# SECTION 10
# LANDSCAPE

**Mr. Will Corley, Section Chairman**
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# Bedding Plant Response to Incorporated Broiler Litter

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**Nature of Work:** Broiler litter is a waste product of the poultry industry that is coming under strict disposal regulations by federal and state government. Poultry producers are continuously looking for disposal alternatives for this waste product. Numerous studies have been conducted with broiler litter in field crops (1, 2). Broiler litter has been shown to improve growth in roses, woody ornamentals, and annuals. Several scientist have speculated that broiler litter slowly releases nitrogen and phosphorus over time resulting in improved plant growth (3). The objective of this study was to evaluate broiler litter rates as a fertilizer source for bedding plants.

A fallow site was chosen which had not received any fertilizer in several years. Beds were tilled twice to a 4 inch depth with a rotary tiller with each plot being 10 feet by 10 feet. Five treatments were applied: 5, 10, and 20 tons of broiler litter/A , 925 pounds/A of a commercial 13-13-13 fertilizer, and a nonfertilized control. The beds were tilled lightly to incorporate the broiler litter and commercial fertilizer. On October 5, 1990 four species of cool season annuals: cabbage, Brassicea oleracea 'Nagoya Red', kale, Brassicea oleracea 'Osaka Red', snapdragons, Antirrhium majus 'Tahiti Red', and pansies, Viola x wittrockiana 'Universal Red' were planted in each bed. In October, 1991, treatments were reapplied and the same four cool season annuals planted in each bed.

Data collected included foliar color ratings taken at 30 day intervals until 120 DAP (days after planting), dry weights taken at 60 DAP, and growth indices taken 60 DAP.

**Results and Discussion: '**Foliar color ratings were taken on all plants at 30, 60, 90, and 120 DAP. With all four species the first year the 20 tons/A rate of broiler litter produced the best looking plants (data not shown). The second year the high broiler litter rate performed as well in most cases as the commercial fertilizer treatment. In year one, dry weights were greatest with the 20 ton/A rate and the fertilizer treatment. The second year the 20 ton/A rate produced slightly more dry weight than the fertilizer treatment and both were greater than the control. Growth indices taken at 60 DAP for both years showed the 20 ton/A rate produced equal or larger plants in all four species compared to the fertilizer treatment and both treatments produced larger plants than the control.

**Significance to Industry:** Use of broiler litter incorporated into annual beds as a soil amendment and fertilizer source results in plants equal to or

larger than plants grown with traditional fertilization. An annual application of broiler litter was adequate to produce excellent quality plants. Nutrient levels in litter may not totally replace tradition fertilizer sources in all situations but they can reduce fertilizer requirements and provide an alternative for broiler litter disposal.

## Literature Cited

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3. Warren, S.L. and C.D. Safley. 1990. Use of Composed Poultry Litter in the Horticultural Industry. Composing Poultry Litter-Economics and Marketing Potential of a Renewable resource. 7.0-7.8.

**Table 1:** Influence of broiler litter on growth of four cool season annuals.

| Species | Treatment | Year 1 Growth Indices | Year 2 Growth Indices |
|---|---|---|---|
| Cabbage | 5 ton/A | 33.4b* | 27.3b |
| | 10 ton/A | 34.ab | 29.5ab |
| | 20 ton/A | 38.7a | 31.6a |
| | 120 lb N/A | 37.4ab | 28.7b |
| | control | 28.3c | 22.0c |
| | LSD | 3.8 | 2.6 |
| Kale | 5 ton/A | 29.4b | 26.0a |
| | 10 ton/A | 29.7b | 28.4a |
| | 20 ton/A | 38.9a | 29.0a |
| | 120 lb N/A | 35.1a | 27.9a |
| | control | 27.8b | 21.6b |
| | LSD | 4.3 | 3.0 |
| Pansy | 5 ton/A | 14.2b | 17.7bc |
| | 10 ton/A | 17.1ab | 18.7ab |
| | 20 ton/A | 18.8a | 19.8a |
| | 120 lb N/A | 18.1a | 19.6ab |
| | control | 15.3ab | 16.0c |
| | LSD | 3.2 | 1.8 |
| Snapdragon | 5ton/A | 17.8a | 15.6bc |
| | 10 ton/A | 13.2b | 17.1abc |
| | 20 ton/A | 14.1b | 18.8a |
| | 120 lb N/A | 13.2b | 18.1ab |
| | control | 11.0b | 15.3c |
| | LSD | 3.4 | 2.5 |

* Means in columns followed by the same letter are not significantly different according to Duncan's multiple range test, 5% level.

# Landscape Fabrics as Weed Blockers: Differences in Weed Cover Suppression

**Robert E. McNiel and Leslie A. Weston**
**Kentucky**

**Nature of Work:** Mulches have been investigated for stability and long-term weed suppression with variable results. Less research has been carried out on long term factors such as mulch and debris accumulation and soil incorporation, synthetic mulch removal from the established landscape, mulching over compacted urban soils, or long term effects on landscape plants. Research at the University of Kentucky investigated weed supression and management associated with 7 different synthetic fabrics covered with hardwood mulch.

Mulching materials were installed in November 1990 over finely cultivated Maury silt loam. Known quantities of selected weed seeds were sown under and over mulching materials. A 3 in. layer of shredded hardwood bark mulch was then placed on top of mulch treatments. Weeds sown into plots included yellow nutsedge, lambsquarters and buckhorn plantain. Mulch materials included new Reemay fabrics (Reemay T 534, T 3201 and T 3301) as well as industry standards [Dewit's Pro 5, Weed X (Dalen), Blunk's Fabric and Weed Block'(Easy Gardner)]. Controls included bare ground and shredded bark mulch-only treatments. Plots measured 6 x 50 feet and treatments were replicated three times.

Data collected on June 14, 1991, the following summer, included weed biomass and establishment of the seeded species. In addition, visual ratings of natural weed population establishment (0 to 100 scale with 0 being no establishment) were collected in June and August, 1991, 7 and 9 months after initiation. Soil temperatures under mulches were also collected. In June of 1992 weed establishment and root penetration of established weeds through the mulching materials were examined, 21 months after initiation. Data collected was subjected to analysis of variance (RCB design) and means were separated by LSD (0.05).

**Results and Discussion:** Several treatments gave significantly greater weed suppression when compared among materials and shredded mulch alone (Table 1). Reemay T 3301 and Dalen's Weed X gave greater overall weed suppression and reduced weed growth from seeds germinating under the mulch fabric when compared to all other treatments. These treatments also reduced yellow nutsedge, lambsquarters and buckhorn plantain seedling establishment and biomass (Table 2). Reemay T 3201 was also somewhat weed suppressive over time.

Weed Block, Blunk's Fabric, Reemay T 534 and Dewit's Pro 5 gave reduced levels of weed suppression, although weed control in July was slightly improved due to their presence compared to shredded bark mulch (Table 1). By 9 months after initiation, weed control throughout was poorer than expected due to environmental conditions favoring rapid weed growth. Summer soil temperatures under the mulches did not differ among treatments and probably did not impact weed growth.

The organic bark mulch proved to be a good medium for the germination and growth of weed seedlings. With time, this mulch became less weed suppressive as it became over grown with invasive species. Greatest weed density and species numbers were associated with bare ground.

The physical properties of the synthetic mulches vary considerably and may result in differences observed in ability to suppress weeds. Dewit's Pro 5, Blunk's Fabric and Reemay T 3301 are considerably heavier fabrics than are other materials under evaluation (Table 3). Dewit's Pro 5 and Blunk's Fabric are also thickest and have greatest tensile strength. Dalen's Weed X was thinner and had less tensile strength. Reemay T 534 and Blunk's Fabric exhibited highest values for air permeability. In general, unit weight and thickness of fabric do not appear to be well-correlated with ability to suppress weeds. Instead, those fabrics with reduced air permeability appear to provide greatest weed suppression and include Reemay T 3301, Dalen's Weed X and Dewit's Pro 5.

In June 1992, 21 months after initiation, reduced weed pressures were observed in Reemay T 3301 and Dalen's Weed X treatments. This may be due to a lack of successful root penetration by germinating weed seedlings into these treatments. We observed a lack of root penetration in these treatments whereas root penetration was extensive in others (Table 4).

**Table 1.** The average percentage of ground cover (weeds) within plots, 7 and 9 months after fall establishment of mulching materials.

| MULCHING TREATMENT | JULY 18[a] % Cover | SEPTEMBER 17[a] % Cover |
|---|---|---|
| 1. Reemay T 534 | 56.7 b | 91.7 ab |
| 2. Reemay T 3201 | 48.3 bc | 83.3 c |
| 3. Reemay T 3301 | 33.3 d | 75.0 d |
| 4. Dewit's Pro 5 | 55.0 b | 90.0 abc |
| 5. Weed X-Dalen | 36.7 cd | 75.0 d |
| 6. Blunk's Fabric | 60.0 b | 93.3 a |
| 7. Weed Block | 60.0 b | 85.0 bc |
| 8. Bare Ground | 95.7 a | 95.0 a |
| 9. Bark Mulch Only | 55.0 b | 91.7 ab |
| Significance | ** | ** |
| LSD 0.05 | 11.90 | 6.84 |

[a] Numbers followed by different letters are significantly different at the 0.05 level.

**Table 2.** Dry weights of specific weeds established in mulched plots either under the mulch itself or over the surface of the mulching material. Weights were collected 7 months after mulch establishment.

| Treatments | DRY WEIGHT (g)[a] Buckhorn Plantain | | Lambsquarters | | Yellow Nutsedge | |
|---|---|---|---|---|---|---|
| | OVER | UNDER | OVER | UNDER | OVER | UNDER |
| 1. Reemay T 534 | 60.2 | 14.2 | 16.9 | 7.4 | 20.4 | 11.2 |
| 2. Reemay T 3201 | 52.7 | 7.6 | 6.1 | 9.3 | 27.9 | 5.3 |
| 3. Reemay T 3301 | 46.1 | 2.3 | 10.1 | 1.6 | 22.5 | 3.6 |
| 4. Dewit's Pro 5 | 53.7 | 13.2 | 25.7 | 17.1 | 19.1 | 7.3 |
| 5. Weed X Dalen | 40.8 | 5.9 | 8.0 | 2.1 | 18.1 | 3.2 |
| 6. Blunk's Fabric | 56.5 | 41.6 | 40.8 | 4.1 | 16.1 | 26.8 |
| 7. Weed Block | 54.5 | 15.4 | 16.8 | 8.4 | 7.6 | 13.2 |
| 8. Bare Ground | - - - | - - - | - - - | - - - | - - - | - - - |
| 9. Baark Mulch Only | 53.9 | 28.2 | 34.6 | 14.4 | 20.6 | 23.7 |
| Significance | NS | NS | NS | NS | NS | NS |
| LSD 0.05 | 32.1 | 25.6 | 29.3 | 11.7 | 19.5 | 16.8 |

[a] Although trends were observed, no significant differences exist among mulch treatments.

**Table 3.** Physical characteristics of selected mulching materials under evaluation in Lexington, Kentucky.

| Mulching Materials | Unit Weight (Oz/Sq Yd) | Thickness (MILS) | Tensile Strength (Lbs Md) | Air Permability (CFM/ Sq Ft) |
|---|---|---|---|---|
| l. Reemay T 534 (Spunbonded) | 1.86 | 11.2 | 57 | 452 |
| 2. Reemay T 3201 (Spunbonded) | 1.95 | 10.2 | 74 | 327 |
| 3. Reemay T 3301 (Spunbonded) | 2.88 | 12.3 | 120 | 149 |
| 4. Dewit's Pro 5 (Woven slit film) | 4.51 | 38.6 | 119 | 64 |
| 5. Weed-X Dalen (perforated composite film) | 1.54 | 6.0 | 31 | 23 |
| 6. Blunk's Fabric (Needled non-woven polyplopylene) | 2.82 | 21.3 | 62 | 339 |
| 7. Weed Block (perforated polyethylene film) | 1.72 | 22.2 | 13 | 376 |

**Table 4.** Root penetration[a] through selected mulching materials in the Spring of 1992, 18 months after experimental initiation.

| Mulching Treatment | Root Penetration Rating |
|---|---|
| 1. Reemay T 534 | 2.83 c |
| 2. Reemay T 3201 | 2.67 c |
| 3. Reemay T 3301 | 1.83 d |
| 4. Dewit's Pro 5 | 3.67 b |
| 5. Weed-X Dalen | 1.08 e |
| 6. Blunk's Fabric | 3.17 bc |
| 7. Weed Block | 4.67 a |
| Significance | ** |
| LSD 0.05 | 0.64 |

[a]()=no root penetration, 5=extensive root penetration

# Almanac Garden

**M.A. Powell and P.K. Britt**
**North Carolina**

**Nature of Work:** The 'Almanac Garden' is an Extension demonstration garden for home gardeners and landscapers. The garden, a part of the NCSU Arboretum, exemplifies how plant material and construction material can be combined and arranged to create a functional and aesthetically pleasing outdoor space. As a part of the NCSU Arboretum, one of the main functions of the garden is to introduce new or different types of plants to the visitors. It is also an area in the Arboretum where the latest trends in landscape garden construction can be exhibited. Many ideas can be transferred to the home garden by visiting this demonstration area. Extension also uses this garden as the "set" for a statewide horticulture program on ourUniversity Educational Television Station. An estimated 60,000 viewers is the weekly audience.

**Results and Discussion:** An estimated 25,000 people visit the Arboretum annually. A large percentage are "industry professionals" ...LA's, nurserymen, contractors, etc. On weekends, the home gardeners, plant hobbyist and tourists are out to observe the plants.

The Almanac Garden is an excellent place to observe plants and get new gardening ideas. Plants are often chosen for landscape use, because of particular aesthetic characteristics. Current trends use plants that offer interest at various times of the year. The "Almanac Garden" was designed with this in mind.

The plants used in this garden are a combination of woody and herbaceous perennials. There are small ornamental trees; Japanese Maple, Euscapus, Kousa Dogwood and Ornamental Persimmon. The focal point tree is a Chastetree (Vitex agnus-castus) which was transplanted from another section of the Arboretum. A major part of the garden is planted with herbs and flowering perennials. These type plants are gaining popularity with home gardeners, not only because of their beauty, but also because of their low maintenance requirements. Most herbs are adaptable to a wide range of sites, and once established, are resistant to environmental stresses, and also many insects and diseases. The reduction (and in some cases, the elimination) of pesticides is a high priority for many gardeners.

Listed below are many of the herbaceous perennials and ornamental grasses planted in the garden.

| | |
|---|---|
| Salvia officinalis 'Purpurea' | Purple Sage |
| Achillea millefolium | Yarrow |
| Rosmarinus officinalis | Rosemary |
| Cuphea hyssopifolia | Elphin Herb |
| Lantana camara 'Radicans' | Varigated Lantana |
| Cymbopogon cikatus | Lemon Grass |
| Allium schoenoprasum | Chives |
| Salvia elegans | Pineapple Sage |
| Foeniculum vulgares | Fennel |
| Foeniculum vulgares 'Purpurascens' | Bronze Fennel |
| Plumbago auriculata | Plumbago |
| Lavandula angustifolia | Lavender |
| Thymus praecox 'Skorpilli' | Jankee Thyme |
| Stachys grandiflora | Betony |
| Allium tuberosum | Garlic Chives |
| Symphytum officinale | Comfrey |
| Perovskia atriplicifolia | Russian Sage |
| Salvia leucantha | Mexican Bush Sage |
| Myrtle communis | Herb Myrtle |
| Vitex agnus-castus | Chaste Tree |
| Tanacetum vulgare | Tansy |

Daylilies, Dwarf Pennisetum, Loropetalum and Rabbiteye type Blueberries are also planted in the beds. Dwarf mondo grass is used as a ground cover.

A lot of attention is directed to our small pool garden. This 5 x 5 foot pool contains several aquatic plants . Tropical lily, Hardy lily, Sweet Flag, Horsetail, Water Hyacinth, and Water Lettuce are located in this area.

Numerous paving materials, in various designs, are used as the patio base. Treated wood, of various dimensions, was used to construct overhead structures, planters and seating arrangements, screening fences and lattice walls. Future additions include night lighting and irrigation.

A backyard composting demonstration is also included in this garden. Several active composting bins are displayed. Literature is available with information on composting organic wastes.

# Backyard Composting in North Carolina

**M.A. Powell**
**North Carolina**

**Nature of Work:** Approximately 20% of the materials entering our North Carolina landfills are organic backyard wastes which could be composted and returned to the landscape. These type materials will no longer be acceptable in the landfills after January, 1993. Therefore, a major educational effort is under way to promote backyard composting. This project is made possible by a grant ($30,000) from the North Carolina Office of Waste Reduction.

**Results and Discussion:** The majority of efforts in this project involve the training of county extension agents and the production of resource materials. The following is an outline for the project:

1. Develop and distribute to garden centers, nurseries, extension offices and other appropriate locations 500 posters and 20,000 flyers to increase the public's awareness of the ease and value of backyard waste composting and encourage their involvement. The office of Waste Reduction will receive 50 posters, 1,000 flyers, and one camera-ready copy of each material.

2. Develop a videotape on how to properly build and maintain a backyard compost system, problems to avoid, and compost uses. Distribute copies to county extension offices and make additional copies available for purchase by organizations and individuals. The Office of Waste Reduction will receive 8 copies of the videotapes and will possess the rights to duplicate them.

3. Develop public service announcements on backyard waste composting for radio and television.

4. Materials developed will be sent to the Office of Waste Reduction (OWR) for review one week prior to distribution. Recognition of the efforts of the Cooperative Extension Service and the Office of Waste Reduction shall appear on printed materials and productions.

5. Plan and implement a Master Composter volunteer program to provide leadership for community information efforts. Provide process and subject matter training to Master volunteers to enable them to speak at community meetings, respond to telephone inquiries, conduct demonstrations, and staff displays at shopping malls and fairs.

6. Expand the number of local backyard composting demonstrations so that all citizens have ready access.

7. Obtain information from states with Master Composter programs and develop notebooks for use in training volunteers.

8. In cooperation with the Office of Waste Reduction, hold one-day training sessions for extension agents and other qualified trainers at four sites throughout the state.

9. Provide 12 to 15 hours of training by Master Composters for interested county volunteers so they may help with local programming and encourage implementation of backyard composting.

10. Develop educational materials and signs to distribute to each County represented at the Master Composter training sessions, along with a thermometer for measuring compost pile temperatures during demonstrations.

11. Develop and distribute to counties request for proposals to receive funds to build demonstration composting bins. County cooperative extension agents will submit three different designs of bins for consideration. The Cooperative Extension Service will award up to $500 to cover the costs of constructing a bin and signs.

12. Prepare a progress report on the project to be submitted to the Office of Waste Reduction by March 31, 1992.

13. Design a measuring instrument to determine the success of the project. Conduct a telephone survey of 300 households using part-time interviewers to determine knowledge, attitudes and behavior concerning yard waste management and the impacts of the yard waste composting project. Build time information into the survey to measure pre- and post-project attitudes. Conduct interviews in three representative counties and include program participants and non-participants. Review the procedure with OWR staff before implementation.

14. Prepare a final report on the project outlining the accomplishments and the shortcomings of the project to be submitted by December 31, 1992.

# Development of the LSU Agricultural Center Native Plant Arboretum

**Allen D. Owings and Charles E. Johnson**
**Louisiana**

**Nature of Work:** A recent mission of the Louisiana Agricultural Experiment Station has been to conduct research utilizing natural resources, while conserving and protecting the environment. The potential utilization of native plants is an important portion of this effort. The Calhoun Research Station has been actively involved in this goal through the recent establishment of the Louisiana State University Agricultural Center Native Plant Arboretum. Located in north central Louisiana between Monroe and Ruston along Interstate 20, this facility will provide nurserymen and the general public an unique opportunity to view native plants that are uncommon to the commercial horticulture industry. This work became necessary due to severe reductions in native plant populations attributable to agricultural land clearing, right-of-way defoliation, flood control efforts, forest monoculture planting, and other land use practices.

Plants indigenous to Louisiana and surrounding states, such as plum (Prunus), hawthorne (Crataegus), oak (Quercus), holly (Ilex), blueberry (Vaccinium), viburnum (Viburnum), pawpaw (*Asimina)*, mayhaw (Crataegus opaca), dogwood (Cornus), magnolia (Maqnolia), pine (Pinus), birch (Betula), crabapple (*Malus)*, redbud (Cercis canadensis), and azalea (Rhododendron), are being located and evaluated in their native habitats. In addition, propagules of these plants are being collected and established in the arboretum for further evaluation and protection. Several native plant enthusiasts have provided some of the seed and/or propagules of native species for inclusion in the arboretum. Currently, emphasis is being placed on native fruit species and native plants that may have potential for landscape utilization . Many native plant species have not been fully evaluated for food and/or landscape potential or for hybridization with current crop species; however, this project is indicating genetic diversity and potential uses for many of these plants.

Staked signs (45° angle) constructed of white pine (stained, weatherproofed, black routered letters) are being used to identify plant species in the arboretum. A computer listing of plants located in the arboretum is updated periodically to provide assistance to arboretum visitors. Maintenance of the LSU Agricultural Center Native Plant Arboretum is provided by civil service employees, summer student workers, and the native plant/ornamental/turf research group at the Calhoun Research Station. Extramural funding for this project was obtained from the Frost Foundation, Denver, CO.

**Results and Discussion:** Upon complete establishment, progress reports will be published relating to short and long term performance of individual species in the native plant arboretum. In addition, valuable information is currently being obtained on propagation methods and other production practices for possible commercial utilization in the future. A high degree of importance has been placed on the preservation and evaluation of native plant germplasm for future utilization. Cooperative evaluations of several native plant species are currently being planned with horticulture faculty at Mississippi State University.

**Significance to the Industry:** Development of the LSU Agricultural Center Native Plant Arboretum will assist the nursery industry by providing valuable information on production of many native plant species. Propagation methods, fertilization requirements, landscape performance, herbicide tolerances, and other important production factors are being thoroughly evaluated to determine commercial production suitability. Extension programs will also be offered to increase public awareness in the utilization of native plants.

## Screening Browse Preference of White-tailed Deer for Landscape Ornamentals

**Dan H. Land, Ken Tilt, M. Keith Causey, Lee Stribling**
**Alabama**

**Nature of Work:** With the increasing popularity of landscaping and the expansion of residential areas into the rural environment, homeowners have become more aware of the presence of the white-tailed deer. Some homeowners like to see the deer while others think of them as pests. Little literature is available outlining controlled research procedures for testing deer browsing preference. This project was devised to expose several species of landscape ornamentals to a known population of white-tailed deer in an enclosed area and evaluate the browse preference.

In the spring of 1991 plants were solicited from several nurseries and stepped up from trade gallon to three gallon containers. The following plants were donated for the trials*: Aucuba japonica 'Variegata', Japanese aucuba, Abelia grandiflora Abelia, Berberis thunbergii var. Atropurpurea, Barberry, x Cupressocyparis leylandii, Leyland cypress, Ilex x attenuata 'Blazer', Blazer holly, Ilex x attenuata 'Fosterii', Fosterii holly, Ilex crenata 'Beehive', Beehive Japanese holly, Lagerstroemia indica Crapemyrtle, Ligustrum japonicum Japanese privet, Myrica cerifera, Southern waxmyrtle, Nandina domestica, Nandina, Prunus laurocerasus, Cherrylaurel, Rhododendron eriocarpum 'Pink Gumpo', Gumpo Azalea, Rhododendron x 'Judge Soloman', Judge Soloman Azalea, Rododendron x 'Mother's Day', Mother's Day azalea, Spiraea x arguta, Spirea, Syringa laciniata, Cutleaf

lilac, Viburnum opulus, European cranberrybush viburnum,Juniperus horizontalis 'Plumosa', Andorra juniper.

The plants were grown under overhead irrigation until fall. During October, the plants were taken to the deer pens in sets of 4 or 5 species. The deer pen was 50' x200' containing 16 deer. A random block design was used with 5 replications and 3 plants of each species per replication inside the pen. A control treatment was placed in similar growing conditions outside the pen. Plants were spaced three feet in the row and six feet between rows to accommodate the wandering style of browsing deer. Each container was staked with a three foot iron rod. A blended feed ration was available to the deer at all times. However, there was no other vegetative matter available for the deer to eat.

Plants were set up on Wednesday, evaluated for preference on Friday. They were given a final browse rating on Wednesday then removed. Due to space restrictions, plants were made available for browsing in 4 different sets. All plants were not available to the deer at any one time. However, a fifth set was installed in the deer pen to evaluate plants that received ratings of "no" to "light" browse in previous sets.

**Results and Discussion:** The evaluation included two stages of browse and each stage was given a rating of light, moderate, or severe. The two stages of browse were; browsing of the foliage and pruning of the woody stems. There were four sets of plants. Each set is listed in order of preference as well as given a browse rating.

* Our thanks to Greene Hill Nursery, Waverly, AL. and Flowerwood Nursery, Loxley, AL for their generous contribution of the plant materials.

| SET ONE | | SET TWO | |
|---|---|---|---|
| Lilac: | severe browse<br>severe prune | Barberry | severe browse<br>severe prune |
| Japanese holly: | severe browse<br>moderate prune | Mother's Day azalea: | severe browse<br>severe prune |
| Cherry-laurel: | severe browse<br>light prune | Crapemyrtle: | severe browse<br>severe prune |
| Foster holly: | severe browse<br>light prune | Andorra juniper: | light browse<br>no prune |
| Aucuba: | severe browse<br>severe prune | | |

| SET THREE | | SET FOUR | |
|---|---|---|---|
| Spirea: | severe browse<br>severe prune | Abelia: | severe browse<br>severe prune |
| Nandina: | severe browse<br>severe prune | Gumpo azalea: | severe browse<br>severe prune |
| Ligustrum: | severe browse<br>severe prune | Southern Waxmyrtle: | severe browse<br>severe prune |
| Blazer holly: | severe brov,~se<br>moderate prune | Viburnam: | severe browse<br>Moderate prune |
| Leyland cypress: | no browse<br>no prune | Judge Soloman azalea: | light browse<br>no prune |

| SET FIVE | |
|---|---|
| Judge Soloman azalea: | severe browse<br>moderate prune |
| Leyland cypress: | light browse<br>light prune |
| Andorra juniper: | light browse<br>light prune |

Most of the plants were severely browsed and pruned. There was, however, an order of browse preference for each set of plants. The plants were randomly selected for each set and other than set five there was no comparison between the sets. We will continue to screen landscape ornamentals. The next step is to evaluate the screening process by taking some plants to natural field settings with a high deer population.

**Significance to Industry:** With the public's increasing interest and awareness of wildlife, and as we continue to encroach on our wildlife areas, a landscaper's knowledge of preferred and non-preferred plants will enable one to design a landscape more or less attractive to deer. This idea may make landscaping less frustrating and more compatible with our environment.

Nurserymen with a deer browse problem can benefit by arranging nursery stock by order of browse preference. One can put the least desirable plants

on the outside perimeter and put the most desirable plants toward the center of the nursery far from the woods or the source of the deer. Also, a border of preferred plants can be planted to attract deer away from the nursery stock. Advertising plants that do or do not attract deer may expand or create markets for landscape ornamentals.

### Literature Cited

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## Performance Evaluation of Herbaceous Plants at Auburn University

**C. Frederick Deneke and Bridget K. Behe**
**Alabama**

**Nature of the Work:** Trial gardens can provide useful information on the performance of a variety of plants for breeders, growers, landscapers, retailers,and hobbyists (6, 10). The All America Selections was organized in 1932 to evaluate and publicize new varieties of flowers and vegetables (1, 9). In 1992 these plants were judged at 44 trial gardens in the United States and were displayed for the public at 235 sites (2).

Since 1990 the Department of Horticulture at Auburn University has conducted an evaluation of warm and cool season bedding plants on about 2500 sq. ft. at the departmental greenhouse grounds on the main campus. This relatively small scale site has been used extensively to evaluate bedding plants, as a resource for teaching plant materials classes, and for display to enhance the campus landscape. With a cooperative effort of the department and the Alabama Agricultural Experiment Station, these evaluations were expanded in Fall 1991 to the E.V. Smith Research Center in Tallassee, Ala.

Seeds were donated by seed companies and were germinated and grown to transplant by commercial growers, who donated their services. Beds in full sun or under 50% shadecloth were tilled, covered with a layer of black plastic, and fumigated with methyl bromide two weeks prior to planting. Soil pH was adjusted to about 6.5. Twelve plants per entry were spaced 9 inches on center in double rows. Plants were drip irrigated with 200 ppm N from 20-10-20 fertilizer as needed. Every two weeks plants were rated on a scale from 0 (dead) to 5 (excellent flowering); growth indices were taken at peak season.

From November 1991 to March 1992, about 130 entries of cool season bedding plants were evaluated. Over 220 entries of warm season bedding plants will be evaluated from May 15 to September 30, 1992.

**Results and Discussion:** Though the campus garden has especially been noted by students, staff, and passers-by, the evaluations were expanded to a research station where land and labor were more readily available. The expanded evaluation site has received favorable comments from growers, landscapers, retailers, extension agents, and hobbyists during our open houses in February and June. Fortunately, the entire research station staff has been very supportive of this work and has encouraged expansion of the evaluations.

Results from these evaluations have been widely distributed in the state (3,5,7,8). A complete summary of our first cool season bedding plant evaluations was printed and distributed by the authors (4). With continued success of these evaluations, the Alabama Agricultural Experiment Station will hopefully publish results in the future. Another goal is to be designated an All-America Display Garden, which will enhance the notoriety of the trials and enable seeds of newer varieties of bedding plants to be more readily obtained.

**Significance to Industry:** Trial gardens are a useful means of evaluating the performance of new and established varieties of plants. However, results can not be viewed as strict recommendations since weather, hardiness zone, soil, exposure, and cultural practices greatly affect the growth of plants. Comparison of results from multiple trial sites will increase the reliability of recommendations.

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## Creating a Xeriscape Garden for West Texas

**David L. Morgan, Cynthia McKenney, and Janet Atyia**
**Texas**

**Nature of Work:** Texas' High Plains is considered a short-grass prairie, with few indigenous woody species present. Yet the population centers in this region, mainly Lubbock, Plainview and Amarillo, are abundant with woody and herbaceous landscape plant material for the most part native to areas of high rainfall. Long-term concerns in this semi-arid area (annual precipitation about 18.5 inches) over water usage have prompted interest in landscaping with Southwestern native and water-efficient plant materials. These interests have not been widely shared by the commercial plant industry, likely because little is known of the identities, growth habits and landscape value of such plants. Four years ago, horticulturists at Texas Tech University designed a xeriscape garden for West Texas in which both Southwestern native and exotic woody and herbaceous plant materials and turfgrasses would be evaluated in this semi-arid climate with minimal supplemental irrigation beyond establishment. The purpose of the garden is threefold: (1) evaluate plant species with ornamental potential as resource efficient in the urban landscape; (2) determine the winter hardiness and resistance to wind and drought of such species; (3) serve as an educational resource for the statewide nursery industry, the local public, and the students of Texas Tech University.

**Results and Discussion:** The Xeriscape Garden was constructed on an approximately 2-acre extension of the present horticultural greenhouse

gardens without the expenditure of state funds. An existing endowment provided funding for the framework of the garden — concrete walkways and irrigation lines — and the acquisition of plant materials have been possible through donations. Chipperwood from the university's grounds maintenance crews is used for walkways, and a 4-inch layer of composed cotton gin trash is soil amendment for the garden. As a part of the resource management program of the greenhouse operation, all biomass, plant waste and discarded growing media are composted and steamed and used in the garden as mulch. Most of the plant materials were donated by Lone Star Growers, Hines Nurseries and various plant collectors, and some came from drought-tolerant research interests at the University, including Southwestern native shrubs, maple tree species, sedums, and turfgrasses. A brick donor program for a memorial walkway has been initiated to establish a permanent endowment for the perpetuation of the garden. In its fourth year, the garden is far from mature, yet has attracted regional attention by the press, local civic interests, nursery organizations, and busloads of schoolchildren. The study of plants and their function in a xeriscape has been incorporated into plant materials classes at the University. The gardens provide a focal point for the annual Charles Weddle Wildflower Conference at Texas Tech. Signage is placed near all plant materials, and a kiosk for the distribution of brochures greets visitors at the main entrance to the garden.

Species which are being evaluated in the xeriscape include: Trees and Shrubs

| | |
|---|---|
| Acer grandidentatum | bigtooth maple |
| A. saccharum 'Caddo' | Caddo sugar maple |
| Chilopsis x Catalpa | chitalpa |
| Cercis canadensis 'Mexicana' | Mexican redbud |
| C. c. 'Texensis' | Texas redbud |
| Caesalpinia gilliesii | bird-of-paradise |
| Chionanthus retusas | fringe tree |
| Diospyros texana | Texas persimmon |
| Juniperus deppeana | alligator juniper |
| J. flaccida | weeping juniper |
| Taxodium mucronatum | Montezuma cypress |
| Prunus serrulata 'Snow Goose' | Snow Goose flowering cherry |
| Cercocarpus ledifolius | curlleaf mahogany |
| Forestiera neomexicana | desert olive |
| Pinus cembroides var. Remota | remote pinyon pine |
| Quercus fusiformis | plateau live oak (from Quartz Mts. in oklahoma) |
| Q. canbyi | sierra oak |
| Q. hinckleyi | Hinckley oak |
| Q. polymorpha | Monterrey oak |
| Q. laceyi | Lacey oak |

| | |
|---|---|
| Ulmus wilsoniana | U.S. National Arboretum elm |
| U. carpiniflora x parvifolia | U.S. National Arboretum elm |
| Atriplex confertifolia | shadscale |

Herbaceous Species

| | |
|---|---|
| Lampranthus aureus | ice plant |
| Verbena bipinnatifida | prairie verbena |
| Lupinus texensis | bluebonnet |
| Machaeranthera tanacetifolia | Tahoka daisy |
| Cosmos bipinnat | cosmos |
| oenothera speciosa | evening primrose |
| O. missouriensis | fluttermill |
| Eustoma grandiflorum | blue bell |
| Artemesia ludoviciana | mugwort |
| A. schmidtiana | silver mound artemesia |
| Monarda spp. | horse mint |
| Gaillardia pulchella | Indian blanket |
| Liatris sp. | gayfeather |
| Lantana camara | lantana |
| Penstemon spp. | various penstemons |
| Ratibida columnaris | Mexican hat |
| Salvia greggii | autumn sage |
| S. farinacea | mealy sage |
| Coreopsis tinctoria | golden wave |
| Helianthus maximiliani | Maximilian sunflower |
| Rudbeckia hirta | brown-eyed suxan |
| Leucophyllum frutescens | ceniza |
| Achillea millefolium | yarrow |
| Sedum spp. | stonecrop |
| Malvaviscus drummondii | turk's cap |
| Sphaeralcea angustifolia | copper mallow |

Grasses and Grass-like Plants

| | |
|---|---|
| Arrhenatherum elatius 'Bulbosum' | bulbous oat grass |
| Festuca ovina 'Glauca' | blue fescue |
| Oplismenus hirtellus 'Variegatus' | ribbon grass |
| Cortaderia selloana | pampas grass |
| Miscanthus sinensis 'Zebrinus' | zebra grass |
| Elymus glaucus | lymegrass |
| Pennisetum alopecuroides | fountain grass |
| Bouteloua gracilis | blue grama |
| Buchloe dactyloides | buffalo grass (varieties 'Texoka', 'Comanche', 'Prairie') |
| Cooperia spp. | rain lily |
| Zephyranthes spp. | rain lily |

**Significance to Industry:** Species that survive a five-year cycle of drought, harsh winters, dry summers, early freezes and late frosts should be considered hardy in West Texas. As the identities of these species are published, nurserymen, landscapers and homeowners should be able to make new selections of plant materials for South Plains landscapes.

## Tree Trunk Wraps, Paints and Protective Devices

**Bonnie Appleton, Susan French and Audrey Salzman**
**Virginia**

**Nature of Work:** The use of some type of trunk wrap, paint or protective device is generally required on all commercial landscape tree planting specifications. While trunk protection is a long standing practice, its benefits, and the materials to use, have not been well researched or documented in landscape situations (1). Reports of various types of trunk damage, ranging from girdling and constriction, to insects and diseases, led to this research.

Three gallon containerized pin oak and Chinese pistache, averaging 1/2" caliper, where field planted on September 6, 1990, watered in at planting, and mulched. Treatments were applied to the pin oak on September 10, 1990, and to the Chinese pistache on September 21, 1990. Treatments were:

- no protective material
- white paint (Gardener's Supply's Silkaben)
- conventional paper and burlap wraps (NYP Crop.)
- white adhesive gauze wrap (Forestry Supply's Guard-Tex)
- tree sap wrap (Ringer's Tree-Skin)
- white polypropylene fabric wrap (DeWitt's Cobra Wrap)
- brown polypropylene fabric wrap (Kimberly Clark)
- metal mesh wrap (Davlyn Manuf.'s Tree Tender)
- white plastic spiral strip guard (Ross' TreeGard)
- perforated white plastic guard (T & G Products' Tree-Shields)
- white and black corrugated plastic guard (Farm Wholesale's TreeWrap)
- pink corrugated plastic tree shelter (Tubex's Tree Shelters
- black rubber guard (Trimmer Guard Products)
- black foam citrus guard (Frostproof Growers Supply).

After one year the degree of product degradation was determined, and the tree trunks were visually inspected for damage. The paint had completely washed off (reapplied several times during the year), whereas all of the guards, plus the metal mesh wrap, were 100% intact. Degradation of the other wraps ranged from 10% for the tree sap and brown fabric, to 50% or more for all of the remaining wraps. What remained of the white fabric wrap was of powder consistency, and was easily brushed off the trunk.

No trunk damage was seen after one year on either tree species for any of the guards, the white and brown fabric wraps, the white paint, or the untreated trees. In many cases, however, little space remained between the trunks and the guards, suggesting that future constriction could occur if the guards were not adjusted.

Slight and considerable moisture retention behind the wraps was observed for the burlap and paper wraps, respectively. On the pin oak trunk lenticels were greatly enlarged, and the trunk had taken on an unusual ridged pattern.

On the Chinese pistache, in areas where the adhesive gauze had degraded and left the trunk exposed, numerous splits had opened up in the bark. Similar bark splitting was observed on peach trunks in another study where patches of white fabric wrap had degraded away. The bark splitting may have been caused by a heating differential between the covered and uncovered portions of the trunk.

Bark of both trees had grown into the metal mesh wrap as the trunks increased in diameter, stripping away bark as the mesh was removed. Tree height and caliper, relative to the control, had begun to be stunted on the metal mesh-wrapped trees. The tree sap-wrapped trunks could not be assessed for damage because the wrap could not be removed (or where removal was tried the bark peeled away with the wrap).

Numerous basal branches on the Chinese pistache grew through the adhesive wrap, and within the tree shelter. The rubber guard was difficult to remove, and had numerous spiders beneath it, as did the black foam guard, the white spiral plastic guard, and the tree sap wrap. No damage to the trunks was anticipated from the spiders; they had simply found a hospitable dark, moist environment.

**Significance to Industry:** The use of predrawn tree planting specifications that mandate the use of some form of tree trunk protective material is questionable. Since frequently no benefit (whether growth enhancement or trunk protection) is realized from their use, and since nonremoval can lead to trunk damage, protective materials should be considered on a per planting situation basis. Their use or non-use should be based on tree species, time of year of transplanting, site microclimate, and type of protective materials. Where protective material use is deemed advantageous, appropriate materials should be selected, and monitored for refitting, and ultimate removal, on a frequent basis.

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# Tree Root Responses to Different Soil Covering Mulch Combinations

**K. Marc Teffeau, Bonnie Appleton and Jeffrey Derr**
**Maryland and Virginia**

**Nature of Work:** The use of organic and inorganic mulches, and mulch/soil covering combinations, for weed suppression has become a standard practice in landscaping and grounds maintenance. In comparative trials the effect of mulch depth, alone or in combination with soil coverings (black plastic and landscape fabrics), has been evaluated for weed suppression, soil moisture conservation and soil temperature moderation (1,2,3,4). Limited research has been conducted on the impact of inorganic mulch and mulch/fabric combinations in landscape situations (1,3). Tree root density, growth and location have been shown to be directly impacted by various organic mulching practices (2,5,6). One objective of this research was to determine tree root responses to various organic and inorganic mulch/soil covering combinations.

One hundred forty four (144) plots, each measuring 6' x 12', were installed in May 1990, representing a factorial arrangement of 6 soil coverings by 6 mulches in a randomized complete block design with 4 replications. The 6 soil coverings were: bare soil, black plastic (solid polyethylene), Dalen's Weed-X (non-woven black polyethylene/ polyester), DeWitt's Weed Barrier (woven black polypropylene), a non-woven white polypropylene, and a blue non-woven polypropylene. The 6 mulches were: shredded pine bark, herbicide-treated shredded pine bark (Surflan @ 3 lb. ai/A), chunk (nugget) pine bark, white marble rock, and Colorado Aggregate's Red FloweRock (large particle volcanic stone) and Red Mite-T-Lite (small particle volcanic stone). All mulches were applied to a uniform 2" depth. Two containerized red maples were planted in each plot. Surflan was reapplied to the herbicide-treated pine bark plots at the 3 lb. ai/A, and all mulches replenished to the original 2" application depth, in May 1991. The study was terminated June 1 - 3, 1992.

Tree root distribution in the mulch layer atop the soil coverings (ie., roots penetrated coverings), within the coverings themselves, and beneath the coverings (ie., on the soil surface) were qualitatively rated. Four 4 1/4" equidistantly-spaced soil cores, to a depth of 6", were pulled at a distance of 12" from the trunk of one tree/plot. Depth of root penetration was measured, roots were separated from the soil, and the four root samples pooled for a total root dry weight per plot.

**Results and Discussion:** The greatest amount of tree root growth in the mulches occurred where no soil covering was used (bare soil), followed by the white non-woven fabric. The least amount of root penetration and subsequent growth into the mulch layers occurred with black plastic, followed by Dalen's Weed-X. Roots penetrated fabrics topped with organic

mulches more than those topped with inorganic mulches, presumably due to the moisture held in the organic mulches.

No roots were found growing within the black plastic itself. The fabric covering with the least amount of internal tree root growth was Dalen's Weed-X, with the greatest amount of internal tree root growth occurring in DeWitt's Weed Barrier. DeWitt's Weed Barrier and the white non-woven fabric were both difficult to remove due to the extent of tree root penetration.

Once the mulches and soil coverings (plastic and fabrics) were removed, the greatest amount of root growth on the soil surface occurred under Dalen's Weed-X, followed closely by DeWitt's Weed Barrier. Both had more surface root growth than black plastic. The least amount of tree root surface growth occurred where no soil covering (bare soil) was used. As with covering penetration/mulch root growth, fewer tree roots were growing on the soil surface where inorganic mulches were used compared to organic mulches.

There were no significant differences in tree root dry weight for soil coverings, mulches, or their interaction. For average tree root depth there was no significant interaction, but significance for soil coverings (0.01) and mulches (0.05). For soil coverings, roots were shallowest under black plastic and deepest in the bare ground. For mulches, roots were shallowest under shredded pine bark and deepest under the marble rock.

**Significance to Industry:** Soil covering selection should be based not only on cost, ease of installation, and weed suppression, but also upon permanence of installation. Tree roots are able to penetrate through all landscape fabrics and black plastic to varying degrees. Tree roots become entangled within the fibers of many of the fabrics, making fabric removal difficult. Root systems can be damaged if fabric removal is necessary for relandscaping. Use of an inorganic mulch atop a fabric minimizes penetration by reducing available moisture and creating a less hospitable growing environment.

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# *Juniperus horizontalis* Cultivar Evaluations at the NCSU Arboretum

**Kim E. Tripp, J.C. Raulston and Paul Fantz**
**North Carolina**

**Nature of Work:** *Juniperus horizontalis is* a standard groundcover of the nursery trade in the southeastern U.S. because of its landscape utility and relative ease of production. A few cultivars with excellent horticultural traits (such as 'Blue Rug'/Wiltoni', and 'Bar Harbor') are widely grown. Over fifty other cultivars exist that are rarely produced. Some of these less frequently cultivated selections offer a range of unique horticultural characteristics that warrant greater production and utilization in the landscapes of the southeastern U.S. Tolerance of a range of soils (as long as they are in full sun) from heavy clay to dry sand, and the ability to thrive in low-maintenance environments, make these plants excellent choices for the tough conditions of new, urban landscapes. They are completely hardy throughout the entire southeastern U.S. and are readily propagated by hardwood cuttings in both winter and mid-summer. The foliage of *Juniperus horizontalis is* attractive twelve months out of the year with many cultivars showing handsome changes in winter foliage color - an excellent trait for promotion of both winter interest in the landscape and nursery sales throughout the year.

**Results and Discussion:** Mr. Lawrence Hatch, under the direction of Dr. Paul Fantz, assembled a reference collection of over 80 different accessions of *Juniperus horizontalis* for study and evaluation at The NCSU Arboretum during the period of 1982 to 1984. These accessions were planted in Piedmont clay soil at equidistant spacing in groups of three plants on three foot centers. Plants were grown with minimal inputs but were irrigated periodically during dry periods along with other Arboretum plantings. The plants of these unusual selections have developed strikingly different characteristics of color, texture, height and shape.

The following are descriptions of the best of these lesser known cultivars which have performed well at the Arboretum and exhibit excellent potential for the nusery industry. Identification of cultivars is often difficult with both familiar and unusual cultivars confused because of their superficial similarity in appearance, especially as young plants. Mr. Hatch summarized the taxonomic characteristics of these cultivars in a detailed Master of Science dissertation (3). Many of these cultivars are also described in horticultural literature (1,2,4), but descriptions may be based on plants grown in cool climates and often differ from the actual growth habit observed in the southeastern U.S., especially as regards height and spread. The descriptions reported here focus on horticultural characteristics and include estimates of current plant size at The NCSU Arboretum after 6 to 8 years of growth, with spread measured in one direction from the crown using the most extended branches in full sun, and height measured at the tallest point of the crown. With one exception explained below, all of these cultivars showed very little, or no, evidence of foliar disease during 1992's cool, wet spring. Cultivars marked with an '**' are especially unique and promising.

'Argenteus'**: A rich blue-green form with new growth in the spring emerging a contrasting grey. Reaching 11" height with somewhat upright, cord-like branches and a 5' spread. Excellent foliage quality and pleasing color.

'Blue Forest'**: A relatively new form with a formal, upright habit, 19" in height with 3' spread. The excellent blue color and unique habit make 'Blue Forest' look almost like a miniature grove of incredibly dwarf *J. deppeana.* A great specimen plant rather than a groundcover because of the upright form. This is the only selection showing appreciable foliar disease but its especially unique habit and color may make it worth growing.

'Blue Horizon': An exceptionally flat form with intensly blue foliage. One of the best cultivars at the Arboretum and currently in production in the trade. The excellent quality foliage turns an attractive bronze green in winter. With a height of only 7" and a spread of 5', 'Blue Horizon' remains uniformly flat without mounding around the central crown - a useful trait for large plantings.

'Blue Mat': Very tight and low blue-grey form with purple-blue winter color. Foliage is so dense as to appear braided. Maximum height of 6-8" and spreading to 6' with especially good, uniform foliage quality.

'Coast of Maine': Long leaders and feathery foliage texture give this blue-green cultivar a relatively soft appearance with an uneven growth surface creating cup-like shapes around the crowns. Height to 9" with a 6' spread.

'Douglasii' (or 'Waukegan'): Rapid grower with upright fans of blue-grey foliage on trailing branches. An especially nice texture for banks. Particularly tolerant of light, dry soils, but has also thrived in clay with a height of 17" and spread of 6'.

'Girard'**: An excellent, especially low, flat cultivar reaching only 6" height and spreading slowly to 5'. Blue-green foliage is tightly woven to create an unusually fine texture.

'Glomerata': A low form with short, upright branches that are covered with emerald green foliage. Foliage is plum colored in winter. Height to 15" and spread to 4' with interesting, uneven texture due to the upright branches mixed with lower, spreading growth.

'Heidi'**: A very slow spreading form to only 3' with unique, 15" tall, fern-like foliage in a handsome grey-green color. An especially attractive choice which should be placed where the unusually striking, fern-like foliage is seen from close proximity.

'Jade River'**: Blue-green foliage with a slight silvery cast on long, spreading leaders over a low and tight mat. Reaches 8-10" and spreads to 6' with a softly undulating appearance.

'Lime Glow'**: This spectacular selection was discovered by Lawrence Hatch in Raleigh, N.C., as a branch sport of 'Plumosa'. Not only is the habit upright and mounded, but the foliage is a bright lime-green to lemon yellow colored. Height is 16-20" with a spread of 2'.

'Livida': Upright fans of grey-green foliage give this cultivar a uniquely attractive scalloped texture. Growth is medium dense, reaching 6-12" in height. Spreads out in a circle from the crown to 5' and tightly covers the ground surface. Foliage turns purplish in winter.

'Mother Lode'**: The only patented cultivar listed here and licensing from Iseli Nurseries in Oregon is required to grow this selection which Jean Iseli discovered as a branch sport of 'Wiltonii'. Relatively slow growing and low (12" probable maximum height) with bright gold variegated, plume-textured foliage. An unusual ground cover for winter interest as well as a unique specimen plant. Plants at the Arboretum are younger than others in the collection and have reached 8-10" in height with a 2' spread.

'Plenifolia'(or 'Planifolia')**: Laterally flattened fans of upright, planar leaders make an intriguing texture, like palm leaves with rough coats on. The foliage is blue-grey and very open, spreading to 7' and reaching heights of up to 25".

'Prince of Wales'**: Rapid spreading, exceptionally cold hardy selection from Canada with extremely tight, low, bright green foliage. Pronounced blue-purple bloom in the winter. Especially good foliage quality and tight, dense form reaching only 12" in height with a spread of 7'.

'Prostrata Glauca': Somewhat loose textured with long leaders and open branching but a low height of only 7" and spread of 6'. The open branching gives this plant a two-tone effect in soft blue coloration. ('Prostrata' is a dark

green form frequently confused with the blue 'Prostrata Glauca').

'Repens': Is an especially tall and vigorous form reaching 20" in height, with blue-gray, cordlike foliage creating an intersting texture and spreading to 7'.

'Slow Blue'**: Not as slow growing as the name implies with a spread to 5' but with very blue, excellent, dense foliage reaching 8-10" in height.

'Turquoise Spreader': From Monrovia Nursery creating a wide mat of 12" high, rich turquoise green, feathery foliage on long leaders to 6'. Foliage quality is excellent and is tinged with grey-purple in winter.

'Watnong'**: A very low, tight form with clear green, bead-like foliage to a height of only 6". Excellent, especially dense groundcover capability with beautiful foliage spreading to 5'.

'Yukon Belle'**: Another extremely hardy form (to zone 2) with especially bright blue, somewhat rough textured foliage with plume-like leaders to 13" in height. The silvery tinge to the blue summer foliage changes to a darkened purple-green in winter. The dense foliage creates an excellent blue mat spreading vigorously to 8'.

**Significance to the Industry:** These cultivars are only a small fraction of the many excellent *Juniperus horizontalis* selections in the collections of The NCSU Arboretum. All of the cultivars listed above offer unique and handsome landscape characters in combination with good adaptability to southeastern landscape conditions, and ease of propagation. The range of spread and height characters reported here reflect the important effect of time and climate on growth, with spread particularly continuing to change over the life of individual plants to potential sizes beyond those given above on young plants.

*Juniperus horizontalis* cultivars may be successfully combined in a mosaic of textures, forms and colors to create a living carpet of pattern in the landscape. The soft gold of 'Mother Lode' woven through 'Jade River's silvery foliage, or the play of textures when 'Livida', 'Watnong' and 'Heidi' intertwine cannot be duplicated by any other type of planting. Groundcovers are often relegated to monoclonal plantings that simply fill space that is not physically appropriate for lawn. The unusual and lesser known cultivars of *Juniperus horizontalis* described here can be used to create groundcover plantings that not only cover the ground but also bring a whole new beauty and dimension to the landscape.

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## Rootstocks for Ornamentals Production in the Southeastern United States

**J. C. Raulston and Kim E. Tripp**
**North Carolina**

**Nature of Work**: Fifteen years of ornamental plant adaptability trials at The NCSU Arboretum with widely diverse species from around the world has shown the single most important environmental/climatic limitation to be root survival under wet, hot summer conditions. As temperatures rise, respiration rates increase which create a requirement for more oxygen to permit root survival. Sudden flooding of poorly drained soils during maximum temperature periods can create temporary, but quickly fatal, anaerobic conditions for roots at the time of peak oxygen demand. This situation is unique to the southeastern U. S. as soils in southwest and western states are dry (and well aerated) at periods of high temperatures, and central and northeast areas are cooler when rains occur. In addition, modern container production with carefully formulated media of coarse texture and rapid drainage allows simple, successful production of plants with fragile root systems which often cannot be subsequently grown easily in landscape soils of the production region. Prominent examples include many Ericaceous plants and such native and exotic taxa as *Franklinia alatamaha*, *Gordonia lasianthus*, *Ilex* X *meserve* ("Blue Hollies"), and *Taxus* X *intermedia*.

Grafting is used to produce plants which combine aerial portions of superior ornamental or productive capacity with adapted and tolerant root systems

suitable for the area of production. The majority of such grafting is used in fruit crop production where an economic product permits the extra costs of such speciality propagation. Very little research has been conducted on potential rootstocks specifically for ornamental plants in the southeastern U. S. due to the lack of commercial grafting operations in the region, the lack of such specific skills among most academic researchers, and the time and expense to conduct such long-term trials on “minor” crops.

Commercial grafting firms in the Pacific northwest and the northeast are not aware of the potential problem and often use rootstocks which work well in those areas, but are failures when planted in the southeastern U. S. A prime example is the use of *Abies balsamea* or *fraseri* seedlings for all fir grafting (due to low cost and ready availability as major Christmas tree species). These are the two weakest root system firs in existance and such grafted plants never survive the first month of wet summer conditions. In early years *Cornus* X ‘Eddies White Wonder’ was grafted in the Pacific northwest on *C. nuttallii* which cannot be grown in the southeast, leading early researchers to believe the scion cultivar could not be grown in the east. Many other such examples exist.

**Results and Discussion**: The following listing contains theoretical proposed graft rootstock:scion combinations for research and production trials. The listing has been formulated from observation of plant behavior at The NCSU Arboretum, in other gardens around the world, and native habitats of many of the species. The plant(s) listed first (before the hyphen) are taxa which have been observed to have more tolerance to hot, wet southeastern U. S. soils than average species of the genera and therefore have potential for understock use. The plant(s) listed following the hyphen are those which have ornamental value, but have been observed to have survival problems in poorly drained soils and therefore would be the scion stock.

In a few cases bigeneric combinations have been proposed where tolerant species do not exist within the problem genera. Bigeneric grafts are generally less successful than interspecific grafts, but enough successful combinations have been achieved in the past to warrent trial. An asterisk (*) is used after the proposed combination where promising trial grafting work has been conducted at NCSU or observed elsewhere.

*Abies firma* - for other *Abies* taxa*.
*Acer japonicum* or *palmatum* - for *Acer circinatum* and *A. macrophyllum.*
*Acer rubrum* - for *Acer pentaphylla**.
*Acer saccharum* - for *Acer griseum**.
*Arbutus unedo* - for *Arbutus arizonica, menziesii*, and *texana.*
*Baccharis halimifolia* - for *Baccharis pilularis*.
*Betula nigra* - for other *Betula* taxa*.

*Calycanthus floridus* - for *Calycanthus occidentalis.*
*Ceanothus* X *pallidus* or *americanus* - for west coast *Ceanothus* taxa.
*Cercis canadensis* or *chinensis* - for *Cercis griffithii, occidentalis.*
*Chamaecyparis pisifera* or *thyoides* - for *Chamaecyparis lawsoniana* and *nootkatensis* cultivars.
*"Chitalpa "* (*Catalpa* X *Chilopsis* hybrid) - for *Chilopsis linearis*.
*Cornus florida* - for *Cornus nuttallii* and *C.* X 'Eddie's White Wonder'*.
*Crataegus aestivalis* - for other *Crataegus* taxa.
*Cupressus bakeri* or *glabra* - for *Cupressus sempervirens* 'Swane's Golden'.
*Eleagnus* X *ebbingii* or *pungens* - for *Eleagnus angustifolia.*
*Fagus grandifolia* - for *Fagus sylvatica* cultivars; trial on *Nothofagus sp.* ??
*Garrya ovata* var. *lindheimeri* - for *Garrya elliptica* 'James Roof'.
*Photinia* X*fraseri* - for *Heteromeles arbutifolia* .
*Ilex* X 'Nellie Stevens' - for *Ilex aquifolium* and *I.* X *meserveae* ("Blue Hollies")*.
*Itea chinensis* - for *Itea ilicifolia*.
*Kalmia latifolia* - for *Kalmia cuneata* and *microphylla.*
*Magnolia virginiana* - for *Magnolia sieboldii* and *wilsonii*.
*Myrica cerifera* - for *Myrica californica*.
*Picea abies, omorika,* or *orientalis* - for *Picea brewerana*.
*Pieris japonica* - for *Pieris floribunda*.
*Pinus glabra , pinea, sylvestris,* or *virginiana* - for *Pinus edulis, muricata.* (2-needle pines).
*Pinus palustris, serotina, rigida,* or *taeda* - for *Pinus coulteri, jeffreyi, ponderosa, sagbiniana* . (3-needle pines).
*Pinus cembra, parviflora,* or *strobus* - for *Pinus albicaulis, aristata, flexilis, torreyana.* (5-needle pines).
*Platycladus orientalis* - for *Microbiota decussata* (Unlikely bigeneric graft - but only possibility for south).
*Pseudolarix amabilis* - for *Larix* taxa. (Unlikely bigeneric graft - but only possibility for Larix in south).
*Quercus virginiana* - for the numerous west coast and Mediterranean evergreen *Quercus* species.
*Raphiolepis umbellata* - for *Raphiolepis indica* taxa.
*Rhododendron chapmani* - for small-leaved evergreen *Rhododendron* taxa; trial for *Kalmiopsis leachiana* ??
*Rhododendron atlanticum* - for deciduous *Rhododendron* taxa; specifically *R. occidentale*.
*Sorbus alnifolia* - for other *Sorbus* taxa.
*Spirea sp*. - for *Holodiscus discolor* . (Unlikely bigeneric graft, understock suckering impractical also).
*Stewartia monadelpha, koreana*, or *pseudocamellia* - for *Stewartia malacodendron* and *ovata*.
*Styrax americanus* or *japonicus* - for *Styrax hemsleyana, obassia, officinalis, officinalis californicus, platanifolia, texana,* and *youngae.*

*Syringa oblata* var. *dilatata* - for *Syringa vulgaris* cultivars.
*Taxus chinensis* - for *Taxus* X *intermedia* cultivars.
*Tsuga canadensis* - for *Tsuga caroliniana, heterophylla* and *mertensiana*.

**Significance to Industry**: Successful combinations from the above potential grafting/rootstock trials would make possible the successful landscape cultivation of new ornamental plants currently impractical or impossible to grow in the southeastern U. S. There is an industry conception that grafted plants are a commodity of the past with increasingly unavailable skills needed and greater costs than for cutting production of clonal taxa. This statement is generically true for mass market crops, but for a number of plants grafting may be the only feasibility for successful use of the taxa in the region. Knowledge of graft combination feasibilities would create opportunities for development of regional speciality propagation nurseries to fill the potential consumer market for such connoisseur plants.

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# Evergreen Vines for Commercial Production in the Southeastern United States

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**North Carolina**

**Nature of Work**: Vines have many vaulable design uses in contemporary landscapes from groundcovers, to trellis and arbor coverage, to softening of wood and stone walls, to patio standards for pot culture. Vines are generically easy to propagate by softwood cuttings and grow rapidly in commercial culture-with control of the rampant growth to avoid entanglement the only major production problem. Southern climates potentially allow a wider array of evergreen species for year-round interest than have been used in traditional northern markets. Planting multiple vines in varied genera together for multi-season interest is a practice in its infancy in the landscape field. As in most areas of plant useage, there are far more potential species for use than are normally found in commercial channels. Carolina jessamine, *Gelsemium sempervirens*, and English Ivy, *Hedera helix* , likely make up over 95% of the current evergreen vine market in USDA hardiness zones 7-9 in the southeastern U. S. Many others remain to be exploited for production and use.

**Results and Discussion:** During the past 15 years a wide array of evergreen vines have been grown and evaluated at The NCSU Arboretum, and others observed in travels to other gardens and nurseries. The following listing briefly describes 47 evergreen vines which have potential for use in the southeastern U. S. Unless mentioned otherwise - all are useful in zones 7-9. Those currently growing in The NCSU Arboretum collection are indicated by an asterisk (*).

***Akebia quinata* 'Shirobana' ('Alba')*** - "White-Flowered Chocolate Vine" [Lardizabalaceae] - The species is a deciduous vine with 5-leaflet compound foliage, purple flowers and fruit introduced from eastern Asia by Fortune in 1845. Climbs by twining stems. This Japanese cultivar has white fragrant flowers and white fruit, and is evergreen to semi-evergreen in zones 8-9. Very ornamental and much admired by visitors.

***Bignonia (Anisostichus) capreolata*** * - "Cross Vine" [Bignoniaceae] - Native throughout the southeastern U. S. and introduced to Europe in 1653. Has 2-leaflet compound foliage with yellowish orange tubular flowers with darker orange-red exterior. Climbs by twining leaf tendrils and will cling to wood surfaces. Rarely grown in the south, though native through much the same range of *Gelsemium* and as showy when in flower. There are also

deep red ('Atrosanguinea'*), tangerine*, and yellow-flowered* selections.

***Clematis armandii*** - "Armand's Clematis" [Ranunculaceae] - Native to central and west China and introduced by Wilson in 1900. Has 3-leaflet compound foliage with fragrant creamy-white flowers in early spring. There are pink ('Apple Blossom'* and 'Hendersoni Rubra') and white ('Snowdrift') cultivars. Climbs by twining growth and a vigorous and spectacular plant when well-established. Will periodically be cold-injured in zone 7, but hardy enough to be of good practical use in that zone.

***Clematis cirrhosa*** *- "Winter Clematis" [Ranunculaceae] - Native to southern Europe and Asia Minor and introduced in 1596. Variable foliage ranging from simple to compound with 3 to 6 leaflets and whitish-yellow flowers in midwinter. Climbs by twining stems. Has grown well in Raleigh in recent years but likely will receive some damage in more severe winters; dependable in zones 8-9. *C. cirrhosa* var. *balearica* is a botanical variety from the Balearic Isles with midwinter yellow flowers and reddish purple spots on the interior. An English cultivar, 'Freckles', received the Royal Horticultural Society Award of Merit in 1989 and was recently introduced to U. S. commerce. 'Wisley Cream' has unspotted creamy white flowers.

***Clematis finetiana*** - No Common Name [Ranunculaceae] - Native to central and west China and introduced by Wilson in 1908 - closely related to *C. armandii* and very similar but with smaller white fragrant flowers. Not yet tried but should be useful in zones 8-9 and possibly 7.

***Clematis meyeniana*** - No Common Name [Ranunculaceae] - A very wide climatic range in its native habitat from China, Japan, Taiwan and Phillipines would seem to indicate provenance would be very important in hardiness and adaptation - but has not been studied. Though cultivated since 1821, still a very rare species. Reported much like *C. armandii* with white flowers in spring. In The NCSU Arboretum for several years but lost in a severe winter - likely a zone 8-9 plant unless from northern provenance.

***Clematis uncinata*** - No Common Name [Ranunculaceae] - Native to western China; discovered by Henry in 1884 and introduced by Wilson in 1901. Dark green compound leaves with large fragrant white flowers in summer. Not seen, but native habitat indicates it should be useful throughout zones 7-9.

***Decumaria sinensis*** - "Chinese Climbing Evergreen Hydrangea" [Hydrangeaceae] - Asian counterpart to our native *D. barbara*; native to central China and introduced by Wilson in 1908. Foliage is simple with obovate shape; intensely fragrant green and white flowers are borne in profusion in late spring. Climbs by aerial rootlets on wood or stone. Seen

in Italy and California, and sold commercially in England - continue attempts to add to our collection for trial - should be hardy in zones 7-9.

***Gelsemium rankanii*** * - "Autumn-Flowering Jessamine" [Loganiaceae] - A little-known southeastern species related to the popular "Carolina Jessamine" below which was introduced to commercial trade by Woodlander's Nursery of Aiken, S. C. in the early 1980's. It differs from *G. sempervirens* by flowering in autumn as well as in spring, and in having non-fragrant yellow flowers. Climbs by twining stems. An outstanding plant which has enjoyed considerable growth in commercial success in recent years.

***Gelsemium sempervirens*** * - "Carolina Jessamine" [Loganiaceae] - The most widely grown evergreen vine in the southeastern U. S. and extremely popular in nursery trade. Native to the southeast (Virginia to Guatamala) and the state flower of South Carolina. Entire simple leaves with bright yellow fragrant flowers in early spring. Climbs by twining stems. The double-flowered form, 'Pride of Augusta'*, has long been in commercial culture. Woodlander's Nursery of Aiken, S. C. introduced a beautiful pale primrose yellow-flowered selection* in 1991 which attracted great attention this spring when it bloomed for the first time.

***Hedera colchica*** * - "Persian Ivy" [Araliaceae] - A strong growing vine with the largest leaves of any ivy in the genus, native to the Caucasus and introduced to cultivation in 1850. Makes an excellent groundcover and like all *Hedera* grows on wood and stone with aerial rootlets. A cultivar, '*H. colchica* 'Dentata Variegata'*, is spectacular with showy golden variegated foliage and other cultivars exist.

***Hedera helix*** * - "English Ivy" [Araliaceae] - Probably the most important groundcover for shady areas, and grown world-wide on walls and fences. Native from southern Europe and northern Africa to the Middle East and cultivated since antiquity. Innumerable cultivars exist of widely varying characteristics. Not all cultivars will grow on walls with aerial rootlets. Detailed cultivar information is available from American Ivy Society, P. O. Box 520, West Carrollton, OH 45449-0520 (513-434-7069).

***Hedera nepalensis*** * - "Himalayan Ivy" [Araliaceae] - A rare vine native to the Himalayas introduced to cultivation in 1880. Distinctly different foliage with long, lance-shaped leaves to 7" with wavy margins, and showy yellow to orange fruit on adult flowering branches. Excellent in Raleigh and will be widely distributed by The NCSU Arboretum in 1992.

***Hedera pastuchowii*** * - No Common Name [Araliaceae] - Introduced to cultivation from Iran in 1972 by Roy Lancaster and has been hardy in The NCSU Arboretum for the last decade. Attractive but not a distinctively different ivy to a casual observer.

***Hedera rhombea*** * - "Korean Ivy" [Araliaceae] - Native to Japan and Korea; dark green roughly triangular leaves. Attractive, hardy and well adapted to southern areas. A variegated cultivar is sold in England.

***Holboellia coriacea , fargesii*, and latifolia*** * - No Common Name [Lardizabalaceae] - Native to China and the Himalayas with various species introduction from 1840 to the 1900's. Leaves are compound with 3 to 7 stalked leaflets. Plants are dioecious, with small but attractive greenish-white flowers in spring followed by large fleshy fruit in autumn if both sexes are present and pollinated. Climbs by twining stems. Virtually unknown in commercial culture but vigorous and attractive vines worthy of production.

***Kadsura japonica*** - "Magnolia Vine" [Schisandraceae] - Native to Japan, China and Taiwan and introduced to western cultivation in 1860. Dark green oval to lanceolate leaves and small creamy white flowers similar to small magnolia blooms in spring followed by red fruit in autumn. Climbs by twining stems. Three Japanese cultivars were received from Brookside Gardens, Wheaton, MD in the early 1980's which have become beautiful plants with ornamental character worthy of commercial use. These include 'Shiromi'* - a white-fruited form, 'Fukurin'* - strongly white/gold variegated and very showy, and 'Chirimen'* - more subtlety variegated with white flecks and streaks. Good commercial potential in zones 8-9, and likely hobbyist use in zone 7.

***Lonicera henryi**** - "Henry's Honeysuckle" [Caprifoliaceae] - Native to western China and introduced by Wilson in 1908. Slender-pointed foliage with fine hairs on leaves and young stems and yellow fading to red flowers in early summer. Climbs by twining stems. Rarely seen but of good potential.

***Lonicera sempervirens**** - "Evergreen Honeysuckle" [Caprifoliaceae] - Native throughout the southeastern U. S. and introduced to Europe as an ornamental as early as 1656. Spring flowering with orange-scarlet flowers. Climbs by twining stems. Though not common, it is produced in quantity and available with hunting. Several useful forms exist including a botanical form, *L. sempervirens* f. *sulphurea** which is yellow flowered, 'Cedar Lane'* a showy coral red selection from Cedar Lanes Nursery in Georgia, and a variety of "local" selections of individual nurserymen and gardens.

***Millettia reticulata*** * - "Evergreen Wisteria" [Leguminosae] - Native to China and grown commercially in southern California (and shipped to the southeast) but seldom produced in the southeast industry - possibly because it is somewhat more difficult from cuttings than many other vines. The compound foliage superficially resembles wisteria with thicker texture, darker green color and rounded leaflet tips. Purple flowers are borne

sporadically through the summer. *Millettia* differs from closely related *Wisteria* in the dehiscence characteristics of the seed pods and in having branched racemes of flowers.

***Pileostegia viburnoides*** * - No Common Name [Hydrangeaceae] - Native to India and south China and introduced by Wilson in 1908. A slow-growing shrubby "vine" which climbs wood and stone walls by aerial roots with much the same character as *Hydrangea anomala* ssp. *petiolaris.* Creamy white flowers in terminal panicles in mid-summer. Would be a beautiful and choice collector's plant well adapted in zones 8-9, but growth rate is too slow when young to be profitable for major commercial impact.

***Rubus henryi*** - "Henry's Raspberry" [Rosaceae] - Native to central and west China and introduced by Wilson in 1908. Leaves are dark green and deeply 3-lobed with white pubescence on the underneath side. Flowers are pink and are produced through the summer followed by edible black fruit. "Climbing" is through long irregular scandent growth which can reach 20' with support. It root suckers and would probably best be used in confined areas or pots for control in the garden.

***Rubus parkeri*** - "Parker's Raspberry" [Rosaceae] - Native to central China and introduced by Wilson in 1907. Leaves are oblong-lanceolate with wavy toothed margins and have densely reddish brown pubescence beneath. Small white flowers are produced in summer followed by black fruit. Growth and spread are as above, though stems are reported to be biennial and will likely need frequent pruning maintenance.

***Smilax sp.* (laurifolia ?)*** - "Evergreen Smilax" [Smilacaceae] - Native to the southeastern U. S. and a somewhat important local "status symbol" plant in the Raleigh area (similar to the use of boxwood in Virginia) with it trained across the top railing of porches or over doorway arches where the branches can reach 25' in length. It cannot be propagated by stem cuttings and seed are difficult resulting in a shortage of plants as they are available only through division of established clumps. Very beautiful plant and highly desired in spite of quite expensive retail prices, but not a commercial mass-market selection.

***Stauntonia hexaphylla**** - No Common Name [Lardizabalaceae] - Native to Japan, Korea and Taiwan and introduced to western cultivation in 1874. A vigorous, coarse textured plant with compound leaves of 3-7 stalked leaflets. Flowers are whitish tinged with lavender and appear in spring. Fruit are reported to be purple and egg-shaped but in a decade have never appeared on our plants in Raleigh. Climbs by twining stems. A rare Japanese cultivar, *S. hexaphylla* 'Cartwheel', with white variegated foliage was introduced to the U. S. by Brookside Gardens, Wheaton, MD but has not appeared particularly attractive in our trials.

***Trachelospermum asiaticum*** - "Japanese Star Jasmine" [Apocynaceae] - Native to Japan and Korea and often grown in the deep south as a groundcover as well as for trellises. Often confused with the following species but has smaller foliage, yellowish white flowers and is more cold hardy. Climbs by twining stems. There are a large number of cultivar selections in Japan which are at times available from U. S. specialists.

***Trachelospermum jasminoides*** - "Confederate Jasmine" [Apocynaceae] - Native to central and south China and Taiwan and introduced by Fortune in 1844. One of the most common landscape plants in zone 9 where it is used as a groundcover. In contrast to the above species, it has larger and coarser foliage and white flowers. In the severe winter of 1985 both species were severely damaged in areas where they had been commonly used. Symmes Nursery found a selection with superior hardiness that was uninjured that year and it has been introduced under the name of 'Madison'*.

**Significance to Industry**: A wider spectrum of evergreen vines are available for commercial production and use in the southeastern U. S. than are currently used. Of the 47 taxa described above, the following 11 are potentially the most "commercial" for potential production expansion: *Akebia quinata* 'Shirobana', *Bignonia capreolata* (tangerine selection), *Clematis armandii* 'Apple Blossom', *Clematis cirrhosa*, *Gelsemium rankanii*, *Gelsemium sempervirens* (pale yellow selection), *Hedera colchica* 'Dentata Variegata', *Hedera nepalensis*, *Kadsura japonica* 'Fukurin', *Lonicera sempervirens* 'Jane Symmes', and *Trachelospermum jasminoides* 'Madison'.

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# *Cryptomeria* Evaluations at the NCSU Arboretum

**Kim E. Tripp and J.C. Raulston**
**North Carolina**

**Nature of Work:** Conifers are staples of the modern landscape and offer a broad spectrum of uses ranging from specialty dwarf rarities to tall, fast growing screens. One conifer which has performed very well in evaluation trials at The NCSU Arboretum is the Japanese Cedar, *Cryptomeria japonica*. As the name suggests, this tree was introduced from Japan in the 1800's where it is important both as an ornamental and for lumber. Many older seedling trees of Japanese Cedar can be seen in the landscapes of the southeast U.S. which were planted throughout the 1900's. These older seedling trees are not always attractive in appearance but, in contrast, the great range of modern *Cryptomeria* cultivars available are especially handsome landscape plants that offer new and versatile conifers for the nursery and landscape industries of the southeast.

**Results and Discussion:** Standard Japanese Cedar, *C. japonica* var. *japonica*, grows in a conical, semi-formal shape and can reach heights of 50 to 75 feet. While not widely grown, it is fully hardy and can be successfully grown throughout USDA zones 6-9, including both mountainous areas and the hot regions of the Coast and Piedmont. Japanese Cedar prefers a rich, deep, acid soil but has performed well in the red clays of the Piedmont during both wet and dry periods. Even large trees transplant readily and will take some drought with minimal browning and die-back. Like almost all conifers, *Cryptomeria* needs full sun to grow well and variegated cultivars often lose their color in shade. A few, but not all, of the variegated cultivars may also lose their color in the heat of Piedmont and Coastal region summers. Japanese Cedar can be propagated easily from cuttings which are best taken in November but will root most any time of year if mature, hardened wood is available. Cuttings should be treated with rooting promoters before being rooted under mist. The species can also be grown from seed but cultivars are so superior and easy to propagate that seed is not recommended commercially.

There are many cultivars of Japanese Cedar with a wide range of horticultural characteristics to offer. Many cultivars exist in Japan that are not grown in Europe or America and a few cultivars are widely grown in Europe and America that are never seen in Japan (e.g. 'Vilmoriniana'). The following list of cultivars describes *Cryptomerias* at The NCSU Arboretum. Underlined cultivars are selections which have performed exceptionally well at The NCSU Arboretum. A number of these cultivars have not yet been treated in the literature (1,2,3,4). Because of the history of *C. japonica* as an important ornamental in Japan, there are often synonymous Japa-

nese and European names for one cultivar. This paper has presented names in general use in the United States or Europe.

**'Araucarioides'**: Full size, with unique, open branching habit. Major branches are very long and spread up and away from the trunk but nod somewhat under their own weight. Branchlets cluster at the apex of each major branch resulting in an unusual, irregular appearance.
**'Benjamin Franklin'**: A full size cultivar which originated in NC in the 1970's with upright, especially good conical shape and full yet defined branching habit. Foliage is rich green with no interior dieback.
**'Black Dragon'**: Dwarf with upright, defined, formal branching and exceptionally dark, quality foliage, popular in Japanese landscapes.
**'Compressa'**: Very dwarf form similar to 'Vilmoriniana' with rounded, compact, extremely small leaves and branchlets. 'Compressa' colors distinctly red-brown in the winter while 'Vilmoriniana' does not.
**'Cristata'**: Full size with cristate or 'cockscomb' growth on branch terminals and very dark green foliage. Good for use as a novelty specimen plant.
**'Elegans'**: Slower growing, full size, with juvenile, feathery foliage which turns a beautiful bronzed plum color in winter months, reverting to green in summer.
**'Elegans Aurea'**: Juvenile foliage, as with 'Elegans' but with bright, golden-chartreuse foliage in winter months and green in summer.
**'Elegans Nana'**: Dwarf, compact, rounded,with foliage that is more stout than 'Elegans'. Foliage is a soft green that is retained all winter. Sometimes seen as 'Elegans Compacta'.
**'Globosa nana'**: A well-known dwarf form, irregularly rounded at maturity with glossy, light green foliage.
**'Globus'**: Not yet in European reference literature, this slow growing cultivar has juvenile, winter-bronzing foliage like 'Elegans' but the habit is more stubby than 'Elegans' as apical branches tend to recurve as they develop.
**'Gyokruyu'**: Also not yet in the European reference literature, this dwarf grows with a softly mounded habit. Pendulous branch tips and uniformly medium green foliage give this cultivar a relaxed silhouette-very useful for informal, small landscapes.
**var. japonica 'Akita strain'**: The true type from Japan. According to Krussman's citation from Dr. Kruse in Japan (3), there are over 200 botanical races and geographical varieties of *C. japonica*. 'Akita strain' is a superior forestry selection collected from Japan by Dr. John L. Creech.
**'Jindai sugi'**: A conical, compact, slow growing Japanese cultivar with dense habit. Somewhat susceptible to winter injury.
**'Kilmacurragh'**: Dwarf form novelty cultivar originating from a plant in Kilmacurragh, Ireland. Almost all branch tips are fasciated. A unique appearance and very different than 'Cristata'.
**'Knaptonensis'**: Slow-growing creamy-white variegated cultivar with

slightly pendulous branchlets. The variegation is similar to that of 'Nana Albospica' as it originated as a witches' broom from 'Nana Albospica'. The variegation does not hold in shade, full sun is required for good color.

**'Lobbii Nana'**: Slow growing, globose, compact with light green, stiffly juvenile foliage similar to 'Elegans Nana'.

**'Lobbii Nana Aurea'**: A yellow-gold foliaged form of 'Lobbii Nana' not yet in the European literature.

**'Monstrosa'**: Upright, slow growing with many shorter branches and shortened foliage with somewhat cristate growth. An irregular habit with dense foliage gives this cultivar an exotic appearance.

**'Nana Albospica'**: Upright, slow growing dwarf with more narrow habit than other cultivars and graceful, somewhat pendulous branching. The foliage is creamy white on the upper surface of the branches and retains its color year round, even through the summer (although it yellows a bit by fall).

**var. radicans**: An upright, full size botanical form with tighter, more dense growth at the branch tips. Named for its propensity to root from branches touching the ground.

**'Sekkan-sugi'**: Supposedly slow growing but ours has reached 20 feet in 12 years. New foliage emerges a striking, light sulfur yellow, but in the hot summers of the Piedmont that color does not last past the first period of hot nights.

**var. sinensis**: Full size tree form from China with more open, pendulous branching and more glaucous foliage than var. japonica. Krussman (3) lists *C. kawai* (synonymous with *C. japonica* var. kawai) as a synonym of this botanical variety.

**'Spiraliter-Falcata'**: Dwarf form with narrow, twisted branchlets and foliage with some yellow variegation in full sun. A good choice for a small specimen planting or where maximum interest is needed from minimum space.

**'Taisho Tamasugi'**: Not yet in any of the European references. Slow to medium growing form with good, conical, upright habit and somewhat irregular, dense foliage.

**'Tansu'**: Very slow growing dwarf with low, round and mounded habit. Very compact and dark green foliage year round with little die-back and beautiful, semi-formal appearance. An excellent low dwarf.

**'Tenzan Yatsabusa'**: Extremely slow-growing dwarf with very compressed and compact quality foliage.

**'Yatsufusa'**: Not yet in European reference literature, an upright, irregular dwarf with dark green, somewhat compressed foliage.

**'Vilmoriniana'**: The classic dwarf *Cryptomeria* with exceptionally globose habit and compact, miniscule foliage.

**'Yellow Twig':** Slow growing form with upright rounded habit and slightly pendulous branchlets. The twig under the foliage is yellowish giving the whole plant a golden cast. Excellent, quality growth with no die-back.

**'Yoshino':** Full size tree form with a true conical habit. The emerald green foliage suffers almost no dieback and remains green all year. Growth rate

is excellent. This is a trouble free cultivar that makes a good screen.
*Cryptomeria* is generally listed as having only one species in the genus but there are two other species that appear on Index Semina from China which are part of the Arboretum's collection .
***Cryptomeria fortunei*** : This species has recently been received from China and appears distinctly different from *C. japonica*. A full size, loosely conical tree with soft, blue-green foliage on pendulous branches.
***Cryptomeria kawai*** : Krussman (3) has called this a synonym of *C. japonica* var. sinensis and its appearance is consistent with this to a certain extent except that branching on the Arboretum plant of *C. kawai* is much more dense than that of *C. japonica* var. sinensis. This is a full size tree form with especially pendulous branching and glaucous foliage in the manner of *C. fortunei* (with which it may also be synonymous).

**Significance to the Industry:** A minor problem with *Cryptomeria* in our landscapes is a certain amount of interior branch die-back as plants of some cultivars mature. The full-size cultivars 'Yoshino' and 'Benjamin Franklin' have shown little susceptibility to this problem at The NCSU Arboretum and, like most of the cultivars available, are better choices for the landscape than seed grown plants. These handsome full size cultivars have lovely, deep green foliage and an especially graceful shape. 'Yoshino' and 'Benjamin Franklin' are tough plants which grow rapidly and make excellent screens. They are currently being recommended as replacements for Leyland Cypress especially as they have shown little susceptibility to bagworm infestations. The excellent adaptability of *Cryptomeria japonica* to landscape environments, its ease of propagation, and the broad range of cultivars with a wide array of habit, foliar color and mature size encourage greater production and utilization by the nursery and landscape industries.

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# Susceptibility of Crape Myrtle Cultivars to Crapemyrtle Aphid and Powdery Mildew

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**Nature of Work:** Crape myrtle is one of the South's most beautiful and widely used landscape plants. It is considered relatively pest-free, but crape myrtle's beauty often is marred by powdery mildew *(Erysiphe lagerstroemiae)* or crapemyrtle aphid *(Tinocallis kahawaluokalani)* and its associated sooty mold *(Capnodium* species).

Initial symptoms of powdery mildew consist of a whitish powder on new shoots. It later spreads to the surface of leaves, stems, and flowers, eventually causing distortion and stunting. Crapemyrtle aphid is host-specific to crape myrtle.

Heavy infestations of crapemyrtle aphids distort leaves and stunt new growth. During feeding, aphids secrete droplets of honeydew which fall onto leaves and stems. Honeydew supports the growth of sooty mold which appears as a black staining or powdery coating on leaves and stems. The blackened leaves and stems are often the most obvious sign of aphid infestation. With heavy crapemyrtle aphid infestations, the entire plant may be blackened by sooty mold.

Many new crape myrtle cultivars have been released in recent years, some with resistance to powdery mildew. Two plantings of 37 cultivars of crape myrtle (Table 1) were established in 1987 at the NFREC-Monticello for evaluation in USDA Zones 8b - 9a (Knox and Norcini, 1991). The NFREC-Monticello is located 25 miles east of Tallahassee, Florida, and about 10 miles due south of the Florida-Georgia border. Annual rainfall averages 55.8 inches with much of it falling from June through September. Mean high temperatures range from 63 F in January to 91 F in July, and mean low temperatures range from 39 F in January to 69 F in August. The first of the two sites is nearly level, exposed, and largely unshaded. It has a Leefield fine sand soil with low fertility (USDA Soil Conservation Service, 1989) and a pH of 5.5. The second site, 850 feet to the southwest, is nearly level with a Dothan loamy fine sand soil with low fertility (USDA Soil Conservation Service, 1989) and a pH of 6.6. The site is unshaded but sheltered by woods on the north and east sides. Two plants of each cultivar are planted in each plot and cultivars are grouped by mature height as classified by Egolf and Andrick (1978). Plants are being evaluated under low maintenance conditions. Rows are mulched with 3 inches of coarse pine bark with centipede/bahia turf between rows. Plants are not irrigated and receive minimal fertilizations of up to 2 lb. of actual nitrogen per 1000 $ft^2$ per year.

Crapemyrtle aphid populations were monitored weekly from May through

September in 1990 and 1991. Crapemyrtle aphids were counted on 10 randomly-selected leaves per plant. Powdery mildew infection was recorded during a natural epidemic in 1992 . Powdery mildew was evaluated weekly by randomly selecting 10 shoots, counting the total number of leaves, the number of infected leaves (to determine disease incidence as percent infected leaves), and the area of infected leaves covered by powdery mildew (to estimate disease severity). Evaluations began in late May and continued into August.

**Results and Discussion:** Powdery mildew was first noticed on May 29. Powdery mildew infection peaked the week of June 19 for most cultivars. Twenty seven cultivars and over half of all plants were infected by powdery mildew. Incidence of powdery mildew (percentage of infected leaves) was greatest on 'Royalty' followed by 'Baton Rouge', 'Cordon Bleu', 'Delta Blush', 'Snowbaby', 'Victor', 'Carolina Beauty', and 'Bayou Marie'. Powdery mildew was most severe on 'Royalty', 'Cordon Bleu', 'Baton Rouge', and 'Carolina Beauty'. Note that all those listed are dwarf cultivars except for 'Carolina Beauty' (medium height). 'Victor' has been reported as powdery mildew resistant (Egolf and Andrick, 1978). Notable infection was also recorded for 'Seminole' and 'Regal Red'.

Crapemyrtle aphids first appeared in early June and peaked the last week of July in both years. Numbers of aphids then decreased rapidly and were low by late August. A second, smaller peak occurred on most cultivars in early September of 1990 only. Mean number of aphids per leaf per sample date ranged from $6.2 \pm 1.7$ for 'Centennial Spirit' to $84.8 \pm 19.1$ for 'Biloxi'. There was no relationship between aphid numbers and flower color or leaf area. Tall and semi-dwarf cultivars had more aphids than dwarf or medium cultivars. Cultivars with *Lagerstroemia fauriei* parentage or powdery mildew resistance had significantly more aphids per leaf. Cultivars with fewest aphids per leaf were 'Centennial Spirit', 'Victor', 'Bourbon Street', 'Baton Rouge', 'Lafayette', 'New Orleans', and 'Potomac'. 'Hopi', 'Apalachee', 'Zuni', 'Comanche', and 'Biloxi' had the most aphids per leaf.

**Significance to Industry:** Information on pest susceptibility of crape myrtle cultivars will allow home owners and landscapers to select pest-resistant plants reducing both landscape maintenance and pesticide use. Consumer preference for pest resistant plants should increase demand for crape myrtle cultivars resistant to powdery mildew and crapemyrtle aphid. Production of pest-resistant cultivars could also potentially reduce costs of growers' pest control efforts.

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**Table 1.** Crape myrtle cultivars under evaluation at the NFREC-Monticello.

| Size-Group[z] | Cultivar | Size-Group[z] | Cultivar |
|---|---|---|---|
| Dwarf | Baton Rouge | Medium | Apalachee |
| | Bayou Marie | | Carolina Beauty |
| | Bourbon Street | | Centennial Spirit[y] |
| | Cordon Bleu | | Comanche[y] |
| | Delta Blush | | Lipan |
| | Lafayette[y] | | Near East |
| | New Orleans | | Osage |
| | Royalty | | Seminole |
| | Snowbaby | | Sioux |
| | Victor | | Yuma |
| Semi-Dwarf | Acoma | Tall | Biloxi |
| | Hope[y] | | Byers Wonderful White |
| | Hopi[y] | | Country Red[y] |
| | Pecos | | Dallas Red |
| | Tonto | | Miami |
| | Zuni[y] | | Natchez |
| | | | Potomac |
| | | | Regal Red |
| | | | Tuscarora |
| | | | Tuskegee |
| | | | Twilight |

[z]Based on Egolf and Andrick, 1978.
[y]Fewer than 4 plants being evaluated.