relatively small (not more than 25′ x 100′) to provide adequate control over temperature and humidity. In large greenhouses plastic covers over individual benches may be necessary (Figure 1).

Figure 1. In large greenhouses the use of clear polyethylene over PVC pipe bows creates a greenhouse within a greenhouse, thus providing the high humidity needed for rooting of many cuttings.

In general, the structure should provide 1) bottom heat for the rooting medium, 2) light intensity similar to that used in production, that is, for shrubs grown in full sun the light intensity should be as high as possible, and 3) a time clock with a mist cycle of one minute with two to three seconds on every minute during daylight hours, or a clock with a five minute cycle with 4 to 5 seconds on during the daylight hours (the objective is to keep a thin film of water over the surface of the leaves at all times), 4) mist lines that are straight and level to prevent dripping (Figure 2), 5) a good fan-pad evaporative cooling system for maintaining a moderate temperature and high humidity during late spring, summer, and fall.

A bench constructed of wire and metal frames which provides good air circulation within the greenhouse is important (Figure 3). Likewise, the absence of wood which may harbor organisms and algae in the propagation house is desirable.

The rooting medium

Many people have tried to define or describe the ideal rooting medium for asexual propagation of cuttings. In general it has been found

Figure 2. Mist lines must be straight and level in order to prevent dripping and overwatering of some containers following each mist cycle.

Figure 3. A wire bench constructed of galvanized welded wire or expanded metal allows air circulation around and among the plants and is easily cleaned. Avoid wood which harbors algae and many disease organisms and is difficult, if not impossible, to clean. The containers are 2¼ x 2¼ x 2½ inches deep bedding plant trays, uncut to provide sturdiness and ease of handling.

that there is no one ideal rooting medium but several combinations of materials can provide a good workable medium. Peat and perlite or peat and ground pine bark on a 1:1 basis works well in a propagation system approximately two and one-half inches deep. If the pot is less than 2½″ deep the perlite or bark should be increased slightly to increase aeration, if it is deeper, a slightly larger proportion of peat could be used.

It very important that the components of the rooting medium are free of diseases and insects. Perlite and vermiculite are sterile when purchased. Good quality peat moss, although not sterile, is clean and ready for use direct from the bale. By contrast, ground pine bark or sand should be treated with either steam or methyl bromide prior to use in propagation.

The open wound at the base of the cutting combined with the warm-moist environment is an ideal entrance for several diseases. In most cases if a disease is present, cuttings will die while still in the propagation greenhouse (Figure 4). In other instances, the young plants may appear healthy and succumb only after an environmental stress more favorable to the disease (Figure 5). Drainage and aeration are functions of the depth of the mix. Therefore, finer particles can be used for deeper containers with satisfactory results.

Nutrients for the cuttings

The incorporation of 8 to 12 lbs. of Osmocote 18-6-12 per cubic yard into the rooting medium prior to the 'sticking' of the cuttings greatly increases plant quality (Figure 6). By incorporating this slow-release fertilizer, the rooting medium can be prepared in advance and stored dry for future use. However, mixing must be done *after* sterilization. It is essential to thoroughly mix the Osmocote into the propagation medium. Otherwise, variations in concentration may either damage the cutting or fail to give proper stimulus to rooting and growth. By incorporating Osmocote into the rooting medium the problems of algae on the surface

Figure 4. Cuttings rooted in a disease infested medium. The cutting on the left developed a basal rot and did not root. The center cutting, although rooted, is infected and will die soon. The apparently healthy cutting on the right may be infected and eventually killed by the disease. However, death may not occur until stress and/or conditions that are more suitable for development of the disease organism such as a period of rainy weather or overwatering occurs.

Figure 5. An apparently healthy *Fatsia japonica* plant (right) and a dead plant (left). The disease probably entered the plant in the unsterilized propagation bed. In this instance, few plants died during propagation, however, many died later when transplanted to a container with a sterilized but less well-drained growing medium which was more conducive to development of the disease.

of the rooting medium and adjacent surfaces in the propagation greenhouse are eliminated. The stimulation of rooting is substantial on some species while others are not affected during rooting, but growth of the liner before and after transplanting is greatly increased (Table 1). A recent study compared Osmocote formulations 19-6-12 (3 to 4 month release), 18-6-12 (6 to 9 month release) and 18-5-11 (12 to 14 month release); each at 3 rates. All 3 plant species studied grew best with Osmocote 18-6-12 at 8 or 12 lbs./cu. yd. This response is thought to be due to the slower initial release rate of the 18-6-12 formulation which is controlled by the plastic coating. At the present time, all other Osmocote formulations available have a more rapid initial release.

A cutting generally does not initiate any roots for 2 to 3 weeks after sticking and thus has little capacity to absorb nutrients. The release rate of Osmocote 18-6-12 more nearly coincides with the root development of the cutting. A study comparing no fertilizer during propagation and

Figure 6. Japanese holly liners after 2 months without (left) and with (right) 18-6-12 Osmocote in the rooting medium at the rate of 12 lbs./cu. yd. The cuttings were of identical size when stuck on November 15.

Table 1. Effects of Osmocote in the rooting medium on root grade of liners and subsequent growth.

	Osmocote 18-6-12 lbs./cubic yard			
	Root Grade[1]			
	0	8	12	24
Ilex crenata 'Hetzi'	5.1	7.1	7.6	8.1
Ilex cornuta 'Burfordi'	4.2	6.3	6.7	7.1
Ligustrum japonicum	7.9	8.1	7.8	–
	Number of branches per plant after one growing season			
Ilex crenata 'Hetzi'	17.8	26.9	30.6	31.2
Ilex cornuta 'Burfordi'	6.6	8.6	10.7	11.0
Ligustrum japonicum	10.3	16.8	17.4	–

[1] Based on a 1 to 10 scale with 1 equaling poor rooting and 10, excellent rooting.

several Osmocote formulations and rates on rate of establishment of purpleleaf Japanese honeysuckle, *Lonicera japonica,* 'Purpurea' was conducted. Following rooting, 30 plants of each treatment were planted in an open field and watered only once. After 1, 2, and 3 weeks, 10 plants of each treatment were dug and evaluated for root growth. No additional water was applied and no rainfall occurred during the study. After only 7 days, treatment differences could be readily observed. After 3 weeks, plants without any fertilizer in the original rooting system were wilted and few roots extended more than 2 inches beyond the original root ball. However, plants that had Osmocote 18-6-12 incorporated into the rooting medium made substantial top growth, showed no visible signs of moisture stress and developed many roots 8 to 10 inches into the surrounding soil (Figure 7).

Containers versus beds

The individual container concept allows the rooting medium to be transferred along with the rooted cutting to either the field or to the container for growing. The root system is undisturbed and establishment

Figure 7. Top and root growth of purpleleaf Japanese honeysuckle after 3 weeks in the field. No fertilizer in the original rooting medium (left) and with 12 lbs./cu. yd. Osmocote 18-6-12 (right).

is very rapid. There is no reusing of the rooting medium and thus no need to sterilize. Generally when cuttings are rooted in small containers, a smaller volume of rooting medium is provided per cutting as compared to bed grown liners. However, there is little difference in the volume of rooting medium used and likewise, in the cost of rooting medium. Containers can be reused but need to be dipped in 5% chlorox solution (1 part chlorox to 20 parts water) in order to sterilize them (any 5% sodium hypochlorite bleach will work). Bedding plant trays that are uncut and are not to be broken apart can be used either once or if labor and facilities provide, can be dipped in a chlorox solution and used again. The advantage is that workers handle multiples of plants at a time rather than individual pots. Therefore labor and space are used efficiently in the propagation house at a very low cost.

Rooting cuttings in beds (Figure 8) can be accomplished for a lower initial investment with several times more plants per sq. ft. of propagation bed. However, because crowding, stunting and disease problems are associated with such propagation beds after several cycles of cuttings, cost per liner is similar for containers and beds. Isolation and removal of diseased plants is easier in containers. In addition, slow release fertilizer incorporated into the rooting medium, which greatly increases plant quality when liners are propagated in containers, can only be effectively used in the initial rooting medium preparation for beds. Liquid

Figure 8. Bed-grown liners are generally crowded and stunted resulting in many losses and culls. Sanitation is difficult if not impossible.

fertilizer can be added to later propagation bed cycles of cuttings but plant response is very limited compared to incorporated Osmocote. IBDU and ureaformaldehyde have been tested and found to be unsatisfactory nitrogen sources for propagation.

When cuttings are crowded together in bulk beds during propagation, it is impossible to remove and plant liners without greatly disturbing and damaging the root system. Liners in containers are undisturbed and growth is continuous with no transplant adjustment as long as they do not remain in the containers too long.

Water quality

Water quality is important in mist propagation. Since nearly all of the mist applied to leaves of cuttings evaporates, any salts or debris in the water is left behind to accumulate on the leaf surface (Figure 9). In some instances salts may shade the leaf enough to reduce photosynthesis and reduce rooting and/or subsequent growth. Salts may also accumulate in the rooting medium and reduce rooting. Approximate guidelines for interpreting water sample results are given in Table 2.

Figure 9. Salt accumulation on leaves of a holly cutting. The salts have been removed from the center top leaf to show the accumulation. Salts may also accumulate on the mist heads causing uneven mist distribution.

Table 2. General Interpretation of Water Quality Using a Solu Bridge.

Solu Bridge Reading	Total Salts in Parts Per Million (PPM)	Water Quality
.00 - .25	0 - 150	Very Good
.25 - .75	150 - 500	Good
.75 - 1.50	500 - 1500	Fair
1.50 - 2.00	1500 or above	Questionable
2.00 or above		Unsuitable

Chlorinated city water is preferred over lake or stream water since it contains few if any living disease organisms and algae. Water from deep wells is generally satisfactory unless boron content or total salts are excessive.

Water pressure of 45-60 psi is needed to provide a mist with small droplets and good coverage. Low water pressure is a frequent cause of poor moisture distribution in the propagation greenhouse.

Selecting cuttings

The condition of the parent plant(s) supplying the cuttings is very important. In general the more vigorous and healthy the parent, the better the cuttings root and grow. In a recent study *Ilex crenata* 'Hetzi', Hetzi Japanese holly were grown using liquid fertilization, Osmocote, or a combination of IBDU (a 31% N slow release fertilizer) and potassium frit. All plants from all fertilizer sources and levels were dark green and healthy at the end of one full growing season in 1 gallon containers. Plants receiving IBDU and potassium frit were largest, followed by Osmocote and liquid feed. Cuttings taken from these plants rooted proportionately to the vigor of the plant (Figure 10).

In addition to the parent plant being healthy and vigorous, one should check carefully to be sure it is the particular species or cultivar desired.

The size and type of cutting to be taken are sometimes dictated by the size and vigor of the branches on the parent plant. In general, however, cuttings should be 5 to 7 inches long and medium to large in stem diameter for the species or cultivar (Figure 11). Slender branches and all branches from shaded portions of the parent plant should be avoided since they are lower in carbohydrates and less likely to root and become vigorous plants. Suggested times for taking cuttings are listed in Table 5, beginning on page 14. Each cutting should be provided enough space to

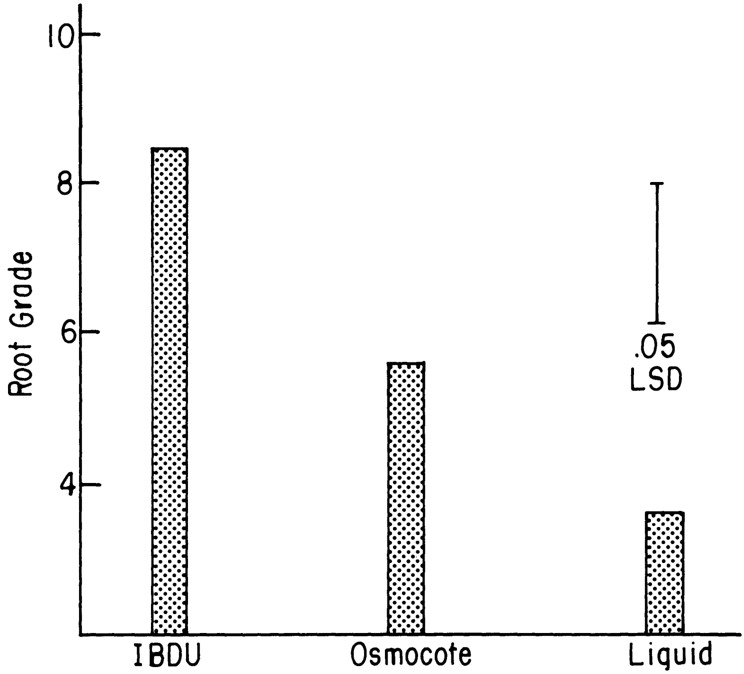


Figure 10. Effects of nutrient source of the parent plant on the rooting of cuttings. Parent plants were grown for one year with either IBDU, Osmocote, or liquid fertilizer prior to taking the cuttings.

avoid over crowding of the foliage and excessive shading of some leaves. The leaves on the cutting play a very important role in rooting. Even *Euonymus japonica,* Japanese euonymus, which roots readily, will root poorly or not at all when part or all of the leaves are removed from the cutting. The practice of removing one-fourth to one-half of the leaf should not be used (Figure 12). This practice was probably developed prior to intermittent mist systems to reduce the transpiring leaf surface area and is not valid with the mist system described here.

Rooting hormones

Rooting hormones (auxins) play a significant role in the rooting of some species and cultivars but have little effect on others. For example, crapemyrtle, *Lagerstroemis indica,* softwood cuttings root readily with no hormone applied; however, lacebark elm, *Ulmus parvifolia,* requires 16,000 to 30,000 ppm (talc preparation, IBA) for rooting of softwood

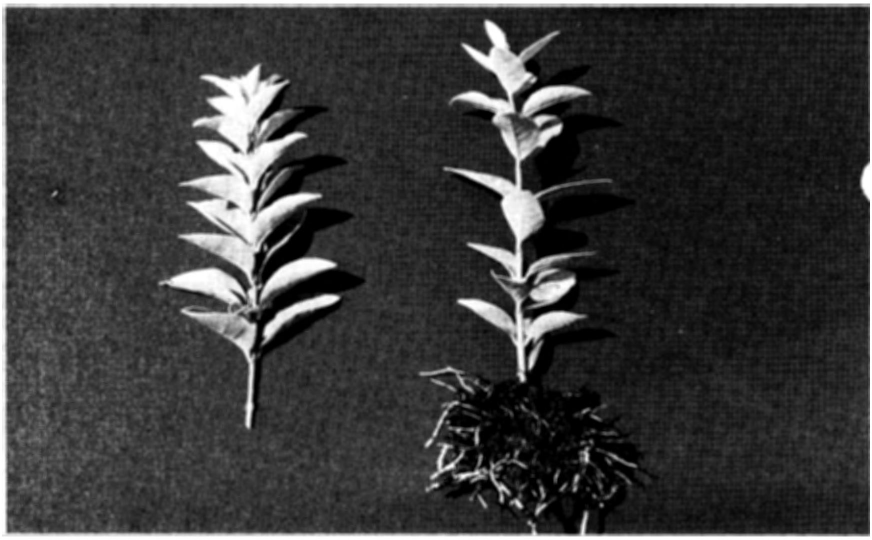


Figure 11. Typical cutting of *Ligustrum vicaryi,* golden vicary privet, before rooting (left) and after 5 weeks under mist. Note the many white healthy roots.

Figure 12. Leaves on cuttings should be left intact (left) rather than cut back as was commonly done prior to the development of intermittent mist systems.

cuttings (Table 4). Rooting of many species and cultivars is improved by 3,000 to 8,000 ppm indole butyric acid (IBA used in a talc preparation (Table 5).

Rooting hormones may also be applied as a liquid quick dip or soak. Vith this method the appropriate amount of IBA is dissolved in a small amount of ethyl alcohol, then mixed with distilled water to form the desired concentration. Cuttings are then prepared and dipped for a few seconds for easy to root species or several minutes for those more difficult to root. For hard to root species the concentration and/or length of soaking time may be increased as desired (liquid dips must be made fresh every 1 to 2 days). For convenience, ease of handling, stability and disease control the dry talc preparation is preferred. If disease organisms are present on a cutting and the liquid dip is used the base of the cutting is "washed" during dipping and the entire solution becomes contaminated. With the talc preparation the talc adheres to the cutting, thus coating any organisms present and preventing their distribution.

Table 4. Percent rooting of cuttings from trees using various auxin levels after 5 weeks under intermittent mist.

	Level of IBA, ppm as a talc preparation				
	0	8,000	16,000	30,000	45,000
Populus alba white poplar	4%	37%	62%	79%	----
Morus alba 'Fruitless' fruitless mulberry	68%	71%	16%	21%	----
Platanus acerifolia London planetree	62%	62%	71%	71%	----
Ulmus parvifolia (from OSU campus) lacebark elm	35%	79%	92%	90%	56%
Ulmus parvifolia lacebark elm (from OSU Nursery)	----	0.0	0.0	83%	----
hybrid elm from National Arboretum	----	0.0	0.0	62%	----
Sapporo Autumn Gold hybrid elm	----	15%	75%	0.0	----
Celtic occidentalis hackberry	0.0	0.0	0.0	0.0	0.0

Table 5. Suggested Times for Taking Cuttings

(Each "X" represents approximately the first or last half of a month.)

Broadleaf Evergreens	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Rooting Time (Weeks)	Suggested Auxin Concentration[1]
Abelia grandiflora							XX	XX	XX	XX	XX	XX	4-6	8
Berberis mentorensis									XX	XX	XX	X	2-3	8
Berberis julianae									XX	XX	XX		6-8	8
Buxus spp.									XX	XX	XX		6-8	8
Cleyera japonica									XX	X			6-8	8
Elaeagnus pungens								XX	XX	XX	XX		6-8	8
Euonymus fortunei	XX	XX	XX			X	XX	XX	XX	XX	XX	XX	3-4	3
Euonymus japonica	XX						XX	XX	XX	XX	XX	XX	5-6	3
Euonymus kiautschovica							XX	XX	XX	XX	XX	XX	5-7	3
Gelsemium sempervirens									XX	XX	XX		6-7	3
Ilex cornuta							XX	XX	XX	XX	XX	XX	7-8	8
Ilex crenata							XX	XX	XX	XX	XX	XX	6-8	8
Ilex opaca						XX							6-8	8
Ilex fosteri									XX	XX			9-11	8
Llex vomitoria							XX	XX	XX				10-12	8
Ilex 'Nellie Stevens'	XX						XX	XX	XX	XX	XX	XX	7-8	3
Ilex aquifolium							XX	XX	XX	XX	XX		7-8	8
Lonicera japonica	XX					XX	XX	XX	XX	XX	XX	XX	4-5	3
Mahonia spp.									XX	XX	XX	X	7-8	3
Nandina domestica									XX	XX	X		7-8	8
Osmanthus spp.									XX	XX	X		7-8	8
Photinia spp.							X	XX	XX	X			8-10	8
Pyracantha spp.								XX	XX	XX	X		7-8	8
Viburnum rhytidophyllum									XX	XX	XX		7-8	8

[1] Level of IBA in parts per million (ppm) as a talc preparation (3 = 3,000 ppm; 8 = 8,000 ppm; 16 = 16,000 ppm).

Table 5. Suggested Times for Taking Cuttings (Cont'd.)

(Each "X" represents approximately the first or last half of a month.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Rooting Time (Weeks)	Suggested Auxin Concentration[1]
Yucca spp. (root cuttings)	XX							XX	XX	XX	XX	XX	10-14	
Ligustrum japonicum							XX	XX	XX	XX	XX	XX	7-8	3
Ligustrum vicaryi							XX	XX	XX	XX	XX	XX	3-4	3
Prunus laurocerasu 'Zabeliana'	XX								XX	XX	XX	XX	6-8	3
Coniferous Evergreens														
Chamaecyparis nootkatensis									XX	XX	XX	XX	10-12	16
Cupressus sempervirens										XX	XX		12-16	16
Juniperus chinensis spreaders	X							XX	XX	XX	XX	XX	8-10	8
J. c. Torulosa									XX	XX	X		12-16	16
J. horizontalis	XX							XX	XX	XX	XX	XX	8-9	8
J. procumbens								XX	XX	XX	XX	X	8-9	8
J. conferta									XX	XX	XX	XX	8-9	8
Taxus spp.										XX	XX	XX	10-14	16
Thuja occidentalis 'Woodward'	XX									XX	XX	XX	7-9	8
Deciduous Trees — Softwood														
Acer palmatum					X	XX	X						6-8	16
Cornus florida					XX	XX	X						6-8	16
Euonymus bungeanea					XX	XX	XX						6-8	8
Ilex decidua					XX	XX	XX	X					6-7	8
Magnolia soulangeana					X	XX							5-6	16
Magnolia stellata					X	XX							5-6	16
Prunus sargenti & others					X	XX	XX						4-6	8
Pyrus calleryana & 'Bradford'					XX	XX							5-6	16

[1] Level of IBA in parts per million (ppm) as a talc preparation (3 = 3,000 ppm; 8 = 8,000 ppm; 16 = 16,000 ppm).

Table 5. Suggested Times for Taking Cuttings (Cont'd.)

	(Each "X" represents approximately the first or last half of a month.)												Rooting Time (Weeks)	Suggested Auxin Concentration[1]
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.		
Platanus occidentalis					X	XX	X					XX	4-5	16
Sapindus drummondi					X	XX	XX						5-6	16
Ulmus parvifolia					XX	XX	XX						4-5	30
Morus alba 'Fruitless'					X	XX	X						3-4	8
Maclura pomifera 'Pawhuska'					X	XX							3-4	8
Deciduous Shrubs														
Berberis thunbergi							X	XX	XX				6-8	8
Chaenomeles spp. (root cuttings)						X	XX	X					10-12	
Euonymus alata						XX	XX	X					5-7	8
Forsythia spp.						X	XX	XX					4-5	3
Lagerstroemia indica						XX	XX	XX	(non flowering shoots)				3-5	0
Ligustrum spp.						X	XX	XX					4-5	3
Spiraea (sp. fl.)						XX	XX						4-6	3
Spiraea (sum. fl.)						X	XX	X					5-7	3
Syringa spp.						XX	X						5-7	16
Viburnum spp.						XX	XX						4-8	8
Weigela spp.						X	XX						4-6	8
Punica graminata							X	XX	X				3-4	3

[1] Level of IBA in parts per million (ppm) as a talc preparation (3=3,000 ppm; 8=8,000 ppm; 16=16,000 ppm).

Summary

In summary the following procedures are most suitable for rooting of most cuttings:

1. small propagation structure for humidity control
2. bottom heat and temperature control
3. light intensity appropriate for the species
4. a mist cycle suitable for seasonal conditions
5. water pressure of 45-60 psi
6. level mist lines and clean mist nozzles
7. metal or plastic benches for ease of sanitation
8. a well aerated rooting medium that supports the cutting well and holds a moderate amount of water
9. small containers for each cutting in flats or trays for ease of handling and adequate space per cutting
10. thorough incorporation of 8 to 12 lbs. of 18-6-12 Osmocote per cu. yd. into the rooting medium
11. good quality water
12. vigorous healthy parent plants and stout well developed shoots for cuttings
13. dip cutting in talc preparation of rooting hormone
14. sanitation in all aspects from cleansing of clippers to occasionally washing down the entire propagation house with chlorox
15. prompt removal of cuttings from mist following rooting
16. prompt removal of cuttings from containers and planting following rooting

Appendix

SCIENTIFIC AND COMMON NAMES OF PLANTS DISCUSSED IN THIS BULLETIN

Scientific Name	Common Name(s)
Abelia grandiflora	Glossy Abelia
Acer palmatum	Japanese Maple
Aucuba japonica	Gold Dust Plant
Berberis julianae	Wintergreen Barberry
Berberis mentorensis	Mentor Barberry
Berberis thunbergi	Japanese Barberry inc., 'Atropurpurea', 'Atropurpurea Nana', 'Crimson Pigmy'
Buxus spp.	Boxwood
Celtis occidentalis	Hackberry
Chaenomeles spp.	Flowering quince
Chamaecyparis nootkatensis	Alaska Cypress
Cleyera japonica	Japanese Cleyera
Cupressus sempervirens	Italian Cypress
Elaeagnus pungens	Thorny Elaeagnus or Silverberry
Euonymus alata	Winged Euonymus
Euonymus bungeanea	Winterberry Euonymus
Euonymus fortunei	Creeping Euonymus
Euonymus japonica	Evergreen Euonymus
Euonymus kiautschovica	Spreading Euonymus or Manhattan Euonymus
Fatsia japonica	Japanese Fatsia
Forsythia spp.	Forsythia, or Golden Bell
Gelsemium sempervirens	Carolina Yellow Jessimine
Ilex aquifolium	English Holly
Ilex cornuta	Chinese Holly, inc. 'Burfordi', 'Rotunda', 'Carissa'.
Ilex crenata	Japanese Holly inc. 'Helleri', 'Compacta', 'Hetzi', 'Convexa', etc.

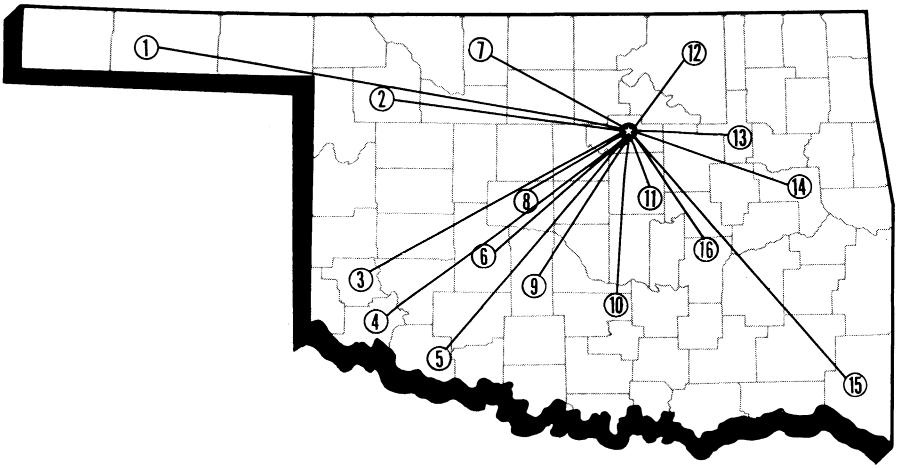
Scientific Name	Common Name(s)
Ilex decidua	Deciduous Holly or Possumhaw
Ilex fosteri	Fosters Holly
Ilex 'Nellie Stevens'	Nettie Stevens Holly
Ilex vomitoria	Yaupon Holly, inc. 'Nana' and 'Shillings'
Juniperus chinensis spreader	Inc. 'Pfitzeriana', 'Pfitzeriana glauca', 'Hetzi', 'Maneyi', 'Blue Vase', 'Mint Julep', etc.
Juniperus chinensis 'Torulosa'	Hollywood or Twisted Juniper
Juniperus conferta	Shore Juniper inc. 'Emerald Sea', and 'Blue Pacific'
Juniperus horizontalis	Creeping Juniper inc. 'Plumosa', 'Andorra', 'Bar Harbor', 'Blue Rug', 'Wiltoni', 'Turquoise Spreader', etc.
Juniperus procumbens	Japanese Garden Juniper inc. 'Nana'
Lagerstroemia indica	Crepemyrtle
Ligustrum japonicum	Waxleaf Privet
Ligustrum spp.	Common Privet, Calif. Privet, Amer. Privet
Ligustrum vicaryi	Golden Vicary Privet
Lonicera japonica	Japanese Honeysuckle inc. 'Purpurea'
Magnolia soulangeana	Saucer Magnolia
Magnolia stellata	Star Magnolia
Mahonia aquifolium	Oregon Grape Mahonia
Mahonia bealei	Leatherleaf Mahonia
Maclura pomifera 'Pawhuska'	Thorneless, Male Osage Orange or Bois'D'Arc.
Morus alba 'Fruitless'	Fruitless Mulberry
Nandina domestica	Nandina or Heavenly Bamboo, inc. 'Nana' and 'Compacta'
Osmanthus fragrans	Fragrant Osmanthus
Osmanthus heterophyllus	False Holly
Photinia frazieri	Frazieri Photinia
Photinia serrulata	Chinese Photinia
Platanus acerifolia	London Planetree
Platanus occidentalis	Sycamore
Populus alba	White Poplar inc. 'Bolleana'

Scientific Name	Common Name(s)
Prunus calleryana	Callery Pear inc. 'Bradford', 'Aristocrat'
Prunus laurocerasus 'Zabeliana'	Zabels laurel
Punica graminata	Pomegranate
Prunus sargenti	
Pyracantha spp.	Pyracantha or Firethorn
Sapindus drummondi	Western Soapberry
Spiraea spp. (sp. fl.)	Inc. thunbergi, prunifolium, etc.
Spiraea spp. (Sun. fl.)	Inc. 'Wateri', 'Frobeli'
Syringa spp.	Liliac
Taxus spp.	Yew, inc. 'Hicksi', 'Densiformis'
Thuja occidentalis	Eastern Arborvitae inc. 'Woodward', 'Pyramidalis', 'Techny', etc.
Ulmus Parvifolia	Lacebark or True Chinese Elm
Viburnum spp.	Inc. 'Tomentosum', 'Marlesei', etc.
Weiglea spp.	Weiglea
Yucca filamentosa	Adams Needle Yucca
Yucca gloriosa	Moundlily Yucca

OKLAHOMA

Agricultural Experiment Station

System Covers the State



Main Station — *Stillwater, Perkins and Lake Carl Blackwell*

1. **Panhandle Research Station — *Goodwell***
2. **Southern Great Plains Field Station — *Woodward***
3. **Sandyland Research Station — *Mangum***
4. **Irrigation Research Station — *Altus***
5. **Southwest Agronomy Research Station — *Tipton***
6. **Caddo Research Station — *Ft. Cobb***
7. **North Central Research Station — *Lahoma***
8. **Southwestern Livestock and Forage Research Station — *El Reno***
9. **South Central Research Station — *Chickasha***
10. **Agronomy Research Station — *Stratford***
11. **Pecan Research Station — *Sparks***
12. **Veterinary Research Station — *Pawhuska***
13. **Vegetable Research Station — *Bixby***
14. **Eastern Research Station — *Haskell***
15. **Kiamichi Field Station — *Idabel***
16. **Sarkeys Research and Demonstration Project — *Lamar***

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