

SECTION 10 LANDSCAPE

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'GulfRay', New Weeping Azalea

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Nature of Work: 'GulfRay' is an evergreen azalea that grows vigorously and produces profuse reddish pink flowers. It is similar in vigor and flowering to such azalea cultivars as 'Elegans Superba' ('Pride of Mobile') and 'Formosa', which are members of the Southern Indian Hybrid azalea group. The distinctive feature of 'GulfRay' is its cascading or weeping prostrate growth habit.

The origin of 'GulfRay' azalea is not known. It was found in the yard of a residence near Agricola, MS, 30 miles (50 km) north of Pascagoula, by Ray Dean of Sun Ray Nursery, Lucedale, MS. The azalea had been planted as part of the foundation planting more than 40 years ago. Dean gave this plant to the Mississippi Agricultural and Forestry Experiment Station for evaluation and release.

Results and Discussion: Experiments were initiated in 1983 and continued through 1991 to evaluate the growth, flowering, and cold hardiness of 'GulfRay'. The azalea was successfully propagated vegetatively and grown in containers using standard cultural practices to produce azaleas.

'GulfRay' grew well in full sun and in the shade at fertility levels usually used to grow azaleas. It was slightly less cold hardy than the popular Southern Indian Hybrid 'Formosa'. The severe winters in the 1980's indicated that this selection can be used effectively in southern Mississippi (USDA hardiness zone 8). However, in northern Mississippi (USDA hardiness zone 7b), cold protection will be required.

The prostrate weeping, or cascading growth habit of 'GulfRay' lends this azalea for landscape use in hanging baskets, for container plants for patios, and for foundation planting where low-growing shrubs are desirable. Flowering occurs from mid-March to early April.

'GulfRay' is described as a shrub with spreading, prostrate branches. Larger stems are 0.5-1 cm in diameter, light brown in color, with dark brown linear fissures. Younger stems are greenish brown with appressed or ascending trichomes, 0.5-2 mm long, white or brownish toward base.

Leaves are mostly crowded toward the apex with occasionally a few distant ones. Overwintering leaves are dark green, elliptic to lanceolate, usually thick-membranous, mostly 2 - 8 cm long, 1-2.3 cm wide, both above and below strongly reticulate-veined, glandular-punctate, strigose above scat-

tered with trichomes 0.5-2.5 mm long, similar below, but with brown trichomes, midribs and margins more densely pubescent, apiculate, acute and mucronate at apex, and cuneate at base. Summer leaves are similar to overwintering leaves but paler and more densely strigose with pale trichomes. Petioles are 0.1-0.6 mm long.

Inflorescences are axillary, 2-3-flowered and sessile, pedicles 0.4-1 cm long, densely strigose. Bracts are 2-5 cm long, 0.5-1.5 cm wide, linear-elliptic, sessile, and broadened toward base, otherwise similar to foliage leaves. Calyx-lobes are 0.5-1.8 mm long by 0.2-0.5 mm wide, narrowly triangular to linear-obovate, acuminate, and densely strigose with white trichomes to 2 mm long. The corolla is single, campanulate, reddish-pink with darker blotches on upper lobe and parts of adjacent lobes, 6-7.5 cm wide. The corolla tube is 1.5-2.5 cm long, 0.3-0.5 cm wide at base, flaring to 2-3 cm broad above, the lobes are 2-3.5 cm long. The stamens are mostly 10, 2-3.4 cm long, the filaments pink or white, the anthers 0.1-0.25 cm long. The ovary is 0.4-0.5 mm long and densely pilose. The pink style is 3.5-4.0 cm long and topped by a short flattened stigma around 0.1 cm long and broad.

'GulfRay' azalea was named and released by the Mississippi Agricultural and Forestry Experiment Station in November 1992. Cuttings from stock plants are available to wholesale nurseries in Mississippi for propagation. Names of nurseries that will have plants available for sale can be obtained beginning in 1993 from this station (South Mississippi Branch Experiment Station, Box 193, Poplarville, MS 39470).

Significance to the Industry: An azalea that has a weeping prostrate growth habit. It can be used in hanging baskets, container plants for patios or as foundation plantings. An azalea that the industry can produce for southern conditions with a weeping growth habit and abundant supply of flowers.

An Updated Checklist of Existing *Cercis* Taxa

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North Carolina

Nature of Work: "Redbuds" (*Cercis taxa*) are excellent shrubs to small trees with spectacular spring flowers commonly grown in nursery production across the US (2, 3, 4, 5, 6, 7, 8, 12, 13, 14, 15). *Cercis* evaluation has been a focused program at The NCSU Arboretum and with the invaluable propagation assistance of Vine & Branch Nursery, Chapel Hill, NC, the living collections today contain the largest number of taxa in any location in the world. Previous papers (9, 10, 11) have variously summarized the contents of the collection and their characteristics. Since these papers were published, further evaluation information has accumulated, new cultivar taxa have been developed and added to the collection, and taxonomic research has resulted in new name changes for botanical species (1). This paper briefly summarizes the currently existing taxa of *Cercis*.

Results and Discussion: The following checklist summarizes the current taxonomy and existing cultivars of redbuds with brief notes on new taxonomy or plant characteristics of the known 54 taxa. Those currently in The NCSU Arboretum collection are indicated by astericks (*) following the name.

Cercis californica Torr. ex Benth subsp. *californica**— "California Redbud" native to north-central California.

Cercis californica subsp. *californica* 'Alba'* - White-flowered selection of the California Redbud introduced by Rancho Santa Anna Botanic Garden, Claremont, CA.

Cercis californica subsp. *californica* 'Claremont' - Deep magenta-flowered selection of the California Redbud introduced by Rancho Santa Anna Botanic Garden, Claremont, CA.

Cercis californica subsp. *nephrophylla* (Greene) Ballenger ined. - "Southern California Redbud" native to mountains east of San Diego, CA. A new taxonomic designation from Ballenger (1).

Cercis canadensis L.* - "Eastern Redbud" native from Florida to Michigan to Mexico. Most commonly grown commercial nursery species in the eastern US.

Cercis canadensis 'Alba'* - White-flowered selection(s) of the Eastern Redbud; multiple clones exist.

Cercis canadensis 'Appalachia'* - Striking "closest-to-red" flower color of any redbud.

Cercis canadensis 'Dwarf White'* - White flowered cultivar with compact growth; selected in Illinois.

Cercis canadensis 'Flame'* - Double-flowered cultivar found in Illinois in 1905 and introduced by Louis Geraldi Nursery, O'Fallon, IL; extremely fast growth; fewer seed pods.

Cercis canadensis 'Forest Pansy'* - Purple-foliaged cultivar with typical flowers; originated at Forest Nursery, McMinnville, TN in 1947; purple color fades with high summer heat.

- Cercis canadensis* 'Pinkbud' - Pink-flowered selection found in Kansas City, MO.
- Cercis canadensis* 'Plena' - Semi-double flowered selection originating before 1894.
- Cercis canadensis* 'Pubescens' - Leaves downy on underside.
- Cercis canadensis* 'Rosea' - Unknown Hortus Third listing which may no longer exist; rose-colored flowers.
- Cercis canadensis* 'Royal White' ('Royal')* - White-flowered selection by Dr. J. C. McDaniel, Univ. of Ill.; introduced by Louis Gerdal Nursery, O'Fallon, IL.
- Cercis canadensis* 'Rubeye Atkinson'* - Pink-flowered selection.
- Cercis canadensis* 'Silver Cloud'* - Silver-white variegated foliage and magenta flowers; introduced by Yew-Dell Nursery, Crestwood, KY in 1964.
- Cercis canadensis* 'Wither's Pink Charm' ('Pink Charm')* - Pink-flowered selection found by D. D. Withers in Virginia around 1930.
- Cercis canadensis* (Unnamed pendulous seedling) - a strongly weeping variant found in New York now in evaluation for production; will likely be patented and introduced in near future.
- Cercis canadensis* (Unnamed variegated seedlings) - several seedlings have been selected by various growers and are under evaluation for introduction.
- Cercis canadensis* subsp. *mexicana* (Rose) Murray* - The "Mexican Redbud" with smaller, glossy foliage with undulate margins. The taxonomy has long been in debate with multiple names in use. It is now formally designated as listed here by the most recent definitive taxonomic study (1).
- Cercis canadensis* subsp. *texensis* (Wats.) Murray* - The "Texas Redbud" with thick glossy foliage. The taxonomy has long been in debate with multiple names in use (*C. reniformis* most common). It is now formally designated as listed here by the most recent definitive taxonomic study (1).
- Cercis canadensis* subsp. *texensis* 'Oklahoma'* - The deepest magenta-purple flowers of any redbud with superb leathery, glossy foliage; a selection of the Texas Redbud found in Arbuckle Mountains of Oklahoma in 1964 and introduced by Warren & Son Nursery, Oklahoma City, OK.
- Cercis canadensis* subsp. *texensis* 'Texas White'* - White-flowered selection of the Texas Redbud with superb leathery, glossy foliage; originated at Germany Nursery, Fort Worth, TX in the late 1960's.
- Cercis canadensis* subsp. *texensis* (Unnamed pendulous seedling) - a strongly weeping variant found in Texas near San Antonio now in buildup stages of production for introduction; will likely be a patented plant.
- Cercis canadensis* subsp. *texensis* (Unnamed variegated seedling) - White-variegated foliage seedling found in Texas; under evaluation but appears it may be too chimeral and unstable to name and introduce.
- Cercis chinensis* Bunge* - "Chinese Redbud"; second most common species in production; more shrubby.
- Cercis chinensis* 'Alba'* - White-flowered selection of Chinese Redbud.
- Cercis chinensis* 'Arborea' - Listed in Hortus Third with no information and does not seem to now exist in cultivation.
- Cercis chinensis* 'Avondale'* - Profuse flower-bud set completely hiding the branches when in flower; a form of Chinese Redbud selected in Avondale, New Zealand and introduced by Duncan & Davies Nursery in New Zealand.

- Cercis chinensis* 'Nana'* - Compact form of Chinese Redbud growing to 3-4'.
Cercis chingii Chun* - Chinese species of extremely fast growth; earliest flowering of all species.
Cercis chingii 'Gong Fen' - Chinese selection of unknown characteristics.
Cercis chingii (Unnamed white-flowered seedling) - Discovered in seedling lot at U. S. National Arboretum; under observation for possible introduction.
Cercis chuniana Metc. - Chinese species; the only *Cercis* species not yet in cultivation at present.
Cercis gigantea Cheng.* - "Giant Redbud"; Chinese species with large foliage and vigorous growth.
Cercis glabra Pampanini* - Chinese species very similar to *C. chinensis*.
Cercis griffithii Boiss* - "Afghanistan Redbud" native to Middle East; similar to *C. siliquastrum*; rare in cultivation.
Cercis orbiculata Greene - "Intermountain Redbud" native to Nevada, Utah and Arizona; very similar to the California Redbud.
Cercis racemosa Oliver* - "Chain-flowered Redbud" native to China; the only redbud producing flowers in chains 3-5" in length; paler flower color than most redbuds; recently distributed by U. S. National Arboretum.
Cercis siliquastrum L.* - "Mediterranean Redbud" native to southern Europe from Israel to Spain; the most commonly grown species in Europe with several listed cultivars which may or may not still exist in cultivation.
Cercis siliquastrum var. *siliquastrum** - found in Royal Botanical Garden, Madrid, Spain - not known how it differs from species.
Cercis siliquastrum 'Alba' ('Albida')* - White-flowered selection of Mediterranean Redbud; produced and sold in Europe.
Cercis siliquastrum 'Bodnant'* - Deep purple-flowered selection of Mediterranean Redbud from Bodnant Gardens, Wales; in England commercial production.
Cercis siliquastrum 'Carnea' - Pink-flowered selection of Mediterranean Redbud; may not still exist in cultivation.
Cercis siliquastrum 'Flora-Plena' - Double-flowered selection of Mediterranean Redbud; may not still exist in cultivation.
Cercis siliquastrum 'Fructu-Rubra' - Red-fruited selection of Mediterranean Redbud; may not still exist in cultivation.
Cercis siliquastrum 'Penduliflora' - Selection of Mediterranean Redbud with long pedicels and drooping flowers; may not still exist in cultivation.
Cercis siliquastrum 'Rubra' - Deep-colored selection of Mediterranean Redbud at Wisley Gardens, England.
Cercis siliquastrum 'Sinensis' - More vigorous selection of Mediterranean Redbud; may not still exist in cultivation.
Cercis siliquastrum 'Sterilis' - Sterile selection of Mediterranean Redbud which does not fruit; may not still exist in cultivation.
Cercis siliquastrum 'Variegata' - Variegated foliage selection of Mediterranean Redbud; may not still exist in cultivation.
*Cercis yunnanensis** - Chinese species very similar to *C. chinensis*.
Cercis yunnanensis (Unnamed white-flowered seedling) - Discovered in seedling lot at U. S. National Arboretum; under observation for possible introduction.

Significance to the Industry: This checklist provides growers with information about the range of *Cercis* taxa which exist for selection of types for potential future nursery production as well as which taxa are available for sharing of scion wood upon request from The NCSU Arboretum. Current correct taxonomic designations presented here can be used by nurserymen to produce catalogs and pricelists with accurate names. The most significant naming change for plants currently in production in the southeastern US is for the Texas Redbuds, 'Oklahoma' and 'Texas White' - which should now be listed as cultivars of *Cercis canadensis* subsp. *texensis*.

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***Cephalotaxus* Evaluations in The NCSU Arboretum**

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Nature of Work: Foundation plants are critical to both landscape and nursery professionals throughout the southeast. The search for a tough, easily produced and maintained, yet handsome foundation plant with good consumer appeal is an ongoing process. In the southeast, the challenge is intensified by the demands of the regional soils and climate which preclude the widespread and long term use of many nationally popular foundation plants like the northern nursery standard, *Taxus*. *Taxus* is not only a favorite of the northern segment of the industry, but is also a favorite of deer, an increasingly serious pest that will likely only become more of a problem with time. In addition to the demands of tough, deer-infested sites, foundation plants are also often subjected to at least partially shaded growing environments in the close confines of tight suburban developments - this is especially a problem as many of the more popular foundation plants that will tolerate some shade are not the best choices in the compacted clays of southeastern urbanized settings. In trials at The NCSU Arboretum, a variety of *Cephalotaxus* selections with forms ranging from strongly upright, to low and spreading, have proven to be well-adapted to sun or shade sites in heavy Piedmont soils. In addition, *Cephalotaxus* has remained completely undisturbed by deer in other, unfenced arboreta and trial sites. Easily produced from cuttings, *Cephalotaxus* is not only a successful alternative in the southeast for the landscape and production niche generally assigned to *Taxus*, but is also an excellent foundation plant in its own right for a diverse array of landscape settings.

Results and Discussion: *Cephalotaxus* selections in a variety of forms have performed well in full sun, partial shade and full shade even in heavy clay soils. All are hardy from zone 5 - 9 and are easily propagated from cuttings and rooted under mist. In general, *Cephalotaxus* is moderate to slow growing, with growth rates slowing as shade is increased (without any overall detriment to the plant). It prefers moist, well-drained soil but appears to thrive in almost any soil if adequate moisture is provided. Foliage may yellow and scorch somewhat in exposed locations with bright winter sun or strong winds. While one or two cultivars of *Cephalotaxus* are currently in general production, there are many other forms that are equally, or more desirable. Some of the best selections from trials at The NCSU Arboretum are described below, as well as brief notes on other forms of interest (either for reference or to avoid nomenclatural confusion). *Cephalotaxus* is dioecious with male and female flowers on separate plants. The large, berry-like fruit are of interest developing as 1-2" olive-green ovals and maturing to a purplish-brown. Certain named cultivars are separated by their male or female character. The nomenclature of *Cephalotaxus* has been historically varied and inconsistent between the

UK and USA. Names used below reflect the most general consensus of current literature available to the authors (1, 2, 3, 4, 5, 6, 7).

C. fortunei - Fortune's Plum Yew is a small tree or large shrub native to China with perhaps the most elegant foliage in the genus. Needles are 2-3 inches long, 1/8 inch wide with a long, tapering (but soft) tip, and glossy, black green. It will ultimately reach 10-15 feet in height with open, whorled branching. Bright white stomatal bands line the needle undersides. 'Grandis' is a female selection from Hillier's Nursery with exceptionally long needles and large fruit - 'Longifolia' is the male counterpart of 'Grandis'. 'Prostrate Spreader' is a low prostrate form selected at Hillier's over 50 years ago with spreading branching that will ultimately form a branching groundcover.

C. harringtonia - Japanese Plum Yew, one of the forms indigenous to Japan, is the most common form found in production in the US. It is shrubbier and coarser than *C. fortunei* with shorter, wider, stubbier needles whose undersides are gray. *C. harringtonia* is more densely branched than *C. fortunei* with narrower branch angles that give the appearance of 'V' shaped profiles. 'Duke Gardens' originated at Duke University as a horizontal spreading sport of 'Fastigiata' with dense growth and dark foliage - a striking and reliable foundation shrub. 'Fastigiata' is an usual form with radially arranged, horizontally held needles on upright branches - the unusual appearance is of bundles of formal, black—green bottle brushes set on end. Young plants of 'Fastigiata' are quite columnar and are excellent as vertical evergreens in shade areas but as the plant matures it develops into a large, global mass (over 10 years). 'Fritz Huber' is a low, outward branching form of especially good foliage quality with reduced burning in exposed sites. 'Gnome' is a Hillier's sport from 'Fastigiata' with similar growth and needle arrangement to 'Fastigiata' but is an overall dwarf form that develops into a low dome. 'Korean Sun' has typical *C. harringtonia* foliage but the new growth emerges a light gold in the spring which quickly fades with the first heat in the south. The growth rate of 'Korean Sun' is especially slow. With 'Prostrata' there is always discussion as to whether this low spreading form is a true mutation or perpetually propagated plagiotropic growth but it is always a beautiful low plant that is especially striking massed around buildings and hardscape. There are also a number of botanical varieties of *C. harringtonia* that seem to shift back and forth between separate species or botanical varieties. *C. harringtonia* var. *drupaceae* is a shrubby form found in the wild of Japan and central China. Needles are held on the branches in a distinctive 'V' shaped pattern with relatively dense branching that develops into a beautiful mass with pendulous branchlets as it matures. *C. harringtonia* var. *koreana* is a compact form found in Korea and China that has been described at different points in time as both *C. harringtonia* var. *koreana* and as a separate species, *C. koreana*. *C. harringtonia* var. *nana* is a low spreading form that reportedly layers easily.

C. koreana at The NCSU Arboretum was collected in Korea in 1985 as a distinct species with vigorous, upright habit and glossy, dark green foliage (not dissimilar to that of *C. fortunei*). This taxa does not consistently fit referenced descriptions of the botanical variety *C. harringtonia* var. *koreana*.

C. sinensis, the Chinese plum yew has an upright habit and horizontal branching similar to *C. fortunei* with shorter, wider needles like those of *C. harringtonia* but with bluish undersides to the needles.

Other species of *Cephalotaxus* presently not in cultivation that can be found in Asia include *C. griffithii*, *hainanensis*, *mannii*, *oliveri*, and *wilsoniana*.

Significance to the Industry: Of the many botanical and horticultural selections of *Cephalotaxus* perhaps the five with greatest potential for nursery and landscape use in the southeast are *C. fortunei* (either the species or 'Grandis'), *C. harringtonia* 'Duke Gardens', 'Fritz Huber', 'Fastigiata', and 'Prostrata' (with 'Korean Sun' as a collector's special interest selection). The species and cultivars of *Cephalotaxus* offer landscapes and nurseries of the southeast an opportunity to provide high quality, deer-proof foundation plantings of great beauty, character and utility combined with excellent potential for production.

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The NCSU Arboretum Evaluation of "Minor" Conifer Genera for Commercial Nursery Crops Potential

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Nature of Work: Diversity of coniferous genera in production and use in southeastern nurseries and landscapes has been limited - both by availability and by the reputation of conifers as relatively slow, uncertain crops and landscape plants in much of the hot, wet southeastern US. In reality, however, many of the world's most beautiful and serviceable coniferous genera have not received adequate trial or evaluation in southeastern landscapes and many of these unusual "minor" conifers make excellent, unique plants in both landscape and modern production environments. In trials at The NCSU Arboretum, a surprising number of these strikingly attractive and unusual plants have proven to be both well-adapted to Piedmont conditions and readily produced by standard nursery practices. Increased production and use of these "minor" conifers by nursery and landscape professionals offers an opportunity for improved plant diversity, and year-round consumer appeal, in today's competitive and environmentally conscious production environment.

Results and Discussion: Of the many hundreds of conifers in trial at The NCSU Arboretum, the following "minor" genera reflect the diversity of coniferous plants that are good choices for southeastern landscapes and nurseries. Selected species within these genera have been chosen for discussion with brief notes on propagation. Those plants described below exhibit a range of cold hardiness appropriate to different areas of the southeast and should be selected for production or use accordingly. Plants of borderline hardiness are noted as such. Nomenclatural changes on obscure genera often take even longer to be reflected in major references than changes in the names of widely grown material. Every effort has been made to use the most currently correct names while including any prior names in parentheses for reference (1, 2, 3, 4, 5, 6, 7).

***Callitris oblonga*, *C. rhomboidea* (*C. tasmanica*)** - Native to Australia and New Zealand and reliably hardy only to zone 8-9, a *Callitris* has grown surprisingly in protected micro-climate at The NCSU Arboretum developing exceptional blue-grey or bright green foliage tightly appressed to the stem and resembling collections of tiny milk bottles. Habit is delicate and brushy on an informally upright plant reaching 10 feet with a spread of 3-4 feet. Propagation is best from seed, winter cuttings can be rooted with difficulty but are extremely unpredictable both during rooting and when they come out of the bench. *Callitris* prefers light sandy soil in full sun and is tolerant of drought and salt - therefore a good experiment for adventurous growers on the coast where its unusual texture would be especially appealing.

Fokienia hodginsii - *Fokienia* is a monotypic genus of the Cupressaceae native to China and parts of Vietnam. The glossy, grass-green foliage superficially resembles that of *Calocedrus* or *Thujopsis* but juvenile foliage is significantly more flattened and the undersides are covered with a dramatic, broad white stomatal band. Habit is loosely conical and relatively open with the foliage appearing silvered when wind-blown. Graceful and exotic with a ferny texture and especially handsome color, *Fokienia* is one of the few conifers that will thrive in partial shade and prefers high heat and humidity in the summer. High summer heat is needed to maximize winter hardiness which can extend to zone 7 in optimal conditions but is generally reliable only to zone 8 (coast and eastern Piedmont). *Fokienia* can be readily propagated from cuttings rooted under mist. It has good potential for the industry and is being propagated for release from The NCSU Arboretum.

Glyptostrobus pensilis (G. lineatus) - The 'Canton Water Pine' is a close botanical relative of Bald Cypress and equally tolerant of wet, periodically flooded sites. *Glyptostrobus* is not as uniformly ornamental as *Taxodium* but has appeal as an unusual deciduous conifer specimen and an exceptionally tough plant that will tolerate a wide range of soil conditions (as does *Taxodium*). *Glyptostrobus* will eventually grow to a large tree with a very open canopy of narrow, slightly pendulous branches in somewhat random arrangement. Needles are appressed to the stem and a handsome light grey-green color that turns warm cinnamon before leaf-drop in the fall. *Glyptostrobus* is generally cited in European literature as not reliably cold hardy but it is successfully grown in zone 6 in the US and has thrived in Raleigh. It can be propagated from summer semi-hardwood cuttings or seed.

Keteleeria davidiana , K. evelyniana - *Keteleeria* is another genus fromn China and southeast Asia that thrives in high heat and humidity. A member of the Pinaceae, *Keteleeria* bears an uncanny resemblance to *Abies* in general and *A. firma* in particular making it an excellent alternative to fir in the southeastern Piedmont. *Keteleeria* is gracefully pyramidal and upright with slightly narrower needles and a more refined texture than *A. firma* . In addition to 12 months of spring-green, excellent quality foliage, new growth emerges blushed with pink in the spring and holds a light rose hue into early summer. *Keteleeria* will eventually reach 50-60 feet in height but with a growth rate of ca.1-2 feet a year is best thought of as a 20 foot landscape tree. *Keteleeria* will perform well in clay soils but needs full sun. It is hardy throughout the south from the coast to the mountains and can be propagated from seed or possibly from cuttings taken in winter with some hardened wood.

Pseudolarix amabilis (P. kaempferi) - The Golden Larch is not a true Larch (*Larix* sp.) but is a closely allied deciduous conifer from China. It has

much of the beauty of *Larix* but shows good adaptability to the southeast without the root-rot problems of *Larix*. Habit is somewhat more coarse and open than *Larix* but the crown-shaped clusters of arching, soft needles turn brilliant gold in the fall with color to rival most maples. It is a formally pyramidal tree with whorled limbs reaching 60-80 feet with age. *Pseudolarix* thrives in full sun in a range of soils from sandy loams to heavy clays and must be propagated from seed - but obtaining seed can be a challenge as cones are only produced on the upper branches of tall, mature trees with multiple plants for cross-pollination. Golden Larch is fully hardy from the coast to the mountains of the southeast and is an excellent conifer for tough, demanding sites that deserves much wider use throughout the southeastern US. There are a few, extremely rare named cultivars in Europe and Asia ('Annesleyana', 'Dawsonii', 'Nana') propagated by grafting.

Sequoia sempervirens - While the general image of the Coastal Redwood of California is of a primeval forest of 300 foot tall trees towering over an understory of leafy fern, young trees are exceptionally handsome and tidy landscape trees. Individual seedling variants of *Sequoia* perform well in the southeastern Piedmont where they may be surprisingly tolerant of the heat and heavy soils. The evergreen foliage is similar to that of *Metasequoia* (Dawn Redwood) but is darker green, and stiffer with rich, glossy color all year. Trees grow 1-2 feet a year in the south and do very well in partial shade, which can be helpful as they do not survive harsh winds or severe exposure. *Sequoia* is reliably hardy into zone 7 and would not be a good choice for the mountains or the dry sands of the coast, but it is an excellent, unique addition to Piedmont landscapes. It is readily propagated from cuttings and there are a few cultivars of note. The new growth of 'Adpressa' emerges creamy white and eventually fades to green with the heat of summer. 'Adpressa' has been the most dependable *Sequoia* cultivar in the Piedmont. 'Chapel Hill' from Camellia Forest Nursery in Chapel Hill, NC is an excellent regional selection. 'Prostrata' is a low, prostrate selection (likely an artifact of cutting propagation) and 'Soquel' is a selection from Iseli's Nursery with especially dense, uniform habit and dark green foliage. *Sequoia* is a good choice to add diversity and interest to protected suburban sites.

Taiwania cryptomerioides - Named for its native island of Taiwan, *Taiwania* is a close relative of *Cryptomeria* with similar foliage and general appearance except that *Taiwania* has stiffer, sharper, more widely angled (and painful) needles. Branches are pendulous and quite dense with foliage. It is informally pyramidal to 50 feet with blue-green needles that is best thought of as a 20-30 foot landscape tree. *Taiwania* performs best with summer sun and winter shade which gives the most handsome foliar color and avoids potential winter scorch of needles. It can be propagated from seed or cuttings taken with hardened wood. Rooted cuttings require several years of field growth to develop desired orthotropic growth.

Thujaopsis dolobrata - False Arborvitae is a shade tolerant, slow growing conifer with flattened needles reminiscent of those of *Thuja* but slightly larger and patterned with white on the undersides. It is gracefully rounded and moderately dense with the dwarf and variegated forms making excellent foundation plants for partial shade. It will eventually reach 70 feet in height with age but is more usually seen at 5 - 15 feet in the landscape. *Thujaopsis* is reliably hardy from the coast to the mountains of the southeast and prefers moist, well drained soils but will tolerate clays. It is easily propagated from cuttings, even from mature, older specimens. The cultivar 'Nana' is a compact, dwarf form and 'Variegata' has foliage liberally variegated with creamy white but may burn in some full sun situations. *Thujaopsis* is a trouble-free conifer with special appeal whose ease of propagation and beautiful form call for wider use in a range of southern landscapes.

Torreya californica, T. grandis, T. nucifera, T. taxifolia - The Nutmeg Yews, (from California, China, Japan and Florida, respectively) are an interesting set of plants related to *Cephalotaxus*, the Plum Yew. *T. taxifolia* is the 'Stinking Cedar' of Florida whose foliage emits an unpleasant odor when crushed. *Torreya* is an upright, stiff needled evergreen with small, black-green leaves similar to those of *Taxus* (true Yew) but narrower and sharper. Branching and foliage are relatively open and the overall habit varies slightly among species but is generally conical (or slightly rounded) with plants eventually reaching 10 - 40 feet in height but usually seen at 5 - 15 feet. The fruits of *Torreya* resemble those of Nutmeg, hence its common name. It is reliably hardy through the coast and Piedmont and can be propagated from seed separated from mature fruits or from cuttings. *Torreya* prefers partial shade and moist, well-drained soils but it will tolerate clay in a shaded site with attention to regular moisture. Its refined, formal outline is especially effective flanking walks, gateways, arches and the like.

Widdringtonia nodiflora (W. cupressoides) - African Cypress is native to South Africa and closely resembles its old namesake, the true Cypress (*Cupressus*), in form and texture but with a softer, more cottony appearance and lighter green foliage. It is pyramidal in youth to about 30 feet and then develops a spreading crown. *Widdringtonia* is reliably hardy in zone 8 and potentially into zone 7 and is very drought tolerant. It prefers well-drained soils in full sun and will likely suffer in extremely heavy clay. *Widdringtonia* is most readily propagated from seed. This is another beautiful genus for adventurous coastal growers.

Significance to the Industry: The "minor" conifer genera described here present an exciting range of new options to expand the palette of conifers in southeastern landscapes and nurseries. Of the plants discussed above, perhaps the top five with best potential for the industry are *Fokienia*, *Keteleeria*, *Sequoia*, *Thujaopsis*, and *Torreya*. Their unique combination of

unusual character, good adaptability, and ready propagation make them excellent choices for the next generation of plants for year-round interest.

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The NCSU Arboretum Evaluation of New Asian Woody Plant Genera with Commercial Nursery Crop Potential

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Nature of Work: The majority of nursery crops grown in the southeastern US belong to a relatively small number of well-known genera often containing dozens of species and at times innumerable cultivars which have been selected through decades to centuries of garden use. Examples would include such groups as *Acer*, *Berberis*, *Juniperus*, *Pinus*, *Quercus*, *Rosa*, and *Thuja*. China is well known to have the most diverse flora of temperate zone woody plants in the world and since the 1700's it has provided a steady flow of outstanding plants which have come to dominate the nursery industry of the southeastern US - with estimates of as high as 85% of the plants now in production having an Asian background. In spite of centuries of exploration and introduction - the wealth of the Chinese flora is still not fully explored and new plants continue to be discovered and distributed.

During the past 10 years, The NCSU Arboretum has actively collected plants from Asia for trial through a plant exploration trip to Korea with the U. S. National Arboretum in 1985, through active use of Index Seminum materials from Chinese, Korean, and Japanese botanical gardens, and through shared materials from nurseries and public garden research programs around the world. Adaptation trials in NC have shown good climatic adaptation and ornamental potential of a variety of rare, often monotypic genera unique to Asia.

Results and Discussion: A selection of twelve taxa that have performed well in NC with commercial nursery crop potential are presented below with brief information on general plant character, propagation, hardiness, and present status in the nursery industry. With such "rare minor genera" published information is often difficult to locate and the following general guides will offer the best potential for search ().

Daphniphyllum macropodum Miq. (Daphniphyllaceae) - "Daphniphyllum". Although 15 species exist, only 2 are in cultivation in the US with this species being the primary one grown. A beautiful large-leaved broadleaved evergreen tree native to China, Japan, and Korea capable of reaching 45' in height but more commonly seen at 15-25' in cultivation. The flowers are green and inconspicuous, but the blue-black fruit are showy in autumn and winter. Easily propagated from stratified seed or softwood cuttings and rapid growing with 2-3' per year potential when young. Plants are growing well in Washington, DC and have potential for use in USDA Zones 7-10 with marginal use in zone 6. Variegated selections exist in Japan. Sold in a few

speciality hobbyist nurseries in the southeast US.

Dendropanax trifidus (Thunb.) Makino (Araliaceae) - "Ivy Tree". The only temperate zone hardy species in a genera of over 80 tropical and subtropical shrubs and trees. A handsome broadleaved evergreen tree to 20' native to Japan with 2-3 lobed leaves. Flowers are yellowish-green in terminal panicles followed by round black fruits. Easily propagated from stratified seed, or less easily with softwood cuttings. Moderate growth rate of 0.5-1' growth per year when young. Potential for use in USDA Zones 7-9. Very rare in US commercial production with only a couple of speciality growers known.

Edgeworthia papyrifera Sieb. & Zucc. (Thymelaeaceae) - "Paper Bush". A very showy flowering 5-8' deciduous shrub native to the Himalayas and southwest China and introduced to Japan where it is commercially grown as a fiber source for high quality paper. Flowers are produced in early spring in terminal 2-3" diameter "balls" of white and yellow tubular flowers before the lance shaped simple leaves appear. Easily propagated from semi-hardwood cuttings under mist in summer. Needs good moisture and drainage - best in light shade in the southeast. Potential for use in USDA Zones 7-9 with occasional damage in zone 7. Rare in US commercial production.

Euscaphis japonica (Thunb.) Kanitz (Staphyleaceae) - No common name. A monotypic genus of a small deciduous tree to 25' native to Japan, Korea and China. The foliage is pinnately compound, thick and leathery, dark green and lustrous through the summer with no notable fall color. Flowers of no particular ornamental merit appear in May. The fruit are exceptionally showy, opening bright red-purple fleshy fruit revealing black fruit in large panicles. The ornamental fruit display continues August to October. In winter the bark shows white stripes on deep purple background. Propagation is by seed with both scarification and cold stratification required, and at times two years are required to get good germination. Growth is slow the first year but established plants can grow 3' per year when young. Widely variable provenances affect hardiness, but Korean collections produce plants hardy for use in USDA Zones 6-9. The NC Association of Nurserymen is propagating and promoting this plant and it is currently entering the markets in NC.

Heptacodium miconioides Airy-Shaw (*H. jasminoides*) (Caprifoliaceae) - "Seven-Son Flower". First collected in China by Wilson in 1907 and described from the herbarium sheets by Rehder in 1916, but it did not enter western cultivation until the 1980 Sino-American Botanical Expedition returned with seed which were grown by the Arnold Arboretum, Cary Arboretum and New York Botanical Garden (). It has been grown at The NCSU Arboretum since 1983. A deciduous small tree to 25' with white fragrant flowers in early autumn which are followed by showy purple bracts

which provide color through the fall. As it develops a mature multi-trunk habit with limbing up, the winter bark is very attractive with peeling white to tan bark. Propagation is by semi-hardwood cuttings in summer. Young plants from cuttings are plagiotropic with sprawling horizontal branches and need to be field grown to establish a good root system, then with topping back to the ground while dormant, the tree form upright growth will develop. Adaptable for use in USDA Zones 5-8. In commercial production around the US by a number of speciality nurseries, but nowhere is it truly common or in garden center sales yet. Great potential for ornamental use - with marketing difficulty due to limited visual appeal in the spring sales period.

Loropetalum chinense (R. Br.) Oliv. (Hamamelidaceae) - "Loropetalum". A broadleaved evergreen shrub to small tree from India, China and Japan which has long been grown as an ornamental in the southeastern US. Showy white flowers are produced in spring. Several clones of the hot-pink/purple-flowered *L. chinense* var. *rubrum* have recently been obtained from China by several collectors and are rapidly entering the commercial market at present. In an attempt to give some order to the confusion of multiple accessions and clones - the US National Arboretum is naming the purple-foliage form, 'Burgundy'; and the green-foliage form, 'Blush'. These clones seem to have lower chilling requirements than the species and provide sporadic flowering throughout the growth period as well as the main heavy bloom in spring. Propagation is by cuttings at most any time of year. Young plants from cuttings are plagiotropic with sprawling horizontal branches and need to be field grown to establish a good root system which will force upright growth without topping. Hardiness of the new clones is unknown but will likely be similar to the species with potential use in USDA Zones 7-10. Of great market potential for both landscape and pot plant use and will likely be a major crop quickly in the southeastern US. The NC Association of Nurserymen is propagating and promoting this plant and it is currently entering the markets in NC.

Poliiothysis sinensis Oliv. (Flacourtiaceae) - No common name. A monotypic genus of a small deciduous tree to 25' introduced from China by Wilson in 1908. Noted for its creamy-white fragrant flowers produced in July and August. Propagation is by seed with cold stratification. Very rarely seen even in botanical gardens and only occasionally sold by one or two rare plant specialists. Well adapted to growth in the southeastern US and is hardy to USDA Zone 5.

Rehderodendron macrocarpum Hu (Styracaceae) - No common name. Although 10 species are reported to exist in China, only this one seems to be in cultivation in the west with probably less than a half dozen flowering size trees in North America today (). It is a deciduous tree with white flowers in hanging clusters in spring which was found on Mt. Omei in west China in 1931. It has great ornamental potential and is described in Hilliers

Manual () as "a magnificent species, in garden merit equal to the best *Styrax*." Fruit are oblong and turn red in fall for ornamental effect. Seed apparently require stratification and may have double dormancy, but it roots readily from semi-hardwood cuttings in summer under mist and there should be no propagation barriers to commercial use. Probably adaptable to USDA Zones 6-9.

Rhamnella franguloides (Max.) Weberb. (Rhamnaceae) - No common name. A monotypic genus of a small 15-20' deciduous tree native to Korea which is so rare as to not be listed in any plant reference beyond the Flora of Korea (). Spring flowers are inconspicuous, but the glossy foliage is handsome through the summer, and the abundant small oblong fruit provide highly ornamental color in summer as they change from green to yellow to orange to red to black. Plants in The NCSU Arboretum were grown from seed collected in Korea in 1985 and have proved to be both ornamental and highly stress tolerant to drought and heavy clay soils. Propagation is by stratified seed which should be collected before birds feed on it. Stem cuttings have not rooted, but sprouts from roots which have been injured by field cultivation equipment indicate that root cuttings may be a possible propagation technique. Of potential for production but probably never yet sold by any nursery anywhere.

Sinocalycanthus chinensis Cheng & Chang (Calycanthaceae) - "Chinese Sweetshrub; Chinese Wax Shrub". A newly discovered and introduced 8-12' deciduous shrub monotypic genus from China which is related to the American sweetshrubs, *Calycanthus*. Although closely related and possessing identical seed pods, the large white flowers resembling single camellias and coarse foliage show no resemblance to the American genera. First flowered in North America at the University of British Columbia Botanical Garden and the Brooklyn Botanical Garden in the last decade (). Easily propagated from cold stratified seed or by semi-hardwood leafy cuttings in summer under mist. Adapted to use in USDA Zones 5-9. Beginning to enter some commercial markets in the northwest and north-east.

Sinojackia rehderiana Hu (Styracaceae) - No common name. A genera of 2 deciduous trees native to China rarely seen in cultivation and until recently, probably never in commercial commerce. Of the two species, this has been the most ornamental in trials at The NCSU Arboretum - primarily on the basis of superior foliage with a dark green, lustrous appearance. White flowers cover the plant in early spring and the unusual cylindrical and beaked fruit have some ornamental character in fall. Mature height is unknown but will likely be in the 25-30' range. The abundant seed have seemed impossible to germinate to date and recent advice from Chinese authorities indicate the need to crack the thick hard seed coat mechanically. Commercial merits include good flowers and foliage, stress tolerance, ease of propagation from semi-hardwood cuttings and good growth rate. The NC

Association of Nurserymen is propagating and promoting this plant and it is currently entering the markets in NC.

Trochodendron aralioides Sieb. & Zucc. (Trochodendraceae) - "Wheel Tree". A monotypic genus of an evergreen tree reaching 50' native to Japan, Korea and Taiwan. Variable in habit from seed with plant habit ranging from shrubby and broadspreading to upright and treelike. Although it can easily be propagated from semi-hardwood to hardwood cuttings, cultivar selections have not been made. The flowers and fruit are interesting though not showy - and the plant would primarily be grown for its attractive foliage and evergreen nature. Adapted for use in USDA Zones 7-9 (with potential for use in Zone 6 for hobbyists). Available from speciality collector nurseries, but it has never been a standard wholesale nursery crop.

Significance to the Industry: The 12 shrubs and trees described above offer potential for new market crops for southeastern US growers. Propagation material is generally available from The NCSU Arboretum in limited quantity upon request, or assistance can be given in locating producers of the crops. Of the 12 plants, perhaps the best commercial potential of combined landscape use, market appeal, propagation ability, and profitability (speed) is offered by *Euscaphis*, *Heptacodium*, *Loropetalum*, and *Sinojackia* at this time.

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Lindera Evaluations in the NCSU Arboretum

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Nature of Work: Among the wide diversity of woody plants in evaluation at The NCSU Arboretum, a large number of *Lindera* taxa were gradually accumulated through various sources. In observing this group of plants over the years it has become apparent that many beautiful and well adapted potential landscape crops for use in the southeastern US are included in this obscure and rarely grown genera.

The genus *Lindera* in the Lauraceae family is named in honor of the Swedish botanist, Johann Linder (1678-1723), and contains over 80 species of deciduous and evergreen shrubs and trees native to temperate and tropical eastern Asia and North America. Over time, various species have been shifted back and forth from this genera to the closely allied *Benzoin*, *Laurus*, and *Parabenzoin*. As a group, the plants are noted for their yellow to greenish-yellow dioecious flowers in early spring, for aromatic foliage which is often colorful in autumn or persistent in winter, and attractive small, round black fruit in fall/winter. Although possessing many plants with highly ornamental qualities and outstanding stress tolerance, only two species of this genus are grown commercially in the US - and those as very minor crops in both instances. This paper summarizes the plants under evaluation at NCSU and provides landscape characteristics and production observations.

Results and Discussion: Twelve taxa in The NCSU Arboretum collection are presented below with brief information on general plant character, propagation, hardiness, and present status in the nursery industry. Published information on this genus is often difficult to locate and the following general guides will offer the best potential for search (1, 2, 3, 4, 5, 6, 7, 8, 9).

Lindera benzoin L. (syn. *Benzoin aestivale*) ("Spice Bush") - A deciduous shrub native to the eastern US where it was often used by pioneers to brew a spicy tea from twigs in winter. Yellow flowers early in spring and red fruit in fall on female plants. Good native shrub for naturalizing and the early spring flowers add late winter interest to a garden. It has been in cultivation in England since 1683, and is probably grown more widely there than where native in the US. Sold occasionally by US nurseries, particularly those specializing in native plants.

Lindera benzoin 'Green Gold' ("Green Gold Spice Bush") - A male clone recently introduced by Tom Clark of Fern Valley Nursery, Yadkinville, NC for its exceptionally showy, large yellow flowers in early spring. Other

cultivars described by Dirr (3) include 'Rubra' with brick red male flowers and darker red-brown winter buds, and 'Xanthocarpa', a yellow-fruited form.

Lindera chienii - A very rare species of deciduous shrub native to China which is not yet in any western garden reference and which may have been introduced to western cultivation by Camellia Forest Nursery, Chapel Hill, NC. It has been notable for extremely showy greenish-yellow flowers in later winter and would be an excellent plant for the winter interest garden.

Lindera erythrocarpa Makino - A large deciduous shrub to small tree native to Japan, China and Korea which was collected by The NCSU Arboretum in Korea in 1985. Reported to grow to 12', but our specimen is nearly that height in only 7 years with rapid growth continuing. Although attractive, so far not outstanding in ornamental value of flowers or fruit in comparison to some other species in trial.

Lindera glauca (Sieb. & Zucc.) - A large deciduous shrub to small tree to 15'; native to Korea, China, Japan and Taiwan. It has been an outstanding ornamental with persistent narrow-elliptic silvery-bronze foliage through the winter months which highlights the abundant black fruit. In addition to garden value, it is excellent as a source of winter cut foliage for floral design work. In China it is used for the manufacture of incense sticks. In bloom in early spring, the greenish-yellow flowers provide a highly unusual color combination with the persistent winter foliage.

Lindera megaphylla Hemsl. - An evergreen shrub or tree introduced by Wilson in 1900 from south and southwest China which has reached over 30' in cultivation in England. It has handsome foliage with highly glossy foliage resembling a Cinnamomum or Daphniphyllum which is aromatic when crushed. Greenish yellow flowers in spring with black fruit in autumn.

Lindera obtusiloba Blume (Japanese Spicebush) - A deciduous shrub or tree to 30' native to China, Japan, and Korea which was introduced by Maries in 1880 from Asia and later reintroduced by Wilson and the Arnold Arboretum in 1908. It is noted for exceptionally beautiful clear yellow foliage in autumn [Dirr - "no other woody plant rivals it for intensity of yellow coloration"] and was given an Award of Merit by the Royal Horticultural Society in 1952. Dirr reports July cuttings root 55%. It is produced and available in the Pacific northwest where it is highly prized by plant connoisseurs.

Lindera praecox (Sieb. & Zucc.) (syn. *Parabenzoïn praecox*) - A deciduous shrub or small tree to 25' native to Japan and Korea.

Lindera praecox (Sieb. & Zucc.) 'Japanese Variegated' - A white variegated clone which was imported from a Japanese variegated plant specialist for trial. It had irregular white variegation on foliage which tended to fade in the summer heat. Since lost, and no longer in the collection.

Lindera reflexa - A deciduous shrub not in western literature introduced from China by Camellia Forest Nursery, Chapel Hill, NC. Too young for true evaluation of ornamental potential.

Lindera salicifolia - A deciduous shrub not in western literature introduced from China by Camellia Forest Nursery, Chapel Hill, NC. Too young for true evaluation of ornamental potential.

Lindera strychnifolia (Sieb. & Zucc.) - An exceedingly handsome species of evergreen shrub native to China, Taiwan, Phillipines, and SE Asia. Hardier than expected with years of slow growth in The NCSU Arboretum with no winter injury noted - now 8' in height. Very dense growth and dark green foliage which highlights the showy yellow flowers in spring. Has excellent potential for a landscape specimen or informal hedging plant. Semi-hardwood to hardwood cuttings root in 90% levels under mist.

Lindera triloba (Sieb. & Zucc.) (syn. *Parabenzoin trilobum*) - A deciduous shrub to 15' native to China & Japan.

Lindera umbellata Thunb. - A deciduous shrub to 20' native to China and Japan. Like the *L. glauca* described above, it has been an outstanding ornamental with persistent silvery-bronze foliage through the winter months which highlights the abundant black fruit. Again, in addition to garden value, it is excellent as a source of winter cut foliage for floral design work.

Other species not yet in our collections which are listed in Korean and Japanese Floras (5, 7) that would likely be well adapted for use in the southeast include *L. citriodora* (Sieb. & Zucc.) Hemsl. and *L. sericea* (Sieb. & Zucc.) Blume. Camellia Forest Nursery, Chapel Hill, NC grows *L. aggregata*, an evergreen Chinese species and the deciduous *L. rubronervia* Gamble from southwest China. In addition, *L. praetermissa* Grierson & Long (Tibet, Burma and China) is reported in cultivation in England (4). *L. melissifolia* (Walt.) Blume (Jove's Fruit) is a rare US native usually found in small endangered populations. Another US native, *L. subcoriacea* (Bog Spicebush), has recently been offered by Woodlanders Nursery, Aiken, SC as well as the Chinese evergreen species, *L. fragrans*.

Significance to the Industry: Hardiness, stress resistance, freedom from pests and diseases, showy spring flowers, handsome foliage and fruit make many *Lindera* species excellent potential landscape plants. Seed of

rare exotic species is rarely available, and the dioecious nature of plants often precludes collection of viable fruit from botanic garden collections where a single plant is on display. If multiple plants of a species were obtained to establish seed blocks, production could become very easy and dependable. Varying degrees of success have been reported in rooting of cuttings, with enough general success to warrant trial of new species - particularly if from young seedlings with juvenile tissue.

Of the species observed at The NCSU Arboretum, *L. chienii*, *glauca*, *megaphylla*, *obtusifolia*, and *strychnifolia* seem the most ornamental with the greatest promise for commercial production in the southeastern US. Camellia Forest Nursery, Chapel Hill, NC and Woodlanders Nursery, Aiken, SC have offered a far wider range of rare exotic *Lindera* species for sale than any other nurseries in the US and provide opportunities to acquire initial plants to use for propagation stock.

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Developing A Plant Selections Program in Georgia

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Georgia

Nature of Work: Producing and marketing new plants in the Professional Green Industry has historically been a sort of Catch-22; nurserymen grow plants that consumers demand in high volume while consumers only demand what is readily available. The result is a cyclic production/marketing scheme dependent on a limited number of so-called "bread-and-butter" plants to carry the market. The consequences of this scheme are that certain plant species become over-planted and landscapes begin to appear monotonous (ie. bradford pear and redbud). Also, when monocultured in landscapes, insect and disease pests are more difficult to control and may mean the demise of the plant.

The plant palate of consumers is becoming more sophisticated as evidenced by the growing interest in herbaceous perennials during recent years. Consumers are looking for low-maintenance alternatives to common plants and durable plants that tolerate environmental extremes and pests. Seasonal interest from flowers, foliage, berries and bark are highly desirable merits. Consumers are also requesting specific cultivars of plants they have read about in gardening books and periodicals.

During the fall of 1992, the Georgia Cooperative Extension Service facilitated the formation of a Georgia Plant Selections Committee. The committee was carefully assembled to represent all areas of the ornamental horticulture industry, including landscape designers, landscape installers, growers of both herbaceous and woody plants and retailers. Also on the committee were faculty from The University of Georgia Horticulture Department who were involved in plant evaluations, Extension Specialists having commodity assignments to the nursery, greenhouse, landscape and garden center industries, and several county Extension agents. The objectives of the committee, agreed upon by the members were as follows: (1) to identify outstanding ornamental plants, including both new, unknown plants with promise as well as under utilized plants already in the trade; (2) to develop a statewide mechanism for evaluating new plants; and (3) to encourage the production and utilization of superior plants identified by the committee.

Results and Discussion: The first thing the committee did was review plant selection programs in other states, including the Coordinated Educational and Marketing Assistance Program (CEMAP) in Texas (1) and the Plant Selections Program of the Ohio Nurserymen's Association (2,3). After considerable discussion and debate, it was decided that a hybrid of these

programs was best for Georgia.

Three sub-committees were formed to address the objectives of the committee. A **Selections and Trialing Sub-committee** was charged with preparing a list of under utilized superior plants and a list of new plants for trialing. This sub-committee was also responsible for developing a mechanism for trialing and evaluating new plants. An **Education Sub-Committee** was assigned the task of developing a list of possible vehicles for educating consumers and landscape professionals about the use, cultural requirements and maintenance of the designated plant selections. A **Production and Marketing Sub-committee** was challenged to develop a logo for the program, creative marketing ideas, and a time-frame for production and promotion.

Numerous sub-committee and committee meetings during the following six-month period resulted in the following action:

1. Two to four plants will be promoted each year and designated "**Georgia Gold Medal Winners**".
2. Initially, for the first two years, selections will consist of under utilized superior plants already in the trade. This will allow the program to get underway without delay.
3. Meanwhile, trial sites for evaluating new plants, both herbaceous and woody, will be established at University Experiment Stations in Blairsville, Athens, Tifton and Savannah.
4. The following criteria will be used when selecting plants:
 - (a) **Consumer Appeal** - What are the merits of the plant that will appeal to consumers? Does the plant offer what the consumer wants? Is the plant a better alternative to another plant?
 - (b) **Low-maintenance inputs** - Does the plant require little care in terms of pruning, grooming, fertilization and pest control?
 - (c) **Survivability** - Is the plant widely adaptable to a variety of sites? Is the plant tolerant of environmental stresses?
 - (d) **Ease of Propagation** - Does the plant propagate readily from seed or cutting?
 - (e) **Seasonal Interest** - What are the seasonal merits of the plant (ie. flowers, foliage, fall color, berries, bark etc.)? Does the plant have market appeal during more than one season?
5. A **Georgia Gold Medal Winner** seal has been developed and will be copyrighted by the committee.
6. By-laws have been written and the committee is in the process of getting incorporated.
7. Four **Georgia Gold Medal Winners** for 1994 have been selected by the committee: *Fothergilla major* 'Mt. Airy'; *Cephalotaxus harringtonia* 'Prostrata'; *Dianthus gratianopolitanus* 'Bath Pink'; and *Verbena* 'Homestead Purple'. Several other selections have been designated for the trial sites in 1994 and 1995. Drs. Michael Dirr and Allan Armitage in the

Horticulture Department at The University of Georgia are providing planting stock for the trial sites. An evaluation form is being prepared for periodic feed-back from the cooperators.

8. Growers will be targeted during the summer, fall and winter of 1993/94 with promotional materials and propagation information on the new plant selections. The Plant Selections Committee will have a booth at the SNA Show in Atlanta, at the Trade Show of the Georgia Green Industry Association in January, 1994, and at the 1994 Atlanta Flower Show.
9. Consumers will be targeted next spring with numerous mass media promotional efforts and displays in garden centers.

Significance to Industry: A plant selections and introduction program, if effective, can benefit growers, retailers and consumers by encouraging the production and utilization of superior plants. In addition to the economic benefits to growers and retailers, a plant selections program can help link the various segments of the Green Industry by opening communication channels, breaking perceived barriers and fostering a spirit of industry-wide cooperation.

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Tennessee's Landscape Industry: A Growing Business.

Sam Osawaru, Fisseha Tegegne, and Surendra P. Singh
Tennessee

Nature of Work: The landscape industry is one of the major sub-industries of the nursery and greenhouse industry. It is a service oriented industry comprising of various size firms that design, install, and/or manage commercial, municipal, recreational, institutional, or private grounds. Trends such as urbanization, development of smaller properties and multi-unit family housing, two income families and an increased demand for renovation of existing properties will drive expansion in all segments of the industry. Various specific studies pertaining to aspects of the landscape industry have been conducted in other states (1,2,3).

In Tennessee, the industry is growing. Out of about 400 landscape firms listed with Tennessee Nursery Association (TNA) in 1992, only a few were in business before 1980. In 1989, almost 14 percent of the total nursery and greenhouse sales of \$325 million were to landscapers directly (4). Most of the firms are located in and around the four metropolitan counties of the state (Shelby, Davidson, Knox and Hamilton counties). In 1992 a study was conducted at Tennessee State University to provide information on the structure of this subindustry, the services they provide, source of purchases and the future prospect for the industry. A mail survey of 115 randomly selected firms from a population of 380 landscape firms was conducted in the summer of 1992. The survey instrument was a two-page confidential questionnaire, 54 firms responded and 48 questionnaires were usable. The survey questions discussed are listed in (Table 1).

Results and Discussion: About 70% of the firms were single owner proprietorship and relatively young (less than 12 years old). Services rendered by the firms were mainly exterior designs, maintenance, and installation to residential customers. The majority of the firms surveyed had a gross sales of more than \$100,000 in a year. Most respondents were optimistic about the future of the industry and expected a moderate increase in their sales volume in the next three years. It is important to note that most firms purchase plants from Tennessee and from neighboring Southern states (Fig. 1).

Significance to Industry: The landscape industry is composed of a great number of professionals involved with the design, installation and maintenance of public and private grounds. Landscapers use a large amount of plant materials, however, one of the frequent problems they face is finding plants, especially trees, of the type and size specified by an architect or a designer. Therefore, the industry has a significant influence on the demand for nursery crops. Growers need to develop a better understanding of

landscape business, its market potential, and trends in consumer buying power. It is also important that landscapers are educated about plants, their identifications, and growth characteristics.

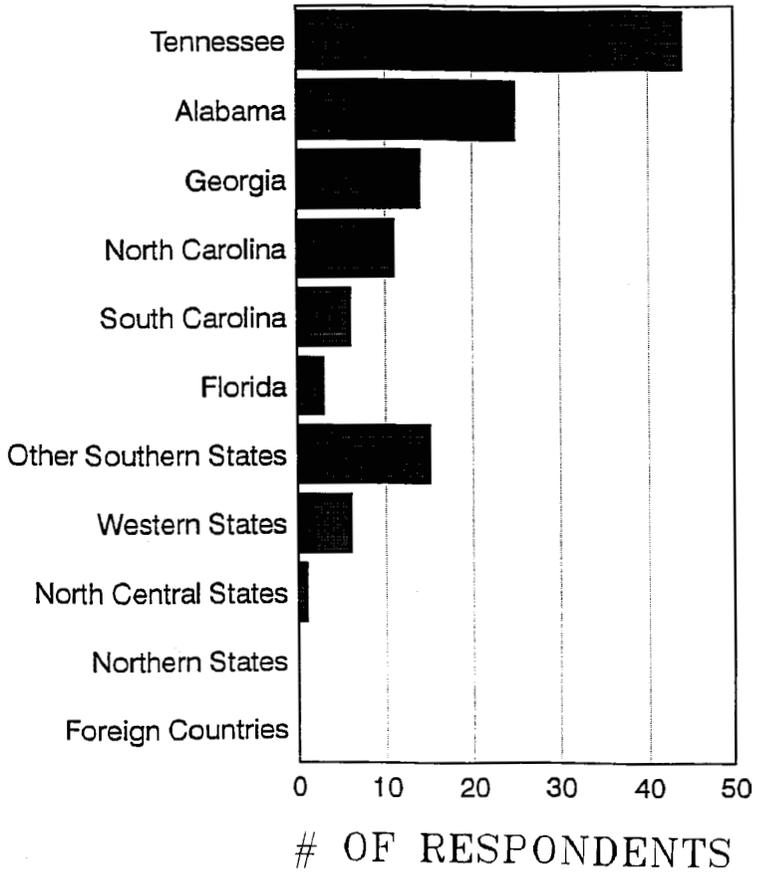
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Table 1. Survey questions discussed in this paper.

1. In what year was your firm established?
 2. What form of business organization describes your firm?
 Proprietorship Partnership Corporation Other
 3. Which of the following services does your firm offer?
 Exterior design Exterior maintenance Exterior installation
 Interior design Interior maintenance Interior installation.
 4. What percentage of your service in 1991 was:
Residential % Commercial % Industrial % Other %
 5. If you purchase plants for landscape installation/maintenance during 1991, from where did they come? (please rank by volume, Highest= 1).
Tennessee North Carolina South Carolina Georgia Florida
Alabama Other Southern states Northeastern states North Central states Western states Foreign Countries .
-

Fig 1. DISTRIBUTION OF STATES FROM WHICH PLANTS WERE PURCHASED



Economic and Environmental Benefits of Open Celled Pavers in the Retail Nursery

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Georgia

Nature of Work: Open celled pavers are precast pavers manufactured from either concrete or plastic by a number of different companies around the U.S. No two brands of these pavers are identical to each other. Each brand of paver varies in its surface area, size, shape, and depth from all other types of open celled pavers, even those constructed of the same type of material. The open cells within the pavers are filled with soil, sand, or a coarse aggregate. The primary traditional use of these pavers has been in site development projects, where they are used in low-intensity traffic areas such as driveways, guest parking spots, overflow parking areas, or to provide emergency vehicle access around buildings. They have also been frequently used to line drainage swales; or on golf courses to provide parking for golf carts around tees and greens, and to line the shoulders of the cart paths. The theory behind the use of these pavers in locations such as these is to allow turfgrass or other groundcover-type plant materials to be grown in locations where those plants would not normally be used or expected to survive. The body of the open celled paver serves to absorb and transmit the weight of any vehicle, thus allowing the cells within to remain free from compaction. The body of the paver also protects the turfgrass or other plant materials from abrasion by the wheels of the vehicles.

By providing a porous pavement surface, open celled pavers offer a number of advantages over traditional impervious paving materials such as asphalt or concrete. Allowing stormwater to infiltrate the ground rather than running off the surface helps to reduce the volume and intensity of stormwater runoff; which in turn helps reduce the frequency and intensity of stream flooding (2, 3, 5). Stormwater infiltration also helps reduce the quantity of pollutants such as automobile fluids, heavy metals, and other toxic compounds by using the soil as a filter (5, 6). Open celled pavers greatly reduce the heat build-up normally associated with traditional paving materials, thus helping people feel more comfortable (6). They also tend to be far more skid resistant than traditional pavements, an important consideration in locations where people or vehicles are present when the pavement is wet or covered with ice or snow (5, 6).

Finally, installation of these pavers requires less skilled labor and expensive equipment than do other types of paving materials, thus homeowners can install these pavers themselves.

A study was begun in April, 1992 at the University of Georgia to compare six different brands of open celled pavers. The study was envisioned as a series of experiments, each lasting approximately one year, that would investigate the appearance of the pavers under a variety of cultural and environmental conditions. The first study in the series was completed in May, 1993, the results of which are included and discussed in this paper.

The pavers were installed in a series of 10' x 10' plots, with six such plots installed for each brand of paver. Each paver was installed according to the individual manufacturer's recommendation for a low intensity traffic area. In most instances, this involved placing the pavers on a 1-2 inch sand setting bed and filling the cells with either sand or topsoil. The plots were grassed with six different varieties of turfgrass. After initial establishment, the plots were maintained under a low intensity of culture to simulate the conditions that frequently occur on many site development projects. In mid October, the plots were visually evaluated by 24 landscape architects from the Athens, Georgia area. The plots were evaluated a second time in mid May of 1993 to determine whether over-wintering had any effect upon the visual appearances of the plots. Following the second round of evaluations, the grass was killed and removed to prepare the plots for the second study in the series.

Results and Discussion: The landscape architects rated each of the paver/turfgrass combinations on a scale of 0 (lowest) to 4 (highest) based upon their personal perception of the visual appearance. Overall low scores of the plots indicated that, for the most part, these paver /turf combinations do not provide an attractive appearance when maintained under a low intensity of culture. This is not too surprising however, particularly considering the rather porous nature of the base material. In statistical comparisons, one brand of paver, Checkerblock, manufactured by The Hastings Pavement Company, consistently scored higher than any of the other pavers, no matter which variety of turfgrass was used. The other brands of pavers were closely grouped together, with no statistically significant differences.

As far as the turfgrasses were concerned, again, overall low ratings indicated that none of the grasses were perceived as performing well under the low-intensity culture. In both the fall and spring evaluations, plots seeded with common bermuda rated as the most highly regarded. The common bermuda plots were significantly higher rated than the other grasses in the fall '92 evaluations, but there was no statistical significance to the spring '93 ratings. All of the plots were observed to have been invaded by common bermuda from outside seed sources. In several instances, the invasive bermuda clearly outperformed the grass that was originally established in the plot. Overall ratings of the plots were slightly lower in the spring

after the plots had overwintered. All of the grasses were observed to be fairly slow to green-up in the spring; being up to two weeks behind nearby stands of these same varieties.

Significance to Industry: Open celled pavers are a material that few retail nurseries currently sell. However, they are a material that retail store owners should consider carrying in the near future. Homeowner interest in these pavers is likely to expand rapidly in the near future. Federal legislation (1987 Clean Water Act) has required that each state begin identifying and controlling nonpoint sources of water pollution (1). Several studies have clearly shown that porous pavement materials are one of the best methods of controlling nonpoint source water pollution (5,6). In response to the Federal legislation, many states are developing plans to educate their population concerning the causes and effects of stormwater runoff and nonpoint source pollution, and about what individuals and groups can do to reduce nonpoint sources and protect surface streams from degradation. The Chesapeake Bay and Great Lakes area states have taken a lead in this educational effort, but other states are now following suit. Georgia has currently hired a consultant to develop an educational plan and program to be completed in 1993 (4). The plan will be targeting homeowners, civic groups, trade associations, design professionals, governmental officials, and educators. A statewide media blitz will be part of the educational efforts of the state. It is anticipated that promoting the use of porous paving materials will be one of the points of emphasis in the plan.

In addition to the use and advantages of these materials in sited development projects, these pavers have several potential applications in the retail nursery. By using these pavers as a walkway material, the nursery has the opportunity to not only demonstrate the use of these pavers to the customer, but can also display different varieties of turfgrass or other plant materials at the same time without requiring additional display space. Their use also presents a desirable image to the public since irrigation overflow or runoff from adjacent display areas is absorbed into the ground rather than puddling on the pavement surface. The pavers also tend to be easier to walk on or pull carts upon than are many loose aggregate pavements.

Paver manufacturers who donated their products and participated in this study were:

'Checkerblock', by the Hastings Pavement Company. 1 800 874 - 4717.

'Eco Stone', by SRM Inc., Selma Division. 1 800 239 - 7421.

'Geoblock', by Presto Products Co. 1 800 558 - 3525.

'Grassrings 2', by Invisible Structures Inc. 1 800 223 - 1510.

'GrassRoads Paver II Plus', by Bartron Corp. 1 800 992 - 9949.

'Turflock', by Paver Systems Inc. 1 800 226 - 0004.

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**Development of the Tennessee State University
Nursery Crops Research Station Landscape Plant Evaluation Program at McMinnville, TN**

**PhilLip C Flanagan, Willard T. Witte and Roger Sauve
Tennessee**

Nature of Work: Comparative evaluation blocks of the following trees and shrubs are currently being established: Acer (maple), Cornus (dogwood), Lagerstroemia (crapemyrtle), Quercus (oak), Syringa (lilac), and Ulmus (elm). These plants will be evaluated for: 1) landscape performance under USDA Zone 6b climatic conditions, 2) ornamental characteristics, 3) resistance to plant diseases and pests, and 4) adaptability for production under commercial conditions. The objectives of this program are to evaluate species/cultivars and unnamed clonal selections for commercial use, providing the nursery industry with a source of propagation material from nonpatented and nontrademarked new cultivars and selections, and making available to all nurserymen these new releases. The long term objective is the establishment of a comprehensive plant introduction program which will include testing and cooperative evaluation.

During 1992 approximately 3 acres of land was prepared for the first field evaluation. After removal of old nursery stock, the area was subsoiled (two directions) to a depth of 24 inches. After receiving soil analysis results, appropriate lime and fertilizer amendments were thoroughly incorporated in the soil. Kentucky 31 Fescue was used as a cover crop for the field. After the fescue established, the plot was marked off with 10 contour rows (each 1200 feet in length) spaced 12 feet apart. Post emergent herbicides were applied to remove a 3 foot wide strip the entire length of the row. During the year the plot area was mowed on a regular schedule in order to maintain the grassy middles between each row. Rows were sprayed with herbicides as needed to keep them weed-free.

In February of 1993 approximately 120 different species/cultivars of the genus Acer were ordered. Field preparation continued with the development of a master plot plan for the maple evaluations. A randomized complete block design with ten single plant replications was used. Each genus will be treated as a separate experiment.

As plant material arrived it was either heeled-in in sawdust or potted into 2 gallon containers using a pine bark potting mix. On 6 & 7 April 1993 approximately 80 species/cultivars of maples were planted in the field. The remaining maples are being grown in a 5 to 10 gallon container production system for the 1993 growing season and will be planted in October 1993. Drip irrigation is being installed on all field plantings to insure establishment of new plant materials and to promote optimum growth. Irrigation will be discontinued after the plants are established.

A routine program of top-dressing with fertilizers has already been implemented to insure vigor and growth. Pesticides are being applied for targeted pests whenever there is an economically damaging build up of a pest or diseases for example leafhopper on maple.

Results and Discussion: After plots are established data will be collected three times annually: early spring, mid-summer, and fall. Blind subjective evaluations will be conducted by a panel of nursery growers and university personnel. During the evaluation process, plants will compared to standard cultivars used as controls. Objective data to be recorded and analyzed include annual measurements of caliper, height, width, mean date of spring bud break, mean date of fall leaf drop, onset and intensity of fall color, flower and fruit characteristics and date of effectiveness, form and branching habit, and obvious pest and disease problems. After the third year of evaluations the best selections of each genus will be tested for adaptability to production under commercial conditions.

Significance to Industry: Through this program, much-needed lists of recommended cultivars and new selections of woody landscape plants

suitable for production by Tennessee's nursery industry will be produced. Recommended cultivars and selections will be available for all nurserymen. This will be especially beneficial for the limited resource nurseryman.

Reports will be written and presented to the following: Tennessee Nurserymen's Association Annual Nursery Short Course, Southern Nurserymen's Association Annual Research Conference, and the American Society for Horticultural Science. Technical reports will be submitted to HortTechnology, HortScience, Plant Disease, or other appropriate refereed journals. Short popular articles will be written for trade journals such as American Nurseryman, Tennessee Home and Farm Science, and for the TSU extension bulletin, Farm and Home Bulletin.

Dwarf Crapemyrtle Classification

Randy Johnson and Ruth Dix
DC

Nature of Work: Crapemyrtle (*Lagerstroemia*) offers the homeowner various summer flower colors and a wide range of plant growth habits. Dwarf crapemyrtles can be used in small gardens, in pots, or as perennials by cutting plants to the ground annually. Dwarf cultivars have been available since the 1960's, but they have yet to become an industry staple as is the case for the larger shrub and tree forms. This lack of popularity may in part be due to a lack of publicity and marketing. The public may also be disappointed with the plants not meeting expectations: they do not stay dwarf. To overcome this misconception, the nursery industry must clearly define the term "dwarf". Improved cultivars must be supplied to the nursery industry that will remain dwarf (short) and have other superior characteristics. This paper discusses the problems associated with defining "dwarf", briefly examines the cultivars which have been released, and then reports on potential new selections by examining the genetic variation found in a seedling population of dwarf *Lagerstroemia indica x fauriei*.

Results and Discussion: If the public is to have an understanding of the plant material they purchase it is necessary to have a standard definition for "dwarf" and other size categories. "Dwarf" is a relative term since even a dwarf plant can become relatively large with time. A better term is "slow-growing".

Definitions for dwarf crapemyrtles are found in the literature. Einert and Watts (1973) defined dwarf as an annual vegetative growth of 24 to 36 inches after dormant pruning. Egolf and Andrick (1978) later defined dwarf as less than three feet. Definitions of plant height found for specific cultivars are shown in Table 1. Most of the size definitions in Table 1 specify a

particular plant height, but fail to specify the age at which one can expect the height to be reached. Other descriptions state that a plant is a given height at maturity, which is confusing since age of maturity is not defined. Still others define height in terms of length of new growth after dormant pruning. This definition may give an indication of growth rate, but does little to define

the height of an unpruned plant. None of these definitions are clear or comparable with each other since they do not specify height of unpruned material at a particular age.

To clarify height classifications, standard crapemyrtle size definitions were developed for the upcoming revision of the *Lagerstroemia Handbook / Checklist* (Egolf and Andrick, 1978). This classification system could be utilized by the nursery industry to standardize crapemyrtle size definitions. The term "maturity" was avoided in constructing the definitions because maturity can be different for different size categories. The basis for classification is height at specific ages. Age-10 height is used to classify all but the dwarf crapemyrtles since this is a reasonable "mature" age for larger plants. Age-5 is a more appropriate "mature" age for classifying dwarf crapemyrtles. A priority system of classification prevents a cultivar from being classified into two categories since two different ages are used for classification.

Category descriptions are those used in Egolf (1990). The system is as follows:

- If height at age-5 is less than four (4) feet then the plant is a **Dwarf**.
- If not a dwarf and the plant is less than 12 feet tall at age-10 then the plant is a **Semidwarf** .
- If not a dwarf and the plant is between 12 and 20 feet tall at age-10 then the plant is an **Intermediate**.
- If not a dwarf and the plant is larger than 20 feet at age-10 then the plant is a **Tree-type**.

According to this new classification system very few of the cultivars in Table 1 would be classified as dwarfs. Most, if not all, will be over four feet tall by age-5 or sooner. Annual pruning is required to keep most of them as a small shrub. For the average homeowner this annual pruning may be an undesirable characteristic and could be one reason that dwarfs have not become a big sales item.

A second reason for the lack of popularity of dwarf crapemyrtles is the fact that most are prone to powdery mildew. The cultivars in Table 1 are all *Lagerstroemia indica* selections. While there is variability in the powdery

mildew resistance within the species, it is necessary to hybridize *L. indica* with other species such as *L. fauriei* or *L. limii* to achieve maximum resistance.

For dwarf crapemyrtles to become a substantial nursery crop it will be necessary to develop slow-growing plants that are resistant to powdery mildew. It will also be important to select an appropriate growth rate: one that is sufficiently slow to be a dwarf, but still be vigorous enough to grow a marketable plant in a reasonable time. Nurserymen must realize that it will take longer to grow a saleable dwarf than other sizes. The plant must therefore demand a higher price in order to make a profit. The public will only pay a higher price if it is assured of a quality plant with known performance expectations.

Dr. Donald Egolf developed a population of improved hybrid dwarfs at the U.S. National Arboretum using *Lagerstroemia indica*, *L. fauriei*, and *L. limii*. The plants show a range of growth habits ranging from prostrate to upright. Age-4 height ranged from 10 inches to 5 feet.

In 1991, controlled pollinations were carried out among 25 of the dwarf selections to produce 26 families. The seed was grown out in 1992 and assessed for height growth, mildew incidence, and flowering time. The means and ranges for these traits are shown in Table 2.

Further analysis of the data showed that much of this variation was under genetic control. Heritability estimates are shown in Table 2. Heritability is defined as the proportion of the total variation that is under genetic control, the remainder being variation due to environment / culture. The lack of a specific crossing design allowed for an incomplete estimate of the genetic variation: all the additive genetic variation and half of the dominance variation. The heritability estimates show that height, flowering date, and mildew incidence are all under moderate genetic control and sufficient variation is present to continue improvement through breeding efforts. The data also showed that height growth was negatively affected by inbreeding, but flowering date and incidence of mildew were not affected by inbreeding.

Significance to Industry: If dwarf crapemyrtles are to become a popular nursery item it will be necessary to market them in an appropriate way. The first step is to properly classify the cultivars in such a way so that the public will understand their growth rate and potential size. Utilizing standard definitions for plant size is one such way this could be accomplished. The system for classifying crapemyrtle size in the upcoming revision of the *Lagerstroemia Handbook / Checklist* is suggested for use by the industry. Standard definitions are needed for all plants in the industry and further discussion as to the appropriateness of this system to other genera is encouraged. The influx of improved cultivars with slower growth rates and

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improved disease resistance anticipated from the U.S. National Arboretum should also improve the popularity of the dwarfs.

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Table 1. "Dwarf" crapemyrtle cultivars listed with flower color and height information.

<u>Cultivar</u>	<u>Flower Color</u>	<u>Height Information*</u>
Baton Rouge ('Beverly')	Deep red	10" Hanging Basket ¹
'Blizzard'	Pure white	Semi-dwarf, 5 ¹³
Bourbon Street ('June Marie')	Watermelon Red	10" Hanging Basket ¹
'Centennial'	Dark purple	26" following dormant pruning
Cordon Bleu ('Louisa')	Lavender	10" Hanging Basket ¹
Delta Blush ('Pink Blush')	Pink	10" Hanging Basket ¹
'Dwarf Blue'	Lavender-blue	Semi-dwarf, 8 ft.
'Maiden Blush'	Purplish-pink	Compact, dwarf, 16-24 in. high
Chico Red®	Red	5-6 ft at maturity ²
Chico Pink®	Pink	5-6 ft at maturity ²
New Orleans ('Passion')	Purple	10" Hanging Basket
Petite Embers™ 'Moners'	Rose red	Dwarf, upright to 4-5 ft
Petite Orchid™ 'Monhid'	Dark orchid	Dwarf, upright to 4-5 ft
Petite Pinkie™ 'Monkie'	Clear pink	Dwarf, upright to 4-5 ft
Petite Plum™ 'Monum'	Deep plum purple	Dwarf, upright branched form 5 ¹⁴
Petite Red Imp™ 'Monimp'	Dark red	Dwarf, upright to 4-5 ft
'Petite Ruby'	Deep ruby red	Dwarf, upright to 4-5 ft
Petite Snow™ 'Monow'	White	Dwarf, upright to 4-5 ft
'Pink Blush'	Light pink	Weeping, dwarf, mature ht 10-20 in
'Pink Parfait'	Clear pink	Dwarf, 4 ¹³
'Pink Ruffles'	Pink	Compact, dwarf shrub 4-5 ft
'Royalty'	Royal purple	Dwarf seedling
'Snowbaby'	Pure white	Dwarf with mature ht 3-4 ft
'Summer Wine'	Deep pinkish red	Semi-dwarf, 5 ¹³
'Tiny Fire'	Rich red	Dwarf
'Victor'	Deep red	7.6 dm (30 in) following dormant pruning

* Height descriptions are from the Lagerstroemia Handbook / Checklist unless noted otherwise.

¹ Hines Nurseries, Santa Ana Plants & Prices, January 1990. All plants are patented.

- ² American Nurseryman, Dec 15, 1992, p. 90.
³ Buds & Bloom, Wholesale Price List, Summer/Fall 1991
⁴ Monrovia Nursery Company, 1993 wholesale catalog

Table 2. Means, range of family means, and heritabilities for a population of 36 dwarf crapemyrtle families.

	<u>Minimum</u>	<u>Maximum</u>	<u>Mean</u>	<u>Heritability</u>
June Height	1.5 in	4.1 in	2.6 in	
August Height	3.9 in	11.8 in	6.7 in	0.26
Percent flowered by August	0%	76%	38%	
Mean flower day	153	198	178	0.23
Mildew incidence	5%	88%	41 %	0.27

CD-ROM: New Technology for Information Dissemination

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Florida

Nature of Work: The University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS), through its Cooperative Extension Service, is responsible for the dissemination of information on agriculture, home economics, 4-H youth, and marine topics to Florida's citizens. In the past, printed media have been the primary means of distribution. With increased numbers of publications, UF/IFAS faces the dilemma of maintaining a massive inventory of publications, making them available to those needing the information, and keeping the information current while staying within our limited budget. CD-ROM (Compact Disc-Read Only Memory) can help resolve the dilemma and create an improved method for the easy retrieval of information by Florida's burgeoning population.

Begun in 1989 with a handful of specialists, agents and staff, the CD-ROM project is still in the developmental phase of formatting, reformatting, and retrofitting the information to fit Extension's diverse groups of clientele. As part of the Florida Agricultural Information Retrieval System (FAIRS), CD-ROMs are available in all of Florida's 67 county extension offices, and can be purchased through UF/IFAS by contacting Publications, IFAS Building 664, P. O. Box 110011, Gainesville, FL 32611-0011.

Results and Discussion: CD-ROM is actually a form of optical media similar to audio discs played on CD players, but it also contains information that can be “read” by a computer. Each disc is approximately five inches in diameter and 1/8th inch thick—similar to the old 45 rpm records, but smaller. One CD can store approximately 250,000 pages of information in an easily accessible form.

No special computer classes are needed to run the UF/IFAS CD-ROM discs, and after a few simple instructions you’ll be off and running; in fact, access to the computer can become a problem as people get caught-up looking at all the material. Detailed information from handbooks currently on CD-ROM discs include agricultural engineering, agricultural safety, beneficial insects, Florida weeds, pest control (aquatic, insect, nematode, plant disease, weed), construction plans (including actual plans for pole barns, storage sheds, pesticide storage, etc.), pesticide poisoning, ExToxNet (Extension Toxicology Network), turfgrass, water quality and woody ornamentals. To use CD-ROM discs your computer must be IBM compatible, and contain at least a 386SX microprocessor, a CD-ROM disc drive, a Super Video Graphics Adapter (Super VGA) monitor, a video card, and at least (recommended) 2 megabytes (Mb) of random access memory (RAM).

Significance to Industry: Currently, many UF/IFAS extension factsheets, circulars, bulletins, handbooks, etc. are available in CD-ROM format at all of the state’s extension offices. To clarify the text in many documents, black and white or color images can be displayed on the computer monitor. For instance, in the Florida Lawn Handbook you can read about mole crickets, see an actual color image on the screen, and view a line drawing for more detail. County agents or those purchasing the disc, can use a laser jet printer to reproduce the publication (containing line drawings if included in the original document) and hand it to a client or employee before they leave the office. Color images, which are created by computer digitization of a standard 35 mm color slide, however, can only be viewed on the computer monitor—at this time. In the future, who knows?

CD-ROM not only permits print-ready copies of materials, but also has a search feature allowing you to look for a specific word or several words related to a particular topic. Using the above example, you can type “mole cricket and control” on the screen and receive several titles of documents that provide information. On the left of each document title a number appears indicating the number of times the term(s) are in that particular document. If you want to know the best method to control mole crickets in St. Augustinegrass turf, you can also go back to your original search and change it to “St. Augustinegrass and mole cricket and control.” Not a good speller? Don’t worry because the search feature has a built-in spelling checker to help you.

Hypertext is another feature that allows you to find more information on a topic. For example, when viewing a document on greenhouse production in the Florida Energy Handbook you might read "conduction and radiation heat loss can be estimated using Equation 7" and see "Equation 7" in red. On the FAIRS CD-ROM disc the red type indicates there is additional information. Then you can use your computer mouse to "click on" "Equation 7." In this instance, the information will give you the full equation including any necessary conversions.

Hypertext also indicates information on authors, availability of figures and color images, etc. In each case, the word or phrase appears in red on the screen to indicate the availability of more information.

In addition to documents and images, CD-ROM has several software programs called "selectors," including plant, landscape, citrus and herbicide. Selectors allow you to search for information based on your particular needs. For example, if you live in north Florida and are looking for a plant with red flowers to grow in a shady area, you can use the plant selector for landscape plants to search for all plants that meet these criteria. You may then read (and print out) some specific information about these plants and view color photographs or line drawings. You may also browse through all of the plants in the selector by common or scientific name. The citrus selector works in much the same way, but deals with orange, grapefruit, tangerine, lemon and lime varieties. The landscape selector gives you a series of landscape plans that cross-reference the plants in the plant selector. The turfgrass herbicide selector allows you to select herbicides by turf variety, common/trade name and weed variety.

This new technology should draw more people to the Extension Service for educational information. CD-ROM portrays Extension to commercial and urban clientele groups as a hightech, cutting-edge agency that can provide educational material and programs that meet their needs. The better the information delivery to people the more likely they can implement its use. Because the disc is a CD-ROM (read-only memory), you can't change or add new information. It has the advantage that the information on the disc can be repeatedly made available, without the fear of being removed or changed.

Farmers, homeowners, nurserymen, county agents, specialists, Florida Master Gardeners, high school vocational-agriculture students, UF environmental horticulture students, pest control companies, vegetable gardeners, plant nurseries, and 4-H youth are now accessing CD-ROM. These groups have found CD-ROM to be an excellent, efficient way to access current UF/IFAS information.

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Urban Tree Pit Design

M .A. Powell
North Carolina

Nature of Work: Planting trees and shrubs along city streets and in urban places is a fundamental part of modern planning. The idea of planting trees in sidewalks and parking lots certainly has merit, and has become an acceptable planning policy in many cities, but the result of a tree surviving under the typical adverse and unnatural conditions can be nothing short of a miracle. There is a high mortality rate for trees planted in tree pits. The tree species, pit design, method of planting and follow-up management will directly impact the growth and establishment of the tree. Many cities and small towns currently have street tree planting ordinances. The City of Raleigh has developed "Policies and Standards Governing Activities Which Impact City Trees" which includes information on desirable and undesirable species, where trees can be located, specifications on how to install the tree and information on proper management. This document offers recommendations on basic tree planting and care, based on some of the latest research, but it continues to minimize the importance of space requirements of plants.

Results and Discussion: There are numerous reasons why street trees are short-lived. The primary factors for an early decline can generally be traced to problems in the rootzone area, species selection and people caused damage. Limited space, compacted and poorly drained soils and backfills are the rule rather than the exception. Trees are constantly too wet or too dry.

Landscape architects and planners should consider incorporating the following planting specifications into all street tree design projects: 1. Tree pits in curb attached sidewalks that are 12 feet wide or more, shall have no less than 25 sq. ft. of surface area for root growth. Tree pits must have a minimum depth of soil that will support good plant growth. 2. Tree species shall be compatible with minimum root zone area. Growth rate and mature size of species should be considered along with expected time frame of

tree. 3. Drainage shall be provided such that water can flow out of the planter or pit if unsatisfactory subgrade soil is encountered . Test the area for drainage capacity by filling it with water. It must drain out in 24 hours. Constructed drainage (tile/drain) shall be supplied if the soil does not meet the drainage requirements. 4. Tree pits shall be designed and located where de-icing chemicals or salts will not enter . 5. Tree grates shall have provision for trunk expansion of the tree, such as pop out concentric rings in the grate around the tree. 6. The area between the soil and the top of the grate shall be filled with washed #78 crushed granite or #67 "river wash" stone. Do not use any organic materials in this space. If no grate is installed then a 3-4" layer of coarse gravel or broken brick chips shall be provided. 7. Trees shall be planted in the center of the pit. 8. Use modular pavers laid without mortar or sealant of any kind, or porous concrete or asphalt, so that air and water can reach the roots, shall be used as a paving in the rootzone area.

Significance to Industry: Incorporating these planting techniques and design features will improve the mortality rate of street trees. Aside from the basic cultural and environmental problems associated with street tree "shortlife", comes the problems of vandalism and accidental mishaps with vehicles. These problems can be minimized with proper design spacing, curbing and tree supports.

Design Specifications

Minimum Depth of Soil:

Shade Trees	3.5 feet
Ornamental Trees	3.0 feet
Shrubs	2.0 feet

Minimum Square Footage of Soil Surface Area:

Shade Trees (Large)	400 square feet per tree
Ornamental Trees	64 square feet per tree
Tree Form Shrubs	16 square feet per tree

Soil Mixture Used in Containers, Tree Pits or Vaults

- * Soil shall be sandy loam as defined by USDA soil classification
- * Soil pH shall be between 5.0-6.0.
- * Soil shall be low in organic material, iron and sulfate content.
- * Drainage shall be provided by: Constructed drainage, such as PVC pipe, tiles, or drainage holes allowing water to pass freely from the container or pit into proper drainage channels. A 4 inch layer of coarse gravel over the

tile drains separated from the soil by a semipermeable fabric. Pipe or holes shall be prevented from clogging up by wrapping or covering with a filter fabric.

References:

1. City of Raleigh Parks and Recreation Dept. 1991 ,” Policies and Standards Governing Activities Which Impact City Trees”

Flood Tolerant Prunus

Thomas G. Ranney
North Carolina

Nature of Work: Many species of *Prunus* are notoriously intolerant of poor drainage. In some cases, inundation of the root system for only a few days can be sufficient to kill certain of these plants (1). Research conducted on commercial fruit trees, however, has shown there to be considerable variation in flood tolerance among different species and hybrids of *Prunus* (3). For example, comparisons among cherry rootstocks have shown that *P. avium* is better adapted to poorly drained conditions than is *P. mahaleb* (2).

Conventionally, many of the flowering prunus are propagated by budding and grafting. Recently, however, there has been greater interest in growing flowering *Prunus* from rooted cuttings. Although this type of propagation can simplify production practices and minimize problems of rootstock suckering, there is little information on the adaptability ornamental *Prunus* trees when grown on their own roots.

The objective of this project was to evaluate differential sensitivity of ownrooted taxa of *Prunus* to acute flooding. Taxa studied included: *P. avium* 'F 12/1', *Prunus caroliniana*, *P. incisa x campanulata* 'Okame', *P. japonica*, *P. mume* 'Peggy Clark', *P. x* 'Newport', *P. sargentii*, *P. serru/ata* 'Kwanzan', *P. subhirtella* 'Autumnalis', *P. virginiana* 'Canada Red', and *P. x yedoensis*.

Own-rooted plants, 12-18" in height, were grown in 3 qt containers filled with a media of 1 perlite: 1 pasteurized loam amended with .75 lbs. dolomite/yd³. Plants were moved into a heated greenhouse on March 4, 1992. The experiment was a 11 (taxa) by 2 (flooded and control) factorial arranged in randomized complete block design with 7 - 10 replicate plants per factorial combination. Flooding was imposed in increments starting on May 4, 1992.

Flooded plants were placed in individual 5 qt. buckets and enough water was added and maintain a water level that submerged the lower half of the root system. After two weeks, the water level was raised to submerge the lower three fourths of the plant's root systems. On May 25, 1992, three weeks after the flooding treatments were initiated, the water level was raised to completely submerged the root system of flooded plants. Flooding was relieved on June 22, 1992 following seven weeks of incremental flooding. Plants were maintained with irrigation as needed until June 30, 1992 at which time all plants were stripped of their leaves, cut back to 18" in height, and were placed in a cooler at 43F for 12 weeks to simulate an overwintering period.

Results and Discussion: At the end of the treatment period, many flooded plants were severely defoliated, yet the stem tissue under the bark was often green. A cold dormant period was then provided so that survival could be more clearly distinguished when plants resumed growth. Survival was 100% for all control treated plants regardless of taxon (Table 1). Flooded plants, however, varied from 0 to 100% survival. *Prunus caroliniana* suffered the greatest with 0% survival while *P. serrulata* 'Kwanzan', *P. mazzard*, and *P. x* 'Newport' had similar survival rates ranging from 90 to 100%. *P. mazzard* and *P. x* 'Newport' also had significantly lower defoliation as compared with the other taxa.

Significance to Industry: This research demonstrates that there is considerable variation in tolerance to poor drainage among taxa within the genus *Prunus*. Of the 11 taxa evaluated, *Prunus serrulata* 'Kwanzan', *P. mazzard*, and *P. x* 'Newport' had the greatest tolerance to poor drainage as indicated by high survival rates and low defoliation following flooding. When selecting own-rooted taxa or rootstocks of *Prunus* taxa for poorly drained sites, more tolerant taxa should be selected (see Table 1). *Prunus mazzard* is a compatible rootstock for many of the flowering cherries and should be considered as an understock for plants growing on poorly drained sites. *Prunus cerasifera*, one of the parents of 'Newport' has been shown to be a compatible rootstocks for some cultivars of *P. mume* and has the potential to considerably enhance the flood tolerance of *P. mume*.

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Table 1. Survival and defoliation of 11 taxa of *Prunus* following seven weeks of treatment (incremental flooding and control).

Taxon	Survival (%)		Defoliation (%)	
	Control	Flooded	Control	Flooded
<i>Prunus caroliniana</i>	100a*	0 a	1 a	82 c
<i>Prunus virginiana</i> 'Canada Red'	100 a	43 b	1 a	100 cd
<i>P. mume</i> 'Peggy Clark'	100 a	50 bc	7 a	95 cd
<i>Prunus japonica</i>	100 a	50 bc	1 a	52 b
<i>Prunus sargentii</i>	100 a	60 bc	1 a	29 a
<i>Prunus x yedoensis</i>	100 a	60bc	0 a	87 cd
<i>Prunus subhirtella</i> 'Autumnalis'	100 a	70 cd	2 a	52 b
<i>P. incisa</i> x <i>campanulata</i> 'Okame'	100 a	70 cd	1 a	80
<i>P. serrulata</i> 'Kwanzan'	100 a	90 de	0 a	58 b
<i>Prunus avium</i> 'F 12/1'	100 a	100 e	1 a	27 a
<i>Prunus</i> x 'Newport'	100 a	100 e	5 a	15 a

* Means followed by the same letter within a column are not significantly different, LSD_{0.05}.

The Effect of Reduced Water Supply on Cold Hardiness of *Rhododendron* 'Catawbiense Boursault'

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Nature of Work: *Rhododendrons* are one of the most popular ornamental woody plants grown in temperate zones worldwide. In the southeastern United States freezing temperatures occur often enough to cause winter injury to these plants. Since favorable cold hardening temperatures do not always precede damaging freezes, alternative ways to induce cold hardiness have been tried [5, 10]. One such alternative is the cultural practice of limiting water supply [2]. Artificial tissue dehydration resulting in increased cold hardiness has been reported in various plants [3, 6]. Low water supply is effective in reducing the top growth, thus increasing cold hardiness, especially if accompanied by fairly high temperature [4]. The purpose of this study was to determine whether growing *Rhododendron* 'Catawbiense Boursault' under conditions of limited water supply has a positive effect on its cold hardiness.

One year old plants were grown in 1-gallon containers, in a greenhouse. The growing medium was "Metro Mix 300" (Grace Sierra Elort. Co., Milpitas, CA). Three watering regimes were compared: wet - 1200/600 ml, medium - 800/400 ml, and dry - 400/200 ml of water per container, per week, where the first number refers to the period between August 24 and October 2, 1992, and the second number to the period between October 2 and January 10, 1993. Following the first freeze test on January 10 watering was withheld until February 21, when the second freeze test was conducted. There were 3 replications of 10 plants for each watering regime, and replications were arranged in a randomized complete block design.

Water content of the growing medium was monitored with TDR (time domain reflectometry). Plant water status parameters, including bound water content and osmotic potential, as estimated from pressure/volume curve, dry matter content and desiccation rate of detached leaves were determined on September 7 as well as on both freeze test dates January 10 and February 21). Visual evaluation of freeze injury using a rating scale of 0 (no injury), 1 (less than 50% of tissue injured), 2 (more than 50% of tissue injured), and 3 (all tissue dead), was performed on leaves after they had been frozen in a freezing bath to -30°C (-22°F) in 2-degree increments.

Results and Discussion: Differences in water content of the growing medium were measured for the three watering regimes (Fig. 1). Differences in water content between wet and medium regimes were small (Fig. 1). In January, leaves of plants under the dry regime were significantly less injured than leaves of plants under wet and medium regimes at tempera-

tures above -18°C (-0.4°F) (Fig.2). In February, following the period of 6 weeks of imposed drought, cold hardiness of plants under wet and medium regimes increased to the level comparable with plants under the dry regime, while the latter maintained the same cold hardiness as in January (Fig.3). Differences in cold hardiness between plants under dry versus wet and medium regimes were not correlated with bound water content, osmotic potential, dry matter content, or desiccation rate, except for the desiccation rate measured in February, when leaves of plants under the dry regime had a significantly higher rate (i.e. 1.25% water content/hr) than leaves of plants under wet and medium regimes (i.e. 0.87% and 0.85% water content/hr, respectively).

Yelenosky [9] in his studies on *Citrus* trees determined that water-stress-induced and low-temperature-induced cold hardening had similar impact on tree survival. To the contrary, Utsunomiya [8] reported that water stress was not effective in increasing cold hardiness of *Psidium* plants until the temperature became lower and plants stopped growing. However, Chen & Li [1] demonstrated that cold hardiness increases in *Comus stolonifera* which resulted from any combination of water stress, low temperature, and short days were as if the individual effects were additive. In our experiment, in January, cold hardiness of *Rhododendron* 'Catawbiense Boursault' plants grown under nonstressful water supply conditions (wet and medium regimes) was much below what is considered typical for this group of hybrids [7]. Possibly, either preceding temperatures or day length, or both, did not favor the acclimation process in those plants under central Georgia conditions. Plants under reduced water supply conditions (dry regime) were able to acclimate and develop tolerance to much lower temperatures. A similar level of low temperature tolerance was developed in plants grown under nonstressful conditions following a period of drought in midwinter. However, it is unlikely that such a period of drought could be reproduced outside in winter in anticipation of a coming freeze.

Significance to Industry: Numerous ornamental woody plants may be unable to acclimate on time or to the required level if grown outside their natural range where their internal development rhythm is not synchronized with existing environmental conditions. It is difficult, if not impossible, to manipulate day length or temperature in order to stimulate hardening of woody ornamental plants. This experiment demonstrated that developing watering regime strategies to promote cold hardiness is a reasonable approach and produces positive results. In addition, it provides opportunities for water conservation. Further research is needed to determine most appropriate timing of reducing water supply and the level of this reduction for individual crops.

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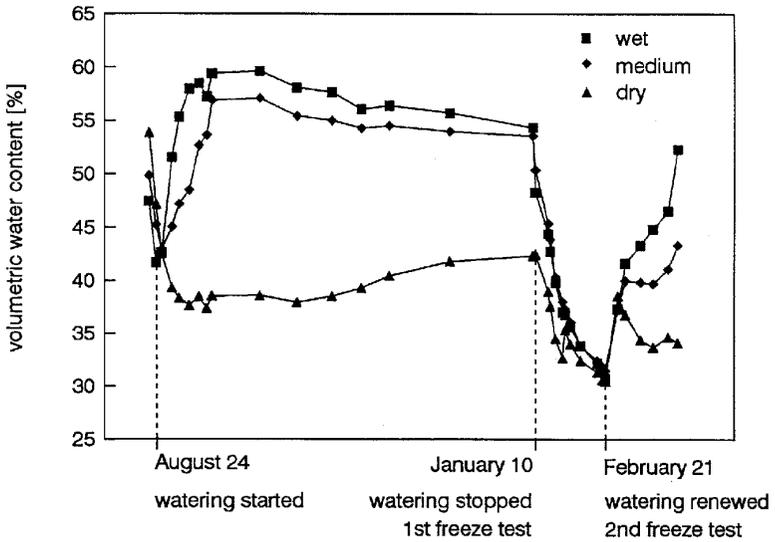


Figure 1. Volumetric water content of growing medium depending on watering regime.

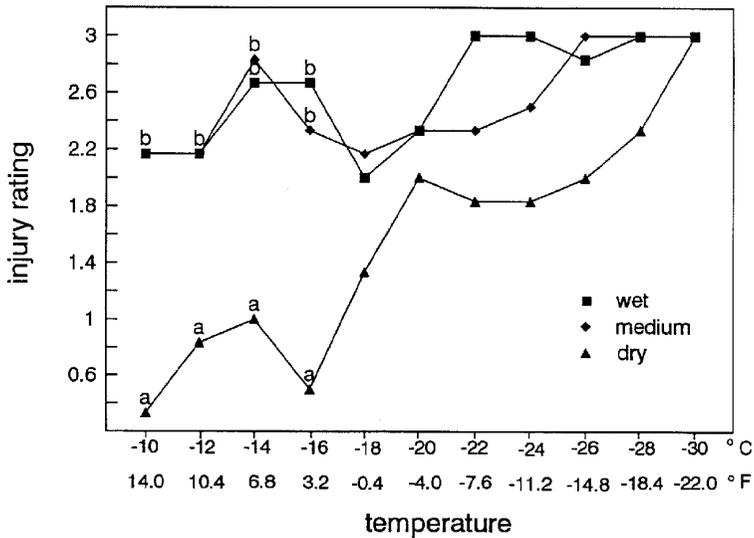


Figure 2. Injury rating of Rhododendron 'Catawbiense Boursault' leaves in January freeze test depending on watering regime (a,b - significantly different at alpha=0.05)

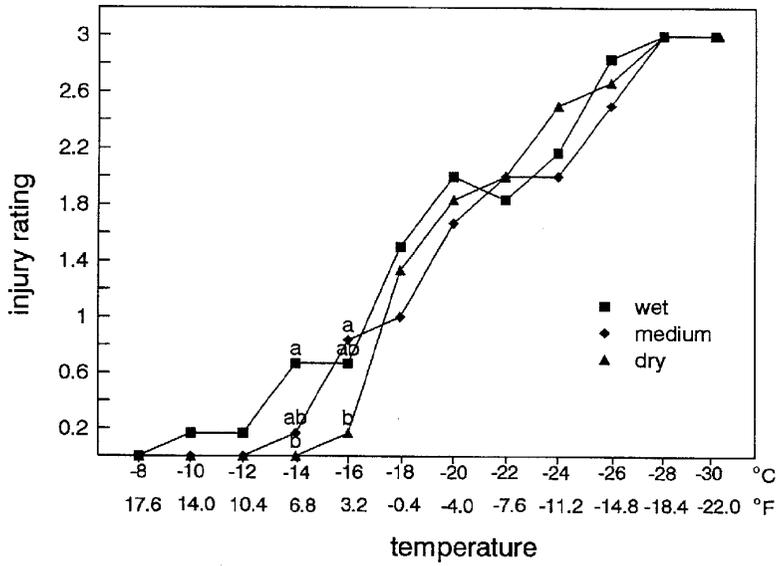


Figure 3. Injury rating of *Rhododendron* 'Catawbiense Boursault' leaves in February freeze test depending on watering regime (a,b - significantly different at $\alpha=0.05$)