NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

TREE/SHRUB ESTABLISHMENT

(Ac.)

CODE 612

DEFINITION

Establishing woody plants by planting seedlings or cuttings, direct seeding, or natural regeneration.

PURPOSE

Establish woody plants for:

- forest products such as timber, pulpwood, and energy biomass
- wildlife habitat
- long-term erosion control and improvement of water quality
- treating waste
- storing carbon in biomass
- energy conservation
- improving or restoring natural diversity
- enhancing aesthetics

CONDITIONS WHERE PRACTICE APPLIES

Tree/shrub establishment can be applied on any appropriately prepared site where woody plants can be grown.

Utilize other practice standards for specialized tree/shrub establishment situations, e.g., Riparian Forest Buffer, 391; Alley Cropping, 311; Windbreak/Shelterbelt Establishment, 380; Critical Area Planting, 342; Hedgerow Planting, 422

CRITERIA

General Criteria Applicable to All Purposes

WV NRCS Personnel should work closely with WV Division of Forestry personnel, the NRCS staff forester, and/or biologist when utilizing this practice.

Composition of species will be adapted to site conditions and suitable for the planned purpose(s**)** ***and will accomplish the client's objectives.***

Plant Guide and Plant Information Sheets for individual species found in the USDA Plants Database will be utilized to supplement the material in this standard. **http://plants.usda.gov**

For selection of species to be encouraged through natural regeneration and a listing of those that may be planted, refer to one ore more of the following:

A. Tree and Shrub Lists for WV found in Section IV – Tools of the WV FOTG.
http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=WV
B. Veg Spec – See NRCS homepage –my.nrcs - Field Tools – Resource Information
http://vegspec.nrcs.usda.gov/vegSpec/index.jsp
C. Technical Guide Reference (Plant Materials) – Plant Selection Guide, Joe Ruffner
D. Technical Guide Reference (Plant Materials) – Conservation Plants for the Northeast, USDA-SCS
E. Technical Guide Reference (Biology) – Shrubs and Trees for Northeastern Wildlife, USFS General technical Report, NE-9, 1974
F. Technical Guide Reference (Forestry) – Conservation Tree and Shrubs Pocket ID Guide, USDA – SCS, 1993
G. Technical Guide Reference (Forestry) – Chesapeake Bay Riparian Handbook – A Guide for Establishing and Maintaining Riparian Forest Buffers, USFS, May 1997, Section VII – Site Evaluation, Planning and Establishment
H. Conservation Tree and Shrub Groups found in Section IV – Tools of the WV FOTG.
I. Soils Information
Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/)
Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Printed Soil Survey (http://soils.usda.gov/survey/printed_surveys)
Section II – Soils Information of the WV FOTG
J. WV Job Sheet – 391 – Trees and Shrubs Recommended for Riparian Forest Buffers – Section IV FOTG
K. WV Pollinator Handbook

Note: Other species not listed in the above reference materials may also be suitable. Consult WV Division of Forestry personnel, NRCS staff forester and/or biologist concerning the suitability of other species.

Species considered locally invasive or noxious shall not be used. ***Native plant materials should be used whenever possible.***

Planting or seeding rates will be adequate to accomplish the planned purpose for the site.

Planting dates, and care in handling and planting of the seed, cuttings or seedlings will ensure that planted materials have an acceptable rate of survival.

Only viable, high-quality and adapted planting stock or seed will be used.

A precondition for tree/shrub establishment is appropriately prepared sites. ***Site preparation is needed if competition from grass, weeds, and/or woody materials will interfere with plant establishment and growth.*** Refer to ***WV conservation practice standards*** Tree/Shrub Site Preparation, 490 ***and/or Brush Management, 314, as applicable.***

Where feasible natural regeneration should be utilized. If desired, supplemental planting of trees and/or shrubs plantings may be added. Adequate seed sources or advanced reproduction needs to be present or provided for when using natural regeneration to establish a stand.

Selection of planting technique and timing will be appropriate for the site and soil conditions.

The acceptability and timing of coppice regeneration shall be based on species, age and diameter.

The planting will be protected from plant and animal pests and fire. If pesticides are used, refer to standard Pest Management, 595, to assist with site-specific strategies for pest prevention, pest avoidance, pest monitoring and pest suppression.

Each site will be evaluated to determine if mulching, supplemental water or other cultural treatments (e.g., tree protection devices, shade cards, brush mats) will be needed to assure adequate survival and growth.

Protect tree/shrub establishment practices should be protected from livestock, fire and other damage. See the WV conservation practice standards, Access Control, codes 472 and Firebreak, code 394, as appropriate.

Wet Areas/Soils – Use adapted species. Another consideration would be to plant in prepared ridges.

Planting methods used should be designed to minimize soil erosion.

Timing and use of planting equipment will be appropriate for the site and soil conditions.

Spacing between rows should allow sufficient room for necessary maintenance equipment.

The planned plant species must be tolerant of any nutrient, pesticide, mine drainage, soil condition or other chemical loading, where loading cannot be corrected.

Comply with applicable federal, state, and local laws and regulations during the installation, operation and maintenance of this practice.

Additional Criteria for Treating Waste

Species used to treat waste shall have fast growth characteristics, extensive root systems, high nutrient uptake capacity and tolerance of the planned effluent.

Additional Criteria for Improving or Restoring Natural Diversity

Composition of species selected for planting or those favored for natural regeneration will be native to the site and create a successional stage or state that can progress to the potential natural plant community.

Additional Criteria for Storing Carbon in Biomass

The species and plant communities that attain biomass more quickly will sequester carbon faster. The rate of carbon sequestration is enhanced as trees and/or shrubs mature and soil organic matter increases. Select plants that have higher rates of growth and potential for carbon sequestration in biomass and are adapted to the site. Plant species at the appropriate stocking rate for the site.

Additional Criteria for Producing Feedstocks for Biofuel or Energy Production

Select plants that provide adequate kinds and amounts of plant material used.

The following criteria sections have been added to the national conservation practice standard, Tree/Shrub Establishment, code 612, in West Virginia:

- ***Additional Criteria for Care and Planting of Seedlings/Cuttings - pages 612-4-612-6***
- ***Additional Criteria for Protection of Plantings/Seedings - pages 612-8-612-10***
- ***Additional Criteria for Spacing Calculations - page 612-11***
- ***Additional Criteria for Ornamental Plantings – page 612-12***
- ***Additional Criteria for Care and Planting of Balled /Burlapped and Containerized Stock – pages 612-13 – 612-14***
- ***Additional Criteria for Timber Production – page 612-15***
- ***Additional Criteria for Christmas Tree Production – pages 612-16 – 612 - 18***
- ***Additional Criteria for Direct Seeding – pages 612-19 – 612-26***
- ***Additional Criteria for Natural Regeneration – page 612-27***
- ***Additional Criteria for Hybrid Tree Species in Agroforestry Plantings – pages 612-28 – 612-29***
- ***Additional Criteria for Surface Mine Reclamation – page 612-30***
- ***Additional Criteria for Riparian Buffer Plantings – page 612-31***
- ***Additional Criteria for Paulownia Plantings – pages 612-32 – 612-33***
- ***Additional Criteria for Bioengineering Plantings – page 612-34***
- ***Additional Criteria for Wildlife Plantings (including pollinators) – page 612-34***
- ***Additional Criteria for Windbreak/Shelterbelt Planting – page 612-34***

Additional Criteria for Care and Planting of Seedlings/Cuttings

Site Preparation

A precondition for tree/shrub establishment is appropriately prepared sites. Site preparation is needed if competition from grass, weeds, and/or woody materials will interfere with plant establishment and growth. Refer to WV conservation practice standards Tree/Shrub Site Preparation, 490 and/or Brush Management, 314, as applicable.

Care, Handling, Size Requirements for Woody Planting Stock

The following should be done when seedlings are received to increase survival rates:

To optimize survival, plant seedlings immediately upon their arrival from the nursery. If this is not possible, the bundles can be stored for two days in a cool (34 -38° F), dark place. Do not unpack the bundles! Water the bundles periodically to ensure the roots are well moistened. It is critical that the roots never be allowed to dry out; exposure to the air for even a few minutes can kill your seedlings.
If controlled storage is not available and seedlings cannot be planted within two days of receipt, dig a trench about one foot deep and bury the seedling roots in soil. This is called "heeling-in". See Figure 1. Pack the soil firmly, water thoroughly, and make certain all roots are covered. Evergreens require extreme care. When heeling in evergreens, split bundles and spread out the seedlings in the trench to make sure the root system of each seedling is protected by soil.

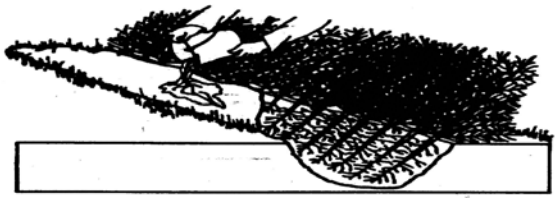

Figure 1 – Healed-In Seedlings

(Source: WV Department of Agriculture Form FM-18)

Live cuttings that will not be immediately planted shall be promptly placed in controlled storage conditions (34-38° F) and protected until planting time.

Plant Inspection

Check planting stock at the time of planting to see if it is free of disease, insects, and mechanical injury and have a well-developed root system. All conifers must have dormant buds.

Seedlings shall not be less than ¼ inch in caliper at 1 inch above the root collar.

For cuttings, avoid using material less than ¾" in diameter. Tops of dormant-season collected cuttings may be dipped into latex paint, paraffin or sealing wax to prevent desiccation and mark the up-end.

Rooted planting stock must not exceed a 2:1 shoot-to-root ratio and have a minimum of a 1:1 root shoot ratio.

General size guidelines are as follows:

Hardwoods - seedlings should have a minimum height of 6-12 inches and a minimum root length of 10 inches.

Conifers - seedlings should have a minimum height of 6-12 inches and a minimum root length of 8 inches

Planting Time

Trees/shrubs can be planted in the fall from the time growth stops until the soil is frozen; or in the spring after the soil has thawed until bud break which usually occurs by April 15th in most places in West Virginia.

Avoid fall planting in clay soils due to frost heaving.

Planting Methods

Seedlings may be planted with any of the following: mattock, planting dibble, hoedad, planting bar, tile spade, post hole digger, tractor/auger, or tree planting machine. The method of planting will depend on the terrain and the type of seedlings being planted. The technique used should ensure the proper depth and placement of planting stock roots.

Roots of bareroot stock shall be kept moist during planting operations. Any directions received with the seedlings regarding care of the seedlings while planting shall be followed.

If no directions accompany the seedlings, roots of bareroot stock shall be kept moist during planting operations by placing the seedlings in a water-soil (mud) slurry, peat moss, super-absorbent (e.g., polyacrylamide) slurry or other equivalent material. Rooting medium kept

moist at all times by periodic watering. Pre-treat stored cuttings by soaking just before planting.

Stock shall not be planted when the soil is frozen or dry. Rooted stock will be planted in a vertical position with the root collars approximately ½-inch below the soil surface. Insert cuttings to the depth required to reach adequate soil moisture. The planting trench or hole must be deep and wide enough to permit roots to spread out and down without J-rooting or L-rooting. After planting of rooted stock or cuttings, pack soil around each plant firmly to eliminate air pockets. See Figure 2.

Dibble Planting Technique

(1) Insert the dibble straight down into the soil to the full depth of the blade and pull back on the handle to open the planting hole. (DO NOT rock the dibble back and forth as this causes soil in the planting hole to be compacted, inhibiting root growth.

(2) Remove the dibble and push the seedling roots deep into the planting hole. Pull the seedling back up to the correct planting depth (the root collar should be ½ inch below the soil surface). Gently shake the seedling to allow the roots to straighten out. DO NOT twist or spin the seedling or leave the roots J-rooted.

(3) Insert the dibble into the soil several inches in front of the seedling.

(4) Push the handle forward to close the hole and hold the seedling in place.

(5) Pull back on the handle to close the planting hole eliminating air pockets around the roots.

(6) Remove the dibble and close and firm up the opening with your heel. Be careful to avoid damaging the seedling.

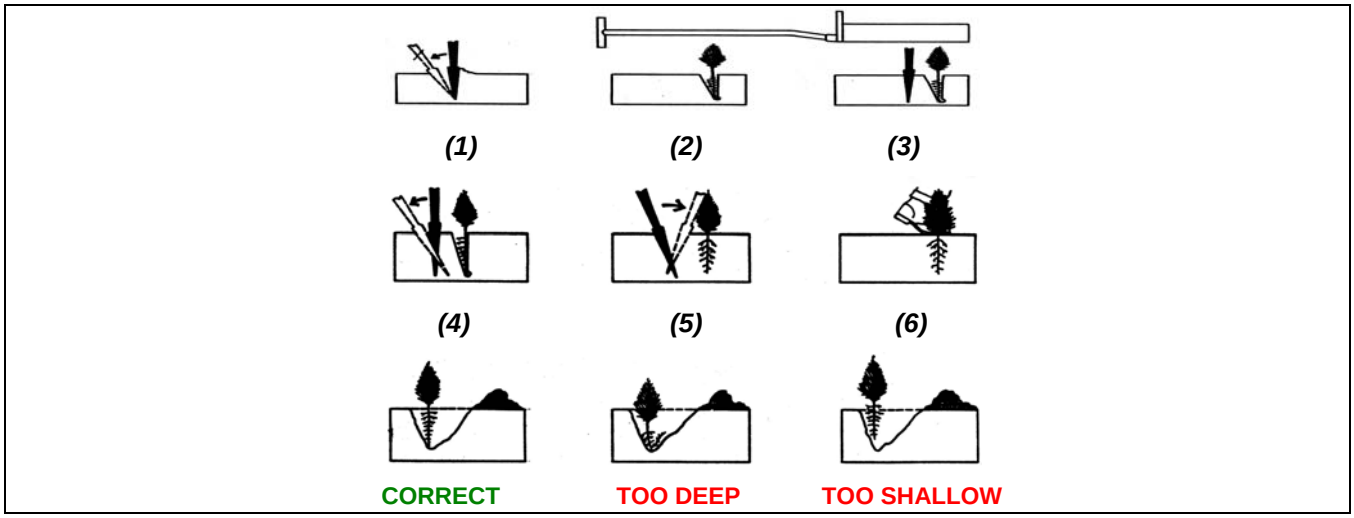

Figure 2 – Correct Dibble Planting Technique (Source: WV Department of Agriculture Form FM-18)

Maintenance and Cultural Practices

Routine surveillance is necessary to detect insect, disease, and animal damage. Competition should also be evaluated while plantings are becoming established.

Control competing vegetation during the first 2 or 3 years by mowing, cultivating, mulching, herbicides, or plant mats.

Mowing – Mowing should be done with extreme caution to avoid damage to the seedlings. Vegetation between rows can be left for wildlife food and cover. For optimum wildlife habitat, do not mow during the primary nesting season (April 15 to August 15).

Cultivating – Care must be used not to damage the seedling or its root system. Note that voles are often attracted to bare soil directly around the seeding when the bare area is surrounded by tall grasses.

Mulching - When used, mulch should be placed two to for inches deep and extended as far as possible from the base of the plant (at least two feet for young specimens). When

possible mulch should extend two or three times the branch spread of the plant specimen.

An adequate mulch layer is two to four inches of loosely packed organic material such as shredded leaves, pine straw, peat moss or composted wood chips. Mulch layers in excess of five inches may inhibit gas exchange.

Plastic should not be used because it interferes with the exchange of gases between the soil and air and inhibits root growth.

Herbicides – NOTE: NRCS does not make pesticide recommendations. Landowners should be told to read product labels and follow product specifications. Landowners may contact the West Virginia Division of Forestry or the WVU Cooperative Extension Service for pesticide recommendations.

Pre-emergent herbicides are most effective if applied to the planting strip. Seedlings should be protected during herbicide applications. Herbicides should not be planted on windy days when drift can damage surrounding seedlings.

Plant Mats – Plant mats should be installed and maintained according to manufacturer specifications.

References

Forest Management Handbook, West Virginia Division of Forestry, 1985.

Service Foresters Handbook, USDA Forest Service, NE State and Private Forestry, February 1978.

West Virginia Forest Stewardship Incentive Program Training, Reference, and Procedures Manual, West Virginia Division of Forestry, WVDOF-TR-92-1, Revised 12/97.

Additional Criteria for Protection of Plantings/Seedings

The planting will be protected from unacceptable adverse impacts from pests, wildlife (deer, voles, rabbits, hares, squirrels, etc.) livestock damage, people, wind or fire. A variety of guards, tree shelters, chemicals and fences are commercially available to provide protection. Additional information may also be found in the WV conservation practice standards Access Control, 472, and Firebreak, 394.

Seedlings may be protected from browsing, grazing, or gnawing with tree protection devices, however, their expense should be taken into consideration when deciding whether or not to use them. However, without proper protection, most plantings will not survive.

All protective devises and/or materials should be applied according to manufacturer guidelines.

Tree protection devices include:

Tree shelters

Tree shelters were originally developed as 'mini-greenhouses', to increase survival and growth rates on newly planted trees, by lessening the stresses caused by transplanting. Growth can be from two to five times the normal rate in the first few years.

Tree shelters are also useful to:

- ***reduce the losses caused by mammals, including browsing, bark stripping and fraying.***
- ***reduce damage by string trimmers, brush cutters and mowers. Care still needs to be taken that the machine does not damage the shelter.***
- ***make trees easy to spot amongst tall vegetation, so speeding maintenance.***
- ***reduce the cost of herbicide application, by making it quicker and easier to spray or apply granules around the tree without damaging it.***

Tree shelters:

- ***are conspicuous, and can attract vandalism***
- ***can result in the leading shoots being badly damaged once they grow above the top of the shelter on windy, exposed sites. Roadside plantings can suffer similar damage from the wind stream of passing vehicles.***
- ***accelerate early height growth, but stem diameter and root growth do not increase proportionally. If shelters are removed too early, the young tree will not be able to support itself***
- ***are generally not recommended for protecting conifers and beech seedlings***
- ***can damage or kill the tree. As the base of the stem thickens it can fill the shelter. If the shelter doesn't split, rainwater can get trapped and kill a ring of bark, so killing the tree***
- ***can enhance weed growth inside the shelter, which may choke the young tree***
- ***must not be seen as the panacea of tree planting. A tree protection devise will not make up for poor quality plants, careless planting or inattention to weeding***
- ***often become a home for bees. Bears often tear down the shelter to get to the enclosed hive.***

The following are requirements for the use of shelters:

- ***shelter heights of 5 feet or greater must be used to provide protection for tree seedlings from deer (except for the direct seeding of heavy seeds which require at least 4 foot shelters)***
- ***shrub shelters may be used for shorter multi-stem shrub species***
- ***shelters should be maintained for a minimum of five years or until they disintegrate naturally.***
- ***competing vegetation should be removed from around the protected seedlings a distance of two feet for a period of 3 – 5 years.***
- ***only commercially treated, fiberglass, metal or plastic stakes should be used to support the shelter. If it is not possible to obtain treated, fiberglass, metal or plastic stakes then oak, black locust or other rot resistant hardwood can be substituted.***

Quills

The quill is a slim-diameter shelter with a pointed base, designed to be used without a stake. In friable soil, the base of the quill can be pushed about 6 inches into the ground without damage, which is sufficient to hold it securely in position. Quills are mainly used on hedging and other low-cost single-stemmed stock.

Gro-Cones

These tree shelters are slightly conical in shape, so they can be nested together for storage and transport. They are made of a net-reinforced transparent plastic, with a weld-line that splits as the stem fills the shelter.

Shrub shelters

These are strong, wide-diameter shelters for shrubs and other multi-stemmed plants. They need to be well anchored with stakes, as they offer greater resistance to the wind than do narrower shelters.

Shelterguards

These are a cross between a shelter and a guard, and are made of plastic mesh laminated with polythene film. The film degrades after two to three years, leaving the mesh to give longer term protection to the stem. Various sizes are available for trees and shrubs.

Plastic spiral guards

These prevent rabbits and voles stripping the bark from young trees, and are suitable for protecting the lower stem of large transplants which are at least 6 inches taller than the guard. Small transplants hidden within an opaque guard will not grow properly. Spiral guards can also be fitted to young established trees with a stem diameter of about 38m 1.5 inches, to protect the bark after a tree shelter has been removed or disintegrated. Spiral guards can be re-used.

Spiral guards are not suitable for feathered trees, multi-stemmed shrubs or conifers, as they are only suitable for protecting a single, clear stem. Spiral guards are often used in addition to further protection, such as a perimeter fence to keep people and domestic stock at bay.

Once the stem has grown larger than about 2 inches diameter, gaps are created in the spiral and the guard no longer gives complete protection. Some guards disintegrate after a few years, whereas in more sheltered positions they can last almost indefinitely. Remove them once they become ineffective. Check particularly that the base of the guard is completely removed, and is not entangled at the base of the stem.

Vole and string trimmer guards

These are short plastic guards which can be wrapped around the base of established young trees in areas where long grass can lead to explosions of vole populations. In most situations, tree shelters or spiral guards will give similar protection from the time of planting, but vole guards can be useful after shelters have been removed. String trimmer guards are used in mown areas to protect the stems of young trees, over 2.5 inches in stem diameter, from damage by string trimmers and mowers. Some companies market the same product against voles and string trimmers, others have separate products.

Plastic mesh guards

These are available in different sizes, heights and weights to protect against the full range of domestic and wild animals. They also protect against mower damage and inadvertent trampling, but are not vandal-proof. They give limited protection from wind damage. Mesh guards are recommended in preference to tree shelters for beech and conifers. Mesh guards need supporting by one or two stakes. On established trees, they can be used without stakes to prevent bark-stripping.

Various mesh sizes, colors and heights are available, either in rolls, or pre-cut and supplied as split tubes. Ring guns are available from tree guard suppliers, for quick fastening of rings to join mesh.

Mesh guards are also available for use over tree shelters to keep birds out.

Steel mesh guards

These are not generally used when planting transplants or other young trees, but are more suited to protecting the trunks of standard trees against vandalism, mowing or bark-stripping.

They are more durable than plastic mesh, but are also more expensive. On some sites it may be worth substituting tree shelters or plastic mesh guards with steel mesh guards once the new trees are established, to give long term protection.

Wire Cages

Cages must be at least 47" tall and made of at least 11 gauge woven or 10 gauge steel concrete mesh wire and placed far enough out from the seedling to prevent deer from accessing the plant and causing damage. It is especially important to protect the leader on conifers. The minimum diameter for wire cages is 36". Cages must be firmly staked to the ground. "T" posts work well. Prior to installation, remove all grass and weeds within the caged area. A 10 foot section of woven wire fencing unrolled and fastened securely at the ends will produce a 36" diameter cage. A 2' high band of chicken wire can be added to the bottom to exclude rabbits. A minimum of two stakes will be used to hold the cage upright and tent stakes will be used to fasten the cage to the ground. When the tree branches reach the sides, the cage is no longer providing protection. If the leader is out of reach of browsing, the cage may be removed and reused.

Mild steel guards and grilles

These may be needed to protect trees planted in pedestrian precincts, car-parks and other vulnerable sites. The grille prevents the tree being dug up, and protects the roots from surface damage.

Timber guards

Custom-built timber guards are suitable for long-term protection of individual trees in pastures and parkland. These can be designed to protect against domestic stock, as well as preventing mower damage and discouraging vandalism. They should be carefully designed and built, and constructed of preserved timber for durability. They are only worth doing well. A poorly constructed guard or one of weak timber will soon be damaged by stock.

Within the timber surround, the young tree can be protected from voles, rabbits and hares by a tree shelter or spiral guard.

NOTE: Only commercially treated, fiberglass, metal or plastic stakes should be used to support tree protection devices. If it is not possible to obtain treated, fiberglass, metal or plastic stakes then oak, black locust or other rot resistant hardwood can be substituted.

The following table is an overview of a variety of tree production products:

PRODUCT	SUITABLE FOR:	PROTECT AGAINST:
Tree Shelters	*Small transplants and cell grown seedlings*	*All wild animals (except for voles*) and sheep*
Quills	*Single-stemmed transplants, hedging*	*Voles, rabbits*
Gro-cones	*Small transplants and cell grown seedlings*	*Vole, rabbits, hares, deer*
Shrub Shelters	*Multi-stemmed planting stock*	*Voles and rabbits*
Shelter Guards	*Small transplants and cell grown seedlings*	*All wild animals, sheep*
Spiral Guards	*Large transplants, at least 40 inches taller than the guard*	*Rabbits and hares*
Vole and String Trimmer Guards	*Established trees*	*Voles and string trimmers*
Plastic Mesh Guards	*All young tress*	*All wild animals, sheep*
Steel Mesh Guards/Woven Wire Cages	*High value tree/shrubs, deciduous and evergreen in vandal-prone sites*	*Deer, stock and people*
Mild Steel Guards	*High value trees in vandal-prone sites*	*Deer, stock and people*
Timber Guards	*Trees in pastures*	*Stock, deer and mowers*

****Tree shelters normally provide protection against voles, provided they are buried at least a half an inch in the ground and securely staked, however, occasionally, voles may gnaw through tree shelters.***

Repellents

Repellents may also be used. Their effectiveness varies. Repellents should be applied according to manufacture guidelines.

Protection may also be provided by other means. See the WV conservation practice standards Fencing, 382, and Access Control, 472.

Access / Fire Lanes

Allow room in plantations for access and fire lanes.

Pulpwood/Timber plantations – approximately 12 -16 foot wide every 400 – 600 feet.

See WV conservation practice standard Firebreak – 394.

References

Forest Management Handbook, West Virginia Division of Forestry, 1985.

Service Foresters Handbook, USDA Forest Service, NE State and Private Forestry, February 1978.

West Virginia Forest Stewardship Incentive Program Training, Reference, and Procedures Manual, West Virginia Division of Forestry, WVDOF-TR-92-1, Revised 12/97.

http://handbooks.btcv.org.uk/handbooks/content/section/3580/

Additional Criteria for Spacing Calculations

The following are some typical spacings that are used:

Spacing (feet)	Trees Per Acre
6x6	1210
8x6	908
8x7	778
8x8	681
10x6	726
10x7	622
10x8	544
10x10	436
12x12	302
15x15	194
16x16	170
20x20	109

The number of trees per acre for spacings can be determined by dividing the square footage of an acre (43560 square feet) by the square footage of the spacing. For example, the number of trees per acre for a 7 foot x 7 foot spacing would be:

$$\frac{43{,}560}{7 \times 7} = \frac{43560}{49} = 889$$

Shrub spacing should usually range from 3' to 6' feet for shrubs less than 10 feet in height and 5 to 8 feet for shrubs 10 to 25 feet in height (includes columnar trees). Anticipated size of the tree/shrub at maturity and aesthetic appeal should be considered when selecting spacing.

Use closer spacing on areas with erosion hazard or where quick crown closure is desired.

Use wider spacing on plantings where the site is favorable for good survival, or on very steep slopes where the tendency is to plant too close.

Wider spacing may also be justified when natural regeneration is anticipated.

Additional Criteria for Ornamental Plantings

Species Selection

When determining what species to plant, it is important to consider the following: function, location, soil conditions, and pest and environmental problems.

Plant function

Most plants in landscaped areas are selected for their amenity value, that is, they serve to make our lives more agreeable, and pleasant by increasing physical or material comfort and, at the same time, increasing the value of residential and commercial real estate. A tree that is large at maturity will provide shade. An ornamental plant may have beautiful flowers, leaves, or bark. Plants with dense, persistent leaves will provide a windbreak, a screen, or privacy. Plants that drop their leaves in the fall allow the sun to warm buildings in winter. A tree or shrub that produces fruit will attract birds and wildlife. A landscape plan that is prepared for a property should be designed to get the greatest benefit from each plant.

Plant location

Trees and shrubs are living organisms that grow larger each year in height, crown width, and in size of root system. Consult publications to see what size the tree will be at maturity before selecting a species. A common mistake is to plant too many trees or shrubs in a limited space. They look good at first but soon will become overcrowded. Consider mature tree shape. Trees vary in height, width and branching pattern. Trees and shrubs may be short or tall. Crowns may be columnar, oval, rounded, pyramidal, upright, or wide spreading. Overhead utility lines will restrict selection to small trees or shrubs. Plants with low spreading branches are appropriate for screens, but not for placement along street where good visibility is essential. The amount of sunlight available will affect tree and shrub species selection for a particular location. Most woody plants require full sunlight for proper growth and bloom; some others do well in light shade. Few tree species perform well in dense shade. Reflected light and heat and soil compaction from buildings and pavement will also affect plant growth and vigor. See Table 1.

Soil conditions

The amount/volume of soil and quality of soil in a given area can limit planting success. In their natural environment, tree and shrub roots grow in topsoil. This is often deep, well-drained soil that contains mineral elements, air, water, and organic matter required for adequate growth. In urban areas, the topsoil has often been disturbed and is frequently shallow, compacted and subject to drought. Under these conditions, plants are continually under stress. Proper maintenance is necessary to ensure adequate growth and survival. The physical aspects of the soil are as important as the chemical aspects, but the chemical aspects can be more easily managed. The physical aspects include soil profile, texture, compaction, and water holding capacity. Texture is a major factor in establishing water holding capacity. Under optimum conditions for best plant growth, the pore space in the soil should be 50% air and 50% water. Compaction increases stress by reducing the availability of oxygen to roots. The chemical aspects of the soil include available nutrients, soil pH, and organic matter content. Soil tests are helpful in establishing the physical and chemical conditions of the soil. A pH of 5.5 to 6.5 is optimum for most trees and shrubs. Soil moisture should also be considered.

Pest and environmental problems

Insect pests and disease organisms affect almost every tree and shrub species. Fortunately, these are usually not life threatening to the plant. Every locality has its particular pest problems and their severity varies geographically. Select plants to minimize pest problems. Environmental problems (temperature, moisture, soil, light, plant competition, pesticides) are more likely to affect plant growth than insects or disease. Zones of hardiness have been established and many sale tags and catalogs specify a hardiness range.

Additional Criteria for Care and Planting of Balled /Burlapped and Containerized Stock

Planting Time

Trees/shrubs can be planted in the fall from the time growth stops until the soil is frozen; or in the spring after the soil has thawed until bud break which usually occurs by April 15th in most of West Virginia.

Stock should be kept in a shady area and kept moist until planting.

Planting Methods

Hand or machine planting may be used. The techniques used should ensure the proper depth and placement of planting stock roots

Dig a large planting hole. CAUTION: Be sure you have had all underground utilities located prior to digging. The planting hole should be dug as deep as the root ball and at least twice as wide. A large-sized hole is important because as the tree begins to take hold in the ground, its roots must push through the surrounding soil. Roots have difficult time if the soil is rocky or compact; however, if the soil has been loosened by digging and backfilling, the roots will have room to establish well.

Prune sparingly. Examine the specimen closely for injury to roots or branches. If any roots are crushed, cut them at a point just in front of the damage. On the top, prune only broken branches, making sure to leave the branch collar (swollen part where one branch meets another) intact. Begin corrective pruning after a full season of growth in the new location. See WV conservation practice standard Tree/Shrub Pruning, code 660.

Prepare the hole and soil. While some newly transplanted trees may benefit from an application of plant food, it is best not to use fertilizer until the plant is well-established. Good, rich native soil is usually adequate. Never apply high nitrogen fertilizer at planting as it may burn tender roots. Use the material excavated from the hole as backfill if at all possible. In cases were soil conditions are fair to poor, peat moss is recommended as an additive, not to exceed 1/4 by volume.

Place tree at the proper height. To avoid damage, when setting the plant in the hole, always lift the tree by the root ball, never by the trunk. Add a sufficient amount of soil to the hole to bring the plant to its original growing level. This level is indicated by a dark stain on the trunk which marks the difference between root and trunk bark. Keep in mind that on balled and burlap plants, the point at which the burlap is tied can be much higher than the original soil line. Planting at the proper height is important because if a plant is set too deep, its roots may suffocate; on the other hand, if the plant is set too shallow, the roots may dry out in the air and sun. See Figure 3.

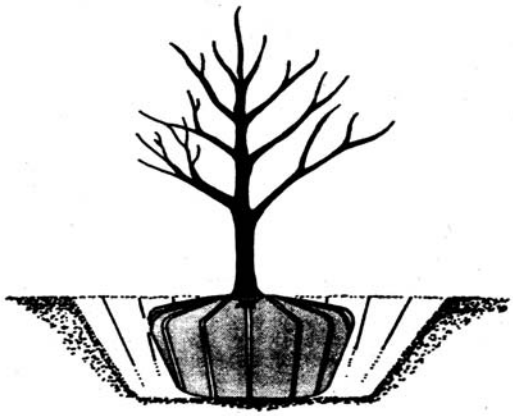

FIGURE 3. Correct planting of balled and burlap specimen.

Source: New Tree Planting - International Society of Arboriculture

Stake the plant, if necessary. Staking a plant can cause bark damage and hinder root and plant stability, so it should be avoided where possible. However, if a specimen is too tall to stand alone, is planted in a windy area, or has a weak root system (such as a dwarf fruit tree), it should be staked to avoid shifting during heavy rains or high winds, as such movement can easily damage tender roots. Staking must be done carefully with soft strapping material such as woven belt fabric or padded wire. Drive two or three stakes in the ground just outside the perimeter of the planting hole, spacing them an equal distance apart. For each stake, attach one end of the strapping material to the plant at the lowest practical level to maintain it upright and fasten the other end to the stake. Remove the stakes as soon as the plant has firmly rooted itself in the soil. As a rule, the stakes should not be left in place for more than a year. See Figure 4.

Mulch the base of the plant. Mulch should be applied to the area at the base of the plant. Some good choices of material are leaf litter,

pine straw, shredded bark and twigs, peat moss, and composted wood chips. A two to four-inch layer is adequate. Mulch should not be placed directly against the root collar and a saucer along the outside edge of mulch is not recommended. Mulch helps conserve moisture, minimize grass and weed competition and protects the tree from lawnmowers and weed cutters.

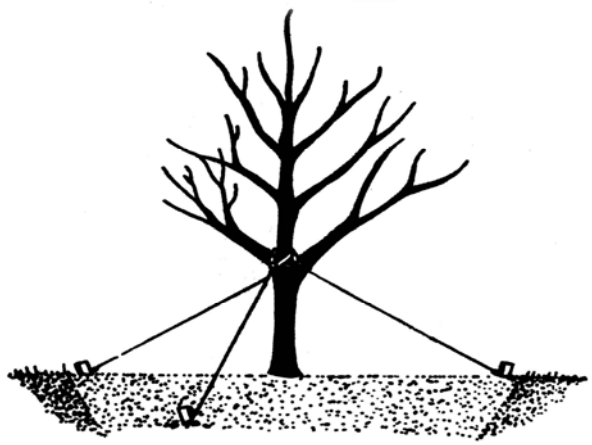

Figure 4. Correct staking of balled and burlap specimen.

Source: New Tree Planting - International Society of Arboriculture

Planting Stock

Large (Balled and Burlap) Stock – Caliper and minimum ball diameters can be determined by referring to the American Standard for Nursery Stock which is located in the NRCS State Office or at:

http://www.anla.org/applications/Documents/Docs/ANLAStandard2004.pdf

Planting Time

Trees/shrubs can be planted in the fall from the time growth stops until the soil is frozen; or in the spring after the soil has thawed until bud break which usually occurs by April 15th in most places in West Virginia.

Containerized Plants/Seedlings – Containerized items usually have better survival. Containerized specimens can be stored for extended periods if they are protected. Store the plants in partial to full shade and water frequently.

Maintenance and Cultural Practices

Since many roots were removed when the plant was dug in the nursery, regular watering is important to aid the development of a strong new root system at the new site. Keep the soil moist but not soaked, as overwatering will cause leaves to turn yellow or fall off. Water plants at least once a week, barring rain, and more frequently in hot weather. When the soil is dry four inches below the surface, it is time to water. Continue until mid-fall then taper off, as this is the time for the plant to stop growing and harden off.

Inspect specimens at least once a year. During the inspection, be sure to evaluate: tree vigor, new leaves or buds, leaf size, twig growth, and crown die-back, if any. Also look for insect, disease, and / or animal damage.

A reduction in the extension of shoots or in the size of leaves is a fairly reliable cue that the plant's health has recently changed.

The use of fertilizer in the backfill at the time of planting is not recommended.

Apply fertilizer, if needed, in the according to soil test results. Fertilizer is best applied in the fall or early spring, although it is not harmful to apply fertilizer at any time during the year.

In the absence of soil test results, apply a slow release fertilizer containing 5% nitrogen, 10% phosphorous, 5% potash, and trace elements.

Fertilizer should be applied within the dripline of the plant at the rate of one cup per caliper-inch for trees and 1/2 cup per foot of height for shrubs.

Fertilizer application once every two to three years will usually suffice.

Replace mulch as needed.

See the standard Tree/Shrub Pruning, 660.

References

American Standard for Nursery Stock - American Association of Nurserymen, Inc.

Mature Tree Care, International Society of Arboriculture, 1991.

New Tree Planting, International Society of Arboriculture, 1991.

Recommended Trees for Cities and Communities, West Virginia Division of Forestry.

Shade Tree Care. West Virginia Department of Agriculture, 07-P006.

Tree Selection, International Arboriculture, 1991.

Additional Criteria for Timber Production

Spacing

Normal spacing for conifers should be a minimum of 6 x 7 feet or a maximum of 8 x 8 feet. The minimum spacing for hardwoods should be 10 x 10 feet. The maximum spacing should usually be 15 x 15 feet, however, spacing for high quality hardwood (black walnut, black cherry, oak, white ash, and paulownia) plantations should be at least 20 x 20 feet. Wider spacing needed to fit field proportions, mowing or other plantation requirements, available machinery and specific management objectives are acceptable but at least 70 trees per acre should be established.

Trainers can be established in conjunction with high quality hardwood plantings. Some suggested trainer species are Japanese larch, European alder, black locust, and Norway spruce.

Site Preparation

A precondition for tree/shrub establishment is appropriately prepared sites. Site preparation is needed if competition from grass, weeds, and/or woody materials will interfere with plant establishment and growth. Refer to WV conservation practice standards Tree/Shrub Site Preparation, 490 and/or Brush Management, 314, as applicable.

The planting site should be cleared to mineral soil in three foot diameter circles. Brushy sites should have all vegetation removed by either mechanical or chemical means. Prior to planting, cutting undesirable woody vegetation without follow-up chemical treatment is unacceptable. Pre-emergent herbicides, cultivation, or other weed control methods should be followed for at least three growing seasons. When using chemicals, read and follow label directions.

Planting Stock

Planting stock should be 1 to 2 year old seedlings with a minimum 1/4 inch stem caliper 1 inch above the root collar. Long lateral roots should be pruned.

Planting Methods

See Additional Criteria for the Care and Planting of Seedlings/Cuttings

When planting high quality hardwoods for timber production an adequate sized hole should be prepared for seedlings with a post hole digger, mattock, or auger. A hole at least 12 inches deep should be dug. Fill the hole back in with loosened soil until the seedling can be planted a deep or slightly deeper than grow in the nursery. The holes should be at least the depth of the root length to prevent "J" rooting.

Cultural Practices

Provide intensive management to improve timber quality especially to species such as black walnut and paulownia.

See the WV conservation practice standard, Tree/Shrub Pruning, code 660 and Forest Stand Improvement, 666.

References

Black Walnut Advisory Sheets, USDA Forest Service, NE State and Private Forestry, Upper Darby, PA, 1970-1971.

Forest Management Handbook, West Virginia Division of Forestry, 1985.

Managers Handbook for Black Walnut, General Technical Report NC-38, North Central Forest Experiment Station, USDA-USFS, 1977.

Service Foresters Handbook, USDA Forest Service, NE State and Private Forestry, February 1978.

West Virginia Forest Stewardship Incentive Program Training, Reference, and Procedures Manual, West Virginia Division of Forestry, WVDOF-TR-92-1, Revised 12/97.

Additional Criteria for Christmas Tree Production

Christmas tree farming is not a "get-rich-quick proposition". However, in many instances, growing Christmas trees has been shown to be an appropriate use of land.

Among the more important aspects that should be considered when discussing Christmas tree production with a landowner are: site, species, consumer preference, planting, insect/disease problems, shaping and shearing, weed control, fire control, and marketing.

Species Selection

Select Christmas tree species adapted to local soil and site conditions that will accomplish the landowner's objectives.

Tables 3 and 4 may be used as a guideline when choosing Christmas tree species in West Virginia.

Site Preparation

A precondition for tree/shrub establishment is appropriately prepared sites. Site preparation is needed if competition from grass, weeds, and/or woody materials will interfere with plant establishment and growth. Refer to WV conservation practice standards Tree/Shrub Site Preparation, 490 and/or Brush Management, 314, as applicable.

Spacing

Christmas trees – Usually 5' x 5' for spruces and firs and 6' x 6' for pines. Spacing may also be determined by mowing equipment, access requirements, and/or landowner desires.

Access / Fire Lanes

Allow room in plantations for access and fire lanes.

Christmas trees – approximately 8 foot wide every 200 – 300 feet.

Planting Methods, Planting Stock, Planting – See Additional Criteria for Care and Planting of Seedlings/Cuttings

Christmas tree shearing should begin as needed after the third year.

See the standard, Tree/Shrub Pruning, 660.

See Technical Guide Reference (Forestry) – Christmas Tree Culture and Marketing, WVU-CES, Publication 525.

Fertilizer is best applied in the fall or early spring, although it is not harmful to apply fertilizer at any time during the year.

When applying fertilizer, nitrogen can be applied directly on the soil surface, whereas phosphorous and potassium, like other insoluble nutrients should applied via holes in the soil.

Maintain Christmas tree stocking at 100%.

References

Christmas Tree Culture and Marketing, WVU-CES, Publication 525.

Forest Management Handbook, West Virginia Division of Forestry, 1985.

Service Foresters Handbook, USDA Forest Service, NE State and Private Forestry, February 1978.

Table 3. Christmas Tree Species Selection Guidelines

Elevation	Moist Soil	Dry Soil
Above 3,000 Ft.	***Balsam Fir***	***Red Pine***
	White Pine	***White Pine***
	Red Pine	
	Norway Spruce	
	White Spruce	
	Red Spruce	
1,500 – 3,000 Ft.	***Blue Spruce***	***Scotch Pine***
	Balsam Fir	***White Pine***
	Norway Spruce	***Austrian Pine***
	Red Spruce	***Eastern Red Cedar***
	White Spruce	
	Douglas-Fir*	
	Scotch Pine	
	White Pine	
	Eastern Red Cedar	
Below 1,500 Ft.	***Norway Spruce***	***Scotch Pine***
	Blue Spruce	***White Pine***
	Douglas-Fir	***Eastern Red Cedar***
	Scotch Pine	
	Austrian Pine	
	Eastern Red Cedar	

****(Mountain Form)*** *Source: WVU-CES Publication 525*

Table 4. Characteristics of Some Christmas Tree Species

SPECIES	SCOTCH PINE	WHITE PINE	NORWAY SPRUCE	BLUE SPRUCE	WHITE SPRUCE	FRAZIER FIR	BALSAM FIR	WHITE FIR	DOUGLAS FIR
EEDLE RETENTION	Very Good	Good	Good	Good	Good	Very Good	Very Good	Very Good	Very Good
BRANCH FIRMNESS	Excellent	Fair	Good	Excellent	Excellent	Good	Very Good	Fair	Fair
FRAGRANCE	Good	Very Good	Good	Good	Good	Excellent	Excellent	Excellent	Excellent
EXPOSURE	S or W	Any Prefer E	Any May burn on W	W, S, E	Any May burn on W	N or E	N or E	Any	Best on W, N, E
PERCENT SLOPE	15% or less	30% or less	25% or less	15% or less	25% or less	30 % or less	30% or less	25% or less	30 % or less
FROST TOLERANT	Yes	Fairly	No	No	No	No	No	No	No
TOLERANT OF SHALLOW SOIL	Yes	Fairly	No	No	No	No	No	Best on deep soil, slow on shallow	No
DROUGHT TOLERANT	No	Fairly	No	No	No	No	No	Yes, but slow to establish	No
SHADE TOLERANT	No	Fairly	Yes	No	Yes	Yes	Yes	Yes, if not too dense	Yes
ROTATION LENGTH (Years)	6-9	6-9	8-11	10-15	8-11	8-12	10-15	10-15	8-12

Source: Service Forester's Handbook, West Virginia Division of Forestry

Additional Criteria for Direct Seeding

There are severe limitations on the use of direct seeding. It does not yield consistent, satisfactory results and should not be considered as a large scale substitute for tree/shrub planting. Careful control of seed storage and treatment is necessary. Loss of seed to rodents and birds often presents a problem. This information provides a basis for discussion with landowners who express an interest in the practice.

The following species have been successfully established using direct seeding:

HEAVY SEEDED SPECIES	LIGHT SEEDED SPECIES
Black walnut	Ash
Oak	Maple
Hickory	Basswood
Persimmon	Sycamore
Kentucky coffeetree	Sweetgum
Black cherry	Hackberry
Chestnut	Yellow-poplar

Seed Collection /Purchase

Scout potential collecting sites during mid to late summer to determine the potential seed crop by species. Best collecting sites are areas of mowed grass where mechanical seed harvesters can be used. Make plans for collecting, bagging, floating, sorting and storing seed before seed fall begins (usually in September and early October).

Note that seed may also be purchased from reputable suppliers.

For more information by species see Illinois Direct Seeding Handbook at:

http://www.il.nrcs.usda.gov/technical/forestry/dshndbk.html

Seed Inspection, Care, Storage and Seeding

Only undamaged, viable, mature seed will be used. Inspect by species at least 10 randomly selected seed per bushel. All seed should be inspected by performing a cut test or crack test. Collected seed can be inspected during the sorting process; purchased seed should be inspected at the time of delivery. Look for filled, moist, light-colored seed.

The following are key points to success:

- ***Early seed drop is suspect and often has low viability compared to later collections.***
- ***If a variety of species are to be planted, be advised that all the species are not likely to fall and be available at the same time.***
- ***Do not delay or postpone collection activities.***
- ***Keep nuts and fruits collected in a cool, protected place, out of direct light.***
- ***Organize seed processing area for efficient use.***
- ***Do not let seeds and nuts dry out or heat up before processing.***
- ***Watch out for excessive heat generation and mold formation. Avoid tall stacks.***
- ***Tag or label all bags of species and lots individually and maintain separation.***

The following are recommendations for some species:

Ash
Place in shallow trays in ventilated areas to dry. When dry, crush and separate seed from debris. Sow about ½ inch deep before the end of October, if possible.
If storing, place in dry closed containers and place in cooler at 40°F until planted.

Black Cherry
Immediately after collection, crush and mash fruits through a wire mesh to separate seeds from skins and pulp. Wash seed into a shallow box. Rub as you wash. Seed to be used within a few weeks or months should only be surface dried (a few hours), then bagged in sealable plastic bags and placed in a cooler until planted. Seed to be stored over winter should be dried at room temperature only about 1 day. Place in 4 mil sealable bags and lay flat in a cooler at about 40°F. Check and rotate bags occasionally to be assured seeds are not molding. Seed can be surface spread fall or spring in areas with loose soil. If mechanically seeded, plant only ½ to ¾ inch deep.

Hickories (all species)
After collection, keep nuts in an area that is protected from squirrels and where drying will be slow. Remove hulls, other debris, and insect damaged nuts by hand. Fall plant as soon as possible at about 2 inches deep with good soil contact. Any nuts to be stored should

be air dried, placed in airtight containers, and placed in a cooler at 36° to 40°F. Pit stratification is an alternative storage method if space and conditions permit. Soak for 2 to 4 days, then bury at least 2 feet deep. Obtain specifics for this method from the references listed.

Oaks (all species except red oak-see following) After collection keep in a cool, shady area in burlap or loose weave onion bags until separation from debris and inferior seed. It is best to process acorns of the white oak group right after collection due to their tendency to sprout. To restore normal moisture content , soak acorns in a large tank or tub for at least 4 hours within 24 hours of collection. Plastic children's wading pools are inexpensive containers for soaking acorns. "Float off" inferior seed, caps and other debris. Note that bur oak and overcup oak acorns will float. These species must be hand sorted. Hand sorting of floated acorns greatly increases seed quality.

Plant seeds as soon as possible or bag in burlap or fine weave onion sacks and store in a cooler at about 40°F.

Check condition regularly (every 3 weeks), particularly for moisture and sprouting. Sprouted acorns are okay, but more susceptible to dehydration.

Any acorns to be stored over winter must be moist. Soak about 12 to 24 hours, drain, place in sealed bags (1.75 mil for white oaks group; 4 mil for red oak group) and place in a cooler at about 34°F. Inspect and rotate bags periodically to drain off excess condensation. If no condensation occurs, add moisture to the bags. Plant as soon as possible after removal from the cooler. Plant white oak group within 6 months.

Discard any acorns of the red oak group not planted the next spring or early summer unless the acorns can be stored in carefully controlled temperature and moisture conditions.

Acorns may have up to one insect hole and ¼ of the nut damaged by insects and still be viable. If any nonviable seed is found the seeding rate will be increased by the percentage of non-viable seed.

Acorns should be planted in mid-May.

Red Oak

COLLECTING ACORNS

Red oak acorns drop from the tree in the fall and germinate in the spring. The collection season is from October 1 to 20, with the primary period between October 5-18 in the northern West Virginia. Acorns that fall early are usually not viable. This is especially true if their caps are stuck on the acorn.

Most red oak trees do not start producing significant quantities of acorns until they are about 50 years of age and 12 inches in diameter. Acorns are produced on the periphery of the crown where there is direct exposure to sunlight. Consequently, trees that have been either open grown or had their crowns released from competition from adjoining trees (crop trees) are likely to produce more acorns. Identifying these potentially productive search areas prior to the acorn drop season increases probability of success.

Good to excellent crops of acorns only occur about every 2 to 5 years. Humans hoping to increase oak regeneration are not the only searchers for this valuable crop. A multitude of creatures looking for carbohydrates to nourish them the winter are competing for this valuable food source. During years of limited acorn production, it is critical to search quickly after the mature acorn crop starts to drop. When there is a windy or even breezy period, it is wise to patrol pre-identified search locations quickly, hoping that you will be one of the first to arrive in the drop zone.

Acorn production is highly variable among trees, even in good seed years. Some trees are always poor producers while others tend to be good producers. Landowners who have the opportunity to visit their woodlot during a good seed crop year may want to identify the best producers. This is good information to support collection in subsequent years.

It takes 2 years for oaks in the red oak group to produce mature acorns. If a tree produces a good crop in a given year, it is less likely to produce much the following year. Oaks in the white oak group produce mature acorns in one growing season. White oak group acorns

germinate in the fall while red oak group acorns germinate in the spring.

SCREENING THE ACORN CROP

After every acorn gathering trip, it is wise to screen the collection to eliminate those acorns that are least likely to be viable. Acorns are attacked by insect predators. The larvae of these insects often make small tunnels in the acorn. If they destroy the radicle the root will not develop. These tunnels create air pockets in the acorn causing them to float in water.

An imperfect screening for viable acorns is the float test. Put the acorns in a pail of water. The ones that float probably have insect damage. The radicle (that will develop into the root) may or may not have been severed. The acorn may or may not germinate. There isn't any way to readily know for sure without destroying the acorn. To increase the probability of success it is appropriate to store only acorns that sink when tested in the pail of water.

STORAGE

Acorns must be kept cool and moist during the winter storage period. A refrigerator (not the freezer) is sufficient for this purpose. However, it is critical that the acorns not be allowed to dry out during storage. To prevent this, a workable technique is to place the acorns in a plastic freezer bag and include a moistened paper towel. Do not completely seal the bag. Leave an inch or two of the seal on the bag open to allow some air exchange. The acorns need to stay moist, but not saturated.

Check the acorns in the bags about every 3 weeks. A small amount of condensation inside the bag is an indication that the acorns are staying moist. They need to be moist, but not sitting in water. If the bag has drops of water in it, it is too wet. Drain the water out and squeeze some of the water out of the towel. If you see mold starting to form, conditions are too wet.

Inevitably, in spite of the screening, some float tested acorns will have weevils. They will emerge into the plastic bag and be visible. It is best to have acorns stored in a separate refrigerator if possible.

SITE PREPARATION

See Tree/Shrub Site Preparation, Conservation Practice Standard, 490.

Germinating acorns need to be placed in contact with mineral soil. Use a Maddox, Pulaski, pick ax, or similar grubbing tool to expose a 36-inch diameter area where the pre-germinated acorn can be planted. This phase of site preparation can be done anytime prior to out-planting the acorns. It saves time during the busy acorn planting season if this work is done during the prior dormant season.

There are advantages to not rushing into out-planting pre-germinated acorns during early spring. If the soil temperature is still cold, the germinating acorn will not respond quickly. Waiting until mid May (in northern West Virginia) provides more favorable soil temperatures. The acorn will have a more immediate growth response. This reduces the time when the acorns are vulnerable to predation.

For an acorn to become a successfully established seedling, it must have sufficient light, moisture, space, and nutrients to make the transition from seed to vigorous seedling. A great inhibitor is all the other plants that are competing for the same resources. If this competition is not controlled, in many cases the new plant will succumb to the opposition.

Site preparation is a crucial means of shifting competitive advantage to the desirable red oak seedling by killing or at least inhibiting other plants near the planting site. Competing plants vary from location to location. In old fields and pastures the primary existing vegetation may be grasses and forbs. On nutrient and moisture rich cutover forest land locations, the existing vegetation may be shade tolerant shrubs and trees.

Each planting location must be evaluated and a prescription made for how competition is to be controlled. What needs to be done and how to do it may vary. For example, an old field might need a spot foliar application of herbicide with a hand or back pack sprayer. A forested cutover area may need residual trees felled and the cambium of stumps treated with herbicide to prevent re-sprouting. Alternatively, trees can be girdled (a continuous saw or ax cut through the bark and cambium) with herbicide applied immediately to the cambium of the girdled tree.

NOTE: WV NRCS does not make pesticide recommendations

A location that was harvested 2 or 3 years ago may need both the above treatment of residuals and a spot application of foliar herbicide. In any case, locations to be seeded with acorns need appropriate site preparation, properly timed to effectively treat the competition.

An advantage of mid spring foliar herbicide application is that it gives the competition time to develop. By mid-May, the competing vegetation around the planting site has expended energy from its roots to produce abundant foliage for the new season. About 1 week before out-planting the acorns, apply a foliar application of herbicide (like glyphosate) that will kill both herbaceous and woody vegetation in the immediate acorn planting site (within a 3-foot radius). A backpack or hand held sprayer works well for this task.

PLANTING PRE-GERMINATED ACORNS

About March, while still in the refrigerator, the seed coats on some of the viable acorns will start cracking and the radicle will emerge. These are pre-germinated acorns. Emerging radicles are a clear indication the acorns are viable and planting them increases the probability that the effort will result in a seedling. There is no need to be anxious about getting the acorns planted. If they are kept cool and moist, they should remain healthy well into mid spring.

In March the soil is still quite cold. If you out-plant the acorn at that time it will not develop rapidly in the cool soil temperature. While sitting there not developing, it is vulnerable to all the creatures who are still looking for acorns to consume. It is better to hold the acorn in near-dormant state in the refrigerator to allow the soil temperature to increase. When all of the site preparation is completed, the tree tubes, ties, and stakes are on-location, transport the pre-germinated acorns to the work site in a cool, moist environment like a Styrofoam cooler. Place the acorns in the center of the exposed mineral soil, and cover each with about 1 to 2 inches of mineral soil. Then install the tree tube over the top of the acorn so the sprout from the germinated acorn will enter the tube.

PROTECTING THE ACORNS FROM PREDATION

Tubes designed to protect trees from predation by animals come in a variety of materials, colors, diameters, heights, styles (solid or vertically slit), ties (releasable or easily releasable) and vented or non-vented. Prices vary with all the aforementioned variables and the supplier. It is highly advisable to match the characteristic of the tube with the type of predators that are potentially damaging your trees. A 2-foot tube may be fine for rabbits, but inadequate for deer. Also, besides the purchase price, consider how much labor is involved installing the tube. Some are shipped in flat sheets that must be hand shaped into a tube prior to installation. They are more labor intensive. The use of tubes is primarily focused on protection from a very high deer population, with a secondary concern for vole predation on sites in the transition zone between field and forest.

For color, rose, manila, or light blue is preferred.

For diameter, about 4 inches is best. Some suppliers insert tubes in tubes for shipping. A disadvantage of doing this is that inevitably the tubes must vary in size. Suppliers with this type of tube have about 4 different sizes they nest (insert) in each other

Four foot tree shelters are adequate even in a very high deer population area. Deer sometimes take a nip of a bud, but it won't stop a red oak that has reached that height. When planting acorns, the expense of purchasing and maintaining 5-foot shelters is not warranted. It takes a taller stake to support that extra 1 foot of height. It is best to get the tree out of the tube as soon as possible. Trees grow better outside the tube.

For style, the solid tube is preferred to one that is in the shape of a C that has its vertical edges overlapping. The solid tubes do not require assembly, and they are easier to handle.

For a tie, an easily releasable tie to permit access for removal of within-tube vegetative competition and other maintenance is preferred. You should not need to use a knife or other tool to release the tie. Your thumbnail should be sufficient. If you purchase ties locally, buy black ones. They have ultra-violet protection. White ties are for indoor use.

Regarding vented or non-vented tubes, vented are preferred. Venting allows for gas exchange

which keeps the temperature inside the tube closer to the temperature outside the tube. Since plants use carbon dioxide and give off oxygen, venting keeps the air mixture inside the tube similar to outside the tube.

SUPPORTING THE TUBE

The support for the tube must be strong enough for the day when the wind is blowing at 30 mph with gusts to 40 mph, and soils are saturated with water. In northern West Virginia, try to drive my stakes 12 inches into the ground.

The options for stake material include non-treated, decay-resistant hardwoods, treated hardwood, steel rebar, plastic and fiber glass. My choice is treated hardwood. Shipping costs on the other materials are high because of their weight. If you are going to use very many tubes, it will be worth the effort to search for a local source of stakes to reduce your costs.

WEED CONTROL

All of the above effort can be easily lost without post acorn planting weed control. Like site preparation, weed control shifts the competitive advantage from surrounding vegetation to the new seedling. Some suppliers sell mulch mats or weed mats to help with this shift. Generally, it is held down by 5 wire staples. Four staples go in each corner, and one in the center of the 3-foot square mat.

In areas where the competition will obtain sufficient height to significantly shade the seedlings, additional control will be necessary. Herbicide can be a valuable tool when applied as a foliar spray or as a cut stump treatment. If there are specific plants in the treatment zone that you don't want to kill (like jack-in-the-pulpit, black cohosh, etc.), foliar applications must be done very carefully, or not at all. In those cases, repeated cutting and cut stump herbicide application may be the only options.

ADVANTAGES AND DISADVANTAGES

The greatest disadvantage of seeding acorns in tubes is the periodicity of the acorn crop. During years when few acorns are produced, collectors will need to look hard for viable acorns. This can be time consuming and the window of opportunity for when the searching can be done is limited. Collectors must also know how to identify red oak trees and acorns, and properly store them during the winter.

For many landowners, these disadvantages are more than off set by the advantage of having a healthy, vigorous seedling that has roots that have not been traumatized by lifting from a nursery bed with the associated loss of many root hairs. Also, the proper handling of pre-germinated acorns in storage and on the planting site is much easier for most family forest owners. It is much easier to keep an acorn in a cool, moist condition than it is a bare root seedling.

Tube seeding is not for every landowner and every artificial reforestation situation. However, it is a viable alternative that should be seriously considered by those who have access to seed sources, a suitable place to store the seed, the means to do site preparation and weed control, and very importantly, the interest to learn how to do all of the above well. For those individuals, tube seeding red oak can be a very rewarding experience.

Yellow-Poplar
Seed collected by shaking will not be completely dry and should be placed in shallow trays to finish drying. Fall seed or store dry in sealed bags or cans at about 40°F.

Black Walnut
After collection in fall or early winter, place seed in burlap or onion sacks to transport. Keep cool and out of sun. If the nuts will be hulled, be sure to complete before the hulls dry and become hard. Old corn shellers or mechanical hullers can be used. Float and wash hulled nuts. Seeds enclosed in their husks will also germinate. Be advised that unhulled nuts will eventually decompose and produce a black liquid that will stain anything it contacts.

Nuts generally fall from trees in September and October. When possible, collect nuts from trees with good stem form (for timber production) or large nuts with a high percentage of kernel (for nut production).

Nuts can be planted with husks, but are easier to handle and sort for viability if husks are removed. If leaving the husks on, plant in the fall at 2 to 3 inch depth. Recommended rates for broadcasting black walnut, which may be

accomplished with a fertilizer spreader, are 3,000 to 4,800 seeds per acre. Recommended rates for planting seeds in rows with a direct seeding machine or by hand are 1,500 to 3,000 seeds per acre.

If removing the husks, collect nuts as soon as they fall and immediately remove husks using one of these methods:

- ***Place nuts in a bucket of water to soften and then peel the husks by hand.***
- ***Place nuts in a hand-operated corn sheller.***
- ***Place nuts in a small cement mixer along with gravel, cover with water, and rotate for 20 to 30 minutes.***

Wear clothing and gloves for protection from stain in the husks. After removing husks, rinse nuts in water. Discard nuts that float; nuts that sink have full kernels and are more likely to germinate.

Walnut seeds require stratification (cold treatment) before they will germinate. Small quantities of nuts can be stratified in a plastic bag in a refrigerator at 34 to 41° Fahrenheit for 90 to 120 days. To stratify large numbers of walnuts for spring planting, dig a pit, spread out the nuts, and cover them with 1 to 2 feet of sand, leaves, or mulch. Cover the pit with screening to keep out rodents.

When the ground thaws in spring, dig up the nuts and plant 1 to 2 inches deep in the prepared site. Plant two nuts at each planting spot. About half the nuts will germinate in four to five weeks. Additional nuts may germinate the following year. Remove excess seedlings to allow adequate growing space.

To reduce predation by squirrels and other rodents, plant nuts in the spring in an open field at least 330 feet from a woodland. When nuts will be planted within 330 feet of a woodlot with squirrels, some form of protection may be needed. Tin (not aluminum) food cans, such as soup cans, may be used to protect small plantings. Burn the cans so they will rust and disintegrate within a few years. Remove one end of each can and cut an X into the other using a chisel. Pry up the cut ends as shown in Figure 1.

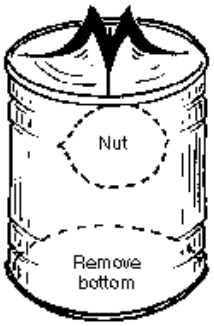

Figure 1. Tin can seed protector.

Grasping the can with the open end up, place 1 to 2 inches of soil into the can, drop in a walnut, then fill the can with soil. Plant the entire can with the sharp points facing up and buried about 1 inch below the soil surface. A seedling will grow out of the can. See Figure 2.

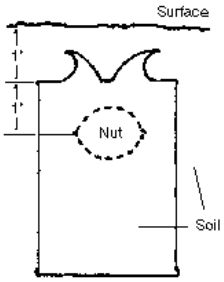

Figure 2. Squirrel protection placement

Persimmon
As soon as possible after collection, remove the seed from the skin and pulp. Do not let fruit heat and ferment or become moldy. Place in a shallow tray with wire mesh bottoms that will let pulp sift through, but not seeds. Wash and rub fruits to remove most of the pulp and skins. Once clean, spread seeds in shallow trays to dry. Plant in fall or store dry in sealed containers at about 40°F.

Sycamore
After collection, whether late fall or late winter, the seed balls should be placed in shallow trays and dried until they can be easily broken apart. Rub over a fine screen to remove the fine hairs attached to individual seeds. This is a dusty job, so wear gloves, goggles, and a dust mask. If seeds are to be sown soon after collection, they may

be stored in a cool, dry, well ventilated place in open mesh bags or in shallow trays. Crush fruit heads (balls) and rub out seeds for planting.

Chestnut
Chestnuts can be planted in spring or fall. Fall planting should be done in September or October with nuts that have been cured and kept in cold storage from the time they are harvested until they are planted. Nuts to be planted in the spring should be stratified overwinter and planted as soon as the soil can be worked.

Choose sites that get full sun in well drained soils. Trees should be at least 20 feet apart. Dig a hole 6 – 8" deep. Blend removed soil with peat moss. Install 12" piece of black plastic drain pipe into the hole at least 6" deep. Pour blended soil in pipe. Lay chestnut seednut on its side in pipe and cover with 1" peat moss. Cover top of pipe opening with hairnet. Construct a cage from a section of woven wire fence. See requirements for wire cages under Criteria for the Protection of Plantings/seedings in this standard. Place over seed/pipe and securely wire to supports. Wire top of cage closed. Mark with flagging write date, seedling number and seedling type on flagging on cage.

NOTE: Directions provided with seednuts provided by the American Chestnut Foundation (ACF) or the American Chestnut Cooperator's Foundation (ACCF) may also be followed to meet criteria requirements.

http://www.acf.org/seeds_seedlings.php

http://www.accf-online.org/seednuts.htm

Other Species
All light seeded species, as well as Kentucky coffeetree, should be kept dry.

Do not allow seed to heat up, avoid storing in large quantities unless well ventilated and refrigerated. Never leave tree seed in the sun.
Site Preparation

Planting sites will be prepared by destroying competing vegetation by either herbicide, or cultivation or both.

Elimination of perennial vegetation (especially sod forming grasses) is critical to seeding establishment. Reed canarygrass, brome, fescue, orchard grass and all warm season grasses must be killed and/or destroyed by tillage. If broadcast seeding the entire site must be treated; if row seeding at least a 3-foot radius circle or 3-foot wide band must be treated, with the planted seed centered in the grass-free area. Depending on the site, it may be necessary to start early in the growing season prior to planned fall planting by spraying regularly with recommended herbicides.

NOTE: West Virginia NRCS does not make pesticide recommendations. Landowners should be instructed to read product labels and follow product specifications. Landowners must contact the West Virginia Division of Forestry or the WVU Cooperative Extension Service for pesticide recommendations.

See WV conservation practice standard Tree/Shrub Site Preparation, code 490.

General Seeding Recommendations

Inspect seed, as described previously in this standard, when removing from storage before planting.

Seed may be planted whenever soil is unfrozen and moisture is adequate, but seed will be in best condition shortly after collection. Acorns in the white oak group can not be reliably stored for more than 6 months. Other species can be stored up to 3 years.

Planting in July, August or early September, however, may result in lower survival due to high soil temperatures and potential for rapid loss of soil moisture. If sprouting of seed begins seed can still be successfully planted but risk of dehydration is increased.

If there is no source of light seeded species within 500 feet of any portion of the planting site that portion will receive an additional 1,000 seed per acre of either heavy or light seeded species. To overcome predation, double the seeding rate for the first 100 feet beyond a forest edge. Seed may be planted mechanically or by hand, in rows or broadcast. Depth of planting for heavy seeded species will be approximately 2 times the seed diameter, or 2 to 5 inches deep depending upon species.
Plant all species at 2 inches or more if seed predation and/or low soil moisture are anticipated.

Plant at least 3,000 seed per acre of heavy seeded species if row planting; 4,800 if broadcast seeding.

Row seeding can be done with specialized equipment or modified tree planters or corn planters. Broadcast seeding can be done with modified agricultural spreaders.

Light seeded species will be sown on the surface of the soil. Seed that is broadcast will be disked in and cultipacked or rolled.

The following chart shows row spacing and seed spacing combinations that will result in 3000 seed per acre:

6' row spacing = 2.4'/seed
7' row spacing = 2.0'/seed
8' row spacing = 1.8'/seed
9' row spacing = 1.6'/seed
10' row spacing = 1.5'/seed
11' row spacing = 1.3'/seed
12' row spacing = 1.2'/seed
13' row spacing = 1.1'/seed
14' row spacing = 1.0'/seed
15' row spacing = 1.0'/seed
16' row spacing = 0.9'/seed
17' row spacing = 0.9'/seed
18' row spacing = 0.8'/seed

Conifers

Virginia pine, shortleaf pine, white pine, red pine and pitch pine are possible candidates for direct seeding, although white pine is a slow starter and is strongly affected by plant competition.

Follow these guidelines for successful direct seeding:

- ***Use seed treated with a bird, mammal, and insect repellent.***
- ***Use stratified seed. Stratified seed has been stored for 45 to 60 days in moist conditions at 36° to 40° F which is necessary to prepare seed for germination.***
- ***Sow in early spring after an inch or more of rain.***
- ***Broadcast .5 to 1 pound of seed per acre by air or by hand- crank seeder.***
- ***Spot seed .25 to .3 pound of seed per acre in areas of desired spacing. At the same time, choose spots where chances of success are greatest. Three or four seed should be used per spot at 6 feet x 7 feet to 8 feet x 8 feet spacing.***

REFERENCES

Establishing Red Oak Seedlings by Tube Seeding Acorns. Perkey, Arlyn W. Tree Farmer Magazine March/April 2009.

Growing Black Walnut, University of Minnesota Extension, http://www.extension.umn.edu/distribution/naturalresources/components/DD0505a.html

Growing Illinois Trees from Seed. 1983. Circular 1219. C.E.S., College of Agriculture,University of Illinois, Urbana-Champaign. 32 pp.

Planting Black Walnut, Kansas Forest Service, Kansas State University, http://www.oznet.ksu.edu/library/FORST2/L731.PDF

Seed Collection Manual. Circa 1980. Illinois Department of Natural Resources, Division of Forestry Resources. 23 pp.

Seeds of Woody Plants in the United States. 1974. Agricultural Handbook No. 450. USDA-Forest Service. 883 pp. Available on the Web at: http://wpsm.net/

Seeds of Woody Plants in North America. 1992. Young, J.A. and C.G. Young. Dioscorides Press. 407 pp.

Additional Criteria for Natural Regeneration

Site preparation should be sufficient for establishment and growth of selected species. Site preparation is needed if competition from grass, weeds, and/or woody materials will interfere with plant establishment and growth.

Mineral soil must be exposed so that seed to soil contact can be made.

See WV conservation practice Standard Tree/Shrub Site Preparation, code 490, and/or Brush Management, code 314, and associated job sheets.

See Table 1.

Table 1. Seed-bearing information by species

SPECIES	SEED BEARING AGE MINIMUM (YEARS)	SEED DISPERSAL DATES	INTERVAL BETWEEN LARGE SEED CROPS (YEARS)
White Pine	*5-10*	*Aug – Sept*	*3-10*
Pitch Pine	*3-4*	*Fall**	*4-9*
Shortleaf Pine	*5-20*	*Oct-Nov*	*3-10*
Virginia Pine	*5*	*Oct-Nov*	*1*
Yellow Poplar	*15-20*	*Oct-Nov*	*1*
White Ash	*20*	*Sept-Dec*	*3-5*
Sugar Maple	*30*	*Oct-Dec*	*3-7*
Red Maple	*4*	*April-July*	*1*

**** Many cones remain closed for several months or years.***

Additional Criteria for Hybrid Tree Species in Agroforestry Plantings

Hybrid poplars and willows may be well-suited for some agroforestry applications. Their convenient propagation and rapid growth allow them to establish and provide conservation benefits more quickly.

Site Selection

Poplars prefer well-drained soils such as sandy loams or silt loams. They will also grow in Clayey poorly-drained soils, but growth and yield are lower. Poplars can tolerate short periods of flooding when they are dormant, but cannot tolerate standing water in the summer months. The summer water table should be at 1.5 feet below the soil surface. Growth and yield on upland sites where the water table is deeper than 6 feet may not be acceptable due to soil depth, pH, fertility, and moisture availability.

Species Selection

Make sure clones or cultivars selected are suited to the climate and site where they will be planted. Use varieties that produce quality fiber or wood and have shown local disease and disease resistance.

Planting Stock

Cuttings 3/8 inch to one inch in diameter are made from one-year old shoots harvested during the dormant season. Length can range from 8 inch cuttings to 6 foot whips, depending on the purpose of the planting. On lowland sites with shallow summer water tables (1.5 to 3 feet deep), or sites that will be irrigated, cuttings can be 8 to 12 inches and planted with one bud above the ground. In all cases, buds should be "pointing up" after planting.

Longer cuttings called "whips", planted 2 to 6 feet deep are recommended for nonirrigated plantings were the water table is deeper than 3 feet. On rich bottomland sites a planting depth of 2 feet should be sufficient.

Site Preparation

For successful establishment and fast growth, site preparation is extremely important. Contact herbicides can be used to kill vegetation followed by deep tillage or ripping to allow easier planting and better rooting.

See WV conservation practice standard Tree/Shrub Establishment, code 490.

NOTE: NRCS does not make pesticide recommendations. Landowners should be told to read product labels and follow product specifications. Landowners may contact the West Virginia Division of Forestry or the WVU Cooperative Extension Service for pesticide recommendations.

Spacing

Tree spacing will depend on the target diameter, buffering or site remediation needs, maintenance methods, and product goals. Biomass plantings of poplar or willow with cutting cycles of 1 to 3 years are spaced 2'x 4' to 4'x 4'. Most poplar plantations for fiber production with cutting cycles of 6 to 7 years are spaced 8'x 8', 9' x 9', or 7'x 10'. As the rotation lengthens, the tree spacing will increase, e.g. for a 10 to 12 year rotation, trees are spaced 12'x 12'to 10'x 16'. Between row spacing is influenced by maintenance equipment used for weed control.

Management

Thinning can also be used when longer rotations are needed for long-term resource protection and/or lumber or plywood products are desired. Trees could be spaced at 7'x 10'and thinned for fiber in 6 to 7 years, leaving a spacing of 14'x 10', 7'x 20', or 14'x 20'. CAUTION: on irrigated plantings in wind prone areas, thinning can cause blow down if roots are shallow. Pruning to 18'is recommended to produce clear wood for quality lumber, veneer, or plywood. Rotation age ranges from 10 to 25 years depending on the site.

Planting Time

Planting should begin in the spring when the soil temperature reaches 50° F. When planting in late spring, soak the lower fourth of the cuttings in water for at least 24 hours before planting to speed up rooting.

Maintenance and Cultural Practices

Within-row and between-row weed control is done with pre-emergent herbicides and or shallow tillage for at least 2 to 3 years until the trees have shaded out competing vegetation. Landowners should read and follow all herbicide label directions.

For plantings in riparian buffers or wastewater treatment plantings, legumes or non-rhizomatous grasses can be used in the early years between the rows as long as they are

mowed to reduce rodent habitat and the tree rows have at least a 6 foot weed/grass-free strip for root development. On riparian sites were herbicide use may not be preferred and competing vegetation will be difficult to control, long cuttings (whips) are needed and should be planted to the depth of the summer water table. The above ground portion of the whip should be above the height of competing vegetation so leaves can capture sunlight.

References

Establishment and Cultural Guidelines for Using Hybrid Tree Species in Agroforestry Plantings, Kuhn, Gary A., Rietveld, W.J., Riemenschneider, Agroforestry Note 11, USDA, USFS/NRCS.

Forest Management Handbook, West Virginia Division of Forestry, 1985.

Service Foresters Handbook, USDA Forest Service, NE State and Private Forestry, February 1978.

West Virginia Forest Stewardship Incentive Program Training, Reference, and Procedures Manual, West Virginia Division of Forestry, WVDOF-TR-92-1, Revised 12/97.

<u>Additional Criteria for Surface Mine Reclamation</u>

NRCS personnel should contact the West Virginia Division of Forestry (WVDOF) for direct assistance when a landowner is planning at tree planting as part of a surface mine reclamation project.

Current agreements between the WVDOF and the Department of Environmental Protection (DEP) make it advantageous to the landowner to have a tree planting plan developed and approved by the WVDOF. Reclamation requirements are affected and can be made less stringent with an approved plan.

Additional Criteria for Riparian Buffer Plantings

See the standard, Riparian Forest Buffer, 391.

Tree and Shrub Lists for WV located in Section IV – Tools of the FOTG and WV Job Sheet – 391- Trees and Shrubs Recommended for Riparian Forest Buffers in Section IV of the FOTG – Conservation Practices – Riparian Forest Buffer – 391 list some trees and shrubs associated with and suited for riparian areas. Review the key attributes for each species to assist in selection and the design process for establishing buffers.

Other species may also be suitable. Consult with West Virginia Division of Forestry personnel, NRCS staff forester and/or biologist concerning the suitability of other species.

Initial plant-to-plant densities for trees and shrubs will depend on their potential height at 20 years of age. Heights may be estimated based on: 1) performance of the individual species (or comparable species) in nearby areas on similar sites, or 2) predetermined and documented heights using Tables 1 and 2, Trees and Shrubs Suitable for Establishment located in Appendix I of this standard. Planting density recommendations for planting open areas are:

Plant Types/Heights:	***Plant-to-Plant Spacing in feet:***
• ***Shrub less than 10 feet in height***	***3 to 6***
• ***Shrubs and trees from 10 to 25 feet in height (includes columnar trees)***	***5 to 8***
• ***Trees greater than 25 feet in height***	***12 to 25***

Interplanting between existing trees and/or shrubs and/or when natural regeneration is expected at spacings greater than those listed above is also acceptable.

INFORMATIONAL NOTE: The Stroud Water Research Center recommends planting 400 seedlings per acre (with tree shelters and follow-up herbicide treatment or tree mats) to end up with 200 seedlings per acre as an acceptable or minimum target for riparian restoration, assuming a 50% survival rate.

Reference

Sweeney, Bernard W, Czapka, Stephen J., and Yerkes, Tina. 2002. Riparian Forest Restoration: Increasing Success by Reducing Plant Competition and Herbivory, Stroud Water Research Center, 970 Spencer Road, Avandale, PA 19311.

Additional Criteria for Paulownia Plantings

It is important to note that paulownia is non-native and can be invasive if not managed. Landowners should be made aware of these issues prior to making the decision to plant this species.

Plantation Size. It is best to start small. Plant no more than 100 root stocks on ¼ acre of land to start.

Site Selection

The site selected should be:

- ***Near a convenient source of water for irrigation if required***
- ***Readily accessible by truck, tractor etc.***
- ***Sloped enough to drain reasonably well***
- ***Positioned such that it has at least exposure to direct afternoon sun. This will minimize future bark damage from sun scald***
- ***Free from flooding***

CAUTION: Do not plant in bottomland or any area subject to prolonged flooding.

Site Preparation

Clear the site of all brush and trees, grass, and weeds. See WV conservation practice Tree/Shrub Site Preparation, code 490.

Soil analysis

Submit a soil sample from your site for analysis and recommendations for corrective treatment.

Planting Layout

The planting rows should be a minimum of 20 feet apart. Straight rows are preferred, but they can bend and vary in length in accordance with the contour and boundaries of the site. Temporarily mark the rows to permit you to subsoil the rows.

Subsoil Site. Subsoil the rows to a minimum depth of 3 feet, then harrow them once to break up the clumps of soil.

Tree Spacing

With a ball of twine or a 100 foot tape, stakes, or sticks, mark the center of the rows. Now proceed to mark the planting spots for each tree at your predetermined intervals (at least 20 feet).

Planting Stock

Root cuttings, measuring 5-6 inches in length and a minimum of ½ inch up to 2 inches in diameter are preferred. When ordering, ask the supplier to identify the smaller ends of the cuttings since some do not taper and are difficult to identify until bud stems develop. If, when received, there are no signs of buds, their development can be stimulated by "stratification," i.e., storing them for a few days in an unsealed box of damp sand, vermiculite, etc.

Planting Operation

1) ***Using a garden trowel, open holes at the marked spots in the rows. These holes should be deep enough to drop the cuttings into, small end down, without harming or breaking any of the buds.***
2) ***Next, with your hands, carefully firm the soil around the cuttings, leaving them covered with about ¼ inch of soil.***
3) ***With a garden spray can, spread ½ gallon of water around the cutting, leaving the soil damp (not mucky). This light watering should be done as necessary to maintain this damp condition. A thin layer of hay, straw, etc. will help to keep the soil damp. Do not use grass clippings which will dry out and form a sealed mat and retard stem growth.***

Sprout Pinching

Stem sprouts will shoot up rapidly, likely in a few days. When the sprouts are 10-12 inches tall, pinch off all but the 2 healthiest looking ones. Two weeks later, pinch off the weaker of the two.

Once the planting operation is completed, the developing stems must be routinely cared for as follows:

Removing Branch Buds

Without harming the leaves, pinch off the branch buds as they appear. These should be removed when they are 3-4 inches in length. If allowed to grow, the branch will leave a knot that devalues the log when marketed.

Fertilization

Do not over fertilize. Give the trees time to respond to each treatment, grow before repeating fertilization. The soil analysis may have revealed a major nutrient deficiency which should have been corrected at the time of site preparation. As a safeguard, 2 months after planting, sprinkle 2 tablespoons of a commercial 10-10-10 slow release fertilizer around and away from the stems. Repeat this treatment as necessary prior to the beginning of each growing season. Increase the dose to trees which are laggards, i.e., slow growers.

Weed Control

This is very important, especially during the first 2 years. Use a rugged type domestic lawn mower, commercial brush mower, and/or a weed eater. Be careful to avoid contacting the stems.

Insect Control

Inspect the trees monthly, especially the terminal bud and the leaves, top side and underneath. Verify and leaf damage such as: yellowish areas, excessive holes, etc., and recommended treatment.

Coppicing

Cutting the stems off 1 inch above ground level, will allow the root system to grow, producing better stems. Use a fine tooth saw to avoid loosening bark at the cut line.

Opinions vary as to when and how often the stems should be coppiced, i.e., after one or more growing seasons or after consecutive seasons. Stem growth is often irregular, some growing 10'-12' or more in the first growing season, others lagging behind. For the small introductory "learning" plantation, Selective coppicing, after the first growing season, is suggested for trees that:

- *Are less than 4-5 feet tall*
- *Have broken, split, crooked, bent, or forked stems*
- *Contain bark damage such as splits, bare spots, deer rubs, etc.;*
- *Are diseased. All diseased trees, including their root ball, should be removed from the site and burned. Do not replant in these spots, the soil may be contaminated.*

After the stumps resprout, repeat the best sprout selection procedure. Following the second growing season, most of the stems should be 9'-10' tall. Let them grow during this period, debudding them as necessary. Continue to debud any "laggards" as they eventually grow to the 9'-10' level.

Summary Note: Taller trees (20'-35') of some growers have been seriously damaged by strong winds, water soaked soil giving way under storm conditions, ice and heavy snow accumulations. It is strongly recommend that trees in the small introductory "learning" plantation be cultivated to yield just one 9'-10' branch free log.

References

Forest Management Handbook, West Virginia Division of Forestry, 1985.

Service Foresters Handbook, USDA Forest Service, NE State and Private Forestry, February 1978.

Some Simple Practical Suggestions for Cultivating Paulownia Trees, American Paulownia Association. Volume 11, No. 1, January 2002.

West Virginia Forest Stewardship Incentive Program Training, Reference, and Procedures Manual, West Virginia Division of Forestry, WVDOF-TR-92-1, Revised 12/97

Additional Criteria for Bioengineering Plantings

See Engineering Field Handbook - Chapters 16 and 18.

Agroforestry Notes 23 and 24.

http://www.unl.edu/nac/afnotes/spec-6/spec-6.pdf

http://www.unl.edu/nac/afnotes/spec-7/spec-7.pdf

Additional Criteria for Wildlife Plantings

See the WV conservation practice standards, Upland Wildlife Habitat Management, code 645 Restoration and management of Declining Habitats, code 643.

Woody pollinator plantings shall be at least one-half acre (0.5 acres) in size. Larger woody pollinator plantings are exponentially more beneficial.

Tree/shrub plantings can be used to establish pollinator habitats. Desirable species should be selected that encourage use by pollinators and bloom throughout as much of the season as possible. Since trees and shrubs typically are available prior to the bloom period of most herbaceous plants, they are often the most visited of plants by bees early in the season. Conversely, woody species stop blooming earlier in the growing season and the floral resources are not available throughout the growing season. Therefore, it is not advisable to depend solely upon woody species to provide pollinator resources. For this reason, it is acceptable when installing exclusively woody species enhancements to utilize bloom periods of very early, early and mid-season.

A woody pollinator mix must contain at least three species in each of the three blooming periods as discussed above (very early, early and mid). Trees and shrubs should be planted at a close spacing to aid in pollinator access but also allow for maximum crown development and bloom. Planting materials may be seedlings, containerized or balled and burlapped.

Refer to the West Virginia Pollinator Handbook and/or the list of Trees and Shrubs Suitable for Establishment in West Virginia for a listing of trees and shrubs that benefit pollinators.

Additional Criteria for Windbreak/Shelterbelt Plantings

See the WV conservation practice standard, Windbreak/Shelterbelt Establishment, code 380.

See the standard, Windbreak/Shelterbelt Renovation, 650.

CONSIDERATIONS

Priority should be given to plant materials that have been selected and tested in tree/shrub improvement programs. All plant materials should comply with minimum standards such as those as established by the American Nursery and Landscape Association, Forest Service, or state-approved nursery.

Plans for landscape and beautification plantings should consider foliage color, season and color of flowering, and mature plant height.

Consider using diverse species combinations which best meet locally native wildlife and pollinator needs.

Tree/shrub arrangement and spacing should allow for and anticipate the need for future access lanes for purposes of stand management.

Residual chemical carryover should be evaluated prior to planting and alter species selection and/or timing of planting/seeding.

When underplanting, trees should be planted sufficiently in advance of overstory removal to ensure full establishment.

Use locally adapted seed, seedlings or cuttings.

Where multiple species are available to accomplish the planned objective, consideration should be given to selecting species which best meet wildlife needs.

Tree/shrub arrangement and spacing should allow for and anticipate the need for future access lanes for purposes of stand management.

Consider associated insect, pest, and disease problems when selecting tree and shrub species (i.e. cedar-apple rust, etc.)

Consider shade tolerance when selecting tree and shrub species to plant.

Consider drainage class and soil type when making plant species selection.

Consider existing species when interplanting to create pollinator habitat.

PLANS AND SPECIFICATIONS

Specifications for applying this practice shall be prepared for each site and recorded using approved specification sheets, job sheets, technical notes, and narrative statements in the conservation plan, or other acceptable documentation.

Substrate material and site preparation necessary for proper establishment of the selected plant/seed shall be included in the design.

At a minimum the following will be identified in the conservation plan (as appropriate):

- ***Purpose of tree/shrub establishment***
- ***Field location / plan view***
- ***Acreage to be establishment***
- ***Site conditions prior to establishment***
- ***Soil amendments (if needed)***
- ***Site preparation methods (if applicable)***
- ***Species to be used***
- ***Stock size (if applicable)***
- ***Spacing (if applicable)***
- ***Establishment method(s)***
- ***Establishment dates***
- ***Protection methods (if applicable)***
  - ***Note dimensions and specifications of protection measures as applicable***
- ***Cultural practices (i.e. pruning, forest stand improvement, etc.) (if any)***
- ***Operation and maintenance requirements***
  - ***Replacement strategies***
- ***Any required permits, including but limited to, the CPA-052 or similar environmental documentation.***

OPERATION AND MAINTENANCE

The following actions shall be carried out to insure that this practice functions as intended throughout its expected life. These actions include normal repetitive activities in the application and use of the practice (operation), and repair and upkeep of the practice (maintenance).

Access by vehicles or equipment during or after tree/shrub establishment shall be controlled to protect new plants and minimize erosion, compaction and other site impacts. Refer to the standard Access Control, 472.

The trees and shrubs will be inspected periodically and protected from adverse impacts including insects, diseases or competing vegetation, fire and damage from livestock or wildlife. ***The planting should be inspected at least annually and after storm/fire events.***

Damaging pests will be monitored and controlled.

If needed, competing vegetation will be controlled until the woody plants are established. Noxious weeds will be controlled. Refer to standard Pest Management, 595 ***and/or Brush Management, 314.***

Replanting will be required when survival is inadequate to ***meet the objective of the practice.***

Supplemental water will be provided as needed.

Periodic applications of nutrients may be needed to maintain plant vigor. If nutrients are applied, refer to Nutrient Management, 595.

After trees and/or shrubs are established, refer to the standards Forest Stand Improvement, 666, and Tree/Shrub Pruning, 660, for subsequent management.

Where practical, management activities will be performed outside the primary nesting season (March 15 - July 15). An exception may be for mowing or cultivation to control vegetative competition.

Pruning, thinning, and/or removal of dead or diseased plants should be performed and timed as to not interfere with the life cycle of the plants or the intended purpose of the planting.

Supplemental water will be provided as needed.

Additional operation and maintenance requirements may be developed on a site-specific basis to assure performance of the practice as intended.

**** NOTE: Information in bold italics has been added to the national standard by West Virginia***

REFERENCES

Talbert, Cheryl 2008. Achieving Establishment Success the First time. Tree Planters Notes, Vol. 52 No. 2 pages 31-317.