North Carolina Forest Service Tree Planting Pocket Guide

8th Edition - 2016

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Notes

How to Use This Pocket Guide

This pocket guide contains information and standards for tree seedling handling and planting to improve the likelihood of a successful planting. The standards that follow are used by the NCFS to insure a quality planting job is completed on projects receiving cost share assistance. This guide supports and interprets the NCFS Tree Planting Quality Control sheet (4204-2).

As per NCFS Policy & Procedure 4204, the NC Forest Service, when requested, will assist and advise the private landowner with:

- √ Ordering and locating seedlings of a suitable seed source.
- √ Locating planting tools or machines.
- √ Demonstrate proper planting techniques.
- √ Loan tree planting bars on a deposit basis.
- √ Assist in locating state or private tree planting contractors.
- √ Provide quality control checks on all cost share projects where NCFS has technical responsibility.

CHILLING HOURS FOR DORMANCY

Much of this pocket guide is designed for the care and handling of dormant bareroot seedlings. Occasionally early "hot planting" occurs when seedlings have not completely reached full dormancy before being lifted then planted. The degree of dormancy a seedling has reached is measured in chilling hours.

The term "Chilling Hours" refers to the number of hours that seedlings are exposed to temperatures between 32°F and 46°F in the field. Chilling hours are recorded and can be obtained from the nursery. Once the seedlings have received more than 400 chilling hours they can be lifted for extended storage. Before that time, storage time for non-dormant seedlings should be limited. In cases where early planting of non-dormant seedlings is requested, we suggest that all seedlings be stored at temperatures set to no more than 50°F. Maximum storage times must follow these guidelines:

Chilling Hours	Planting Guidelines
0-200	24 hr. refrigeration, plant immediately
201 - 350	2 weeks refrigeration, plant immediately
351-400	3 weeks refrigeration, plant immediately

NOTE: Planting of non-dormant seedlings should not occur during SEVERE conditions.

CLASSIFICATIONS OF WEATHER CONDITIONS FOR TREE PLANTING

Each NCFS District office will broadcast a predicted tree planting category "day" based on predicted weather conditions at 1300. Three categories are listed below.

Satisfactory Day	
Air Temperature:	33°F to 75°F
Relative Humidity:	50% +
Winds Less than	10 mph
Soil Moisture:	Moist to touch

Marginal Day	
Air Temperature:	76°F to 85°F
Relative Humidity:	30% to 50%
Winds Less than	10 to 15 mph
Soil Moisture:	Upper 1-inch Dry

Severe Day	
Air Temperature:	32°F or below, or 85°F+
Relative Humidity:	30% or less
Winds Less than	15 mph or stronger
Soil Moisture:	Upper 3-inches dry, or ground is frozen

WEATHER REQUIREMENTS FOR CONTAINERIZED SEEDLINGS

Weather conditions have little effect on containerized stock as long as the soil is moist at time of planting, drought conditions do not prevail after the planting operation, and the seedlings are not exposed to temperature extremes during handling and storage. Planting of quality containerized seedlings improves survival and initial growth therefore refer to page 23 for culling standards.

Planting Containerized Seedlings

Advantages	Disadvantages
Roots not as easily damaged when lifted in the nursery or planted in the field	Usually more expensive
Easier to plant	Not all species are available in all nurseries
Extended planting season-earlier or later in the season	Requires good site preparation
Uniform seedlings	Bulky to handle
Improved performance of some species	Seed source sometimes unknown

DETERMINATION OF SEEDLING CONDITION

Indicators of seedling deterioration:

- ⊗ Sour smell or fermentation.
- ⊗ Yellow needles on conifers.
- ⊗ Trees warm to the touch.
- ⊗ Mold developing.

Indicators of dead seedlings:

- ⊗ Bark slips off easily, especially on roots.
- ⊗ Cambium layer has turned brown.
- ⊗ Mold present on most of seedlings.
- ⊗ Trees too hot to touch.
- ⊗ Seedling roots are powder dry.

NOTE: Do not plant if these conditions exist.

Prior to planting, if any of these conditions exist contact the local N.C. Forest Service, District Seedling Coordinator to resolve the issue.

TREE PLANTING STANDARDS FOR DELIVERY / TRANSPORTATION

SATISFACTORY

√ Vehicles used for transporting seedlings **will have a cover to shade and protect seedlings.** A "Heat-Shield" is preferred.

√ Bags/boxes will not be stacked over **3 deep** unless spacers are used to provide air circulation between layers.

√ Provide at least **12" of air space** between top of seedling bags and the cover to avoid heat build-up.

√ Vehicles **will not be parked in direct sunlight**. In case of emergency stops, or breakdowns, when stops exceed **45 minutes**, seedlings should not be planted **until their condition has been determined**.

√ Inspect and repair torn bags **immediately**.

8 Delivery and Transportation

MARGINAL

In addition to Satisfactory Day standards:

√ Field delivery in non-refrigerated vehicles should be held to a **minimum**.

√ Seedling delivery from a non-refrigerated storage point to destination **should not exceed 1 hour**.

√ Bags/bundles **will not be stacked over 2 deep** unless spacers are used.

WARNING - Seedlings must be protected from high temperatures, direct sun, and freezing.

SEVERE

In addition to Marginal Day standards:

- √ Field delivery in non-refrigerated units should not be made when the temperature is **85ºF** or higher.

- √ Field delivery in non-insulated units when the temperature is **32ºF** or less will be made only if the vehicle is covered adequately to prevent freezing.

- √ Unload and **protect seedlings** immediately upon arriving at destination.

Seedlings can deteriorate in storage even under the best of conditions.

TREE PLANTING STANDARDS FOR OFF SITE STORAGE

SATISFACTORY

- √ Store seedlings in building, shed, basement, etc. that will protect from freezing, heating, and direct sunlight.
- √ Bags/bundles should be stacked on pallets or slats and should not be stacked over **2 deep** without spacers to allow air circulation between layers.

TEMPS: 35° - 38°F
Ideal temperatures, usually maintained with refrigerated units.

- √ Bags stored under ideal conditions can be kept at least **3 months**, with the exception of bareroot Longleaf Pine.
- √ Bags of bareroot Longleaf Pine need to be planted within **1 to 2 days** of pickup from the nursery.
- √ Bags can be stored under ideal conditions for a maximum of **10 days**.
- √ Storage of bareroot longleaf should be kept to a minimum.

Off Site Storage

Off Site Storage

√ Many hardwood species are lifted with the leaves exposed and can dry out quickly even under ideal storage conditions. Hardwood seedlings must be inspected frequently and be watered as necessary.

TEMPS: 38° - 50°F
Temperatures, commonly found in non-refrigerated locations

√ Bags stored under these conditions can be kept up to **3 or 4 weeks**.

√ Bundles with seedlings dipped in clay slurry will keep **2 to 3 weeks**.

√ Bareroot Longleaf pine should not be stored under these conditions.

TEMPS: 50° - 75°F
Temperatures commonly found in a shed, basement, or non-refrigerated locations.

√ Seedlings should be removed within **3 to 5 days**.

√ Bareroot Longleaf pine should not be stored under these conditions.

MARGINAL

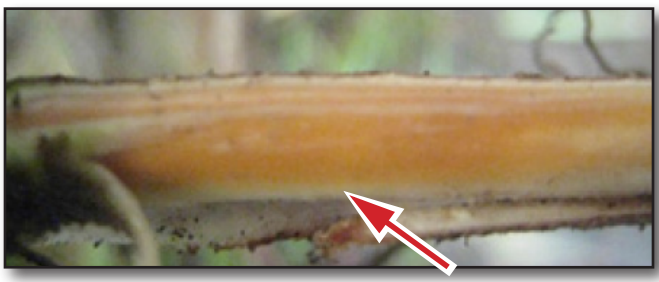
- √ If temperature inside storage area **is above 75ºF**, do not store seedlings more than 24 hours.
- √ Do **not stack over 2 deep** without spacers.

SEVERE

- √ Seedlings should not be stored in bags/bundles/ boxes for more than a few hours at temperatures above **85ºF**, or seedling damage will occur and survival will be adversely affected.
- √ Lethal temperatures occur in bags/bundles at 118ºF.
- √ Do not store seedlings in an area where the temperature is **32ºF** or less.
- √ Do not allow seedlings to freeze.
- √ If trees have been frozen less than 36 hours:
  - (1) Thaw seedlings slowly.
  - (2) Determine condition.

Off Site Storage

- √ If frozen more than 36 hours, then seedlings most likely have been severely damaged and should not be planted. Containerized seedlings will suffer severe mortality if the root ball temperature drops to **22° F**.



Freeze damaged cambium will be a dark brown color versus green and healthy.

Seedlings are highly perishable and must be stored properly to maintain their viability.

TREE PLANTING STANDARDS FOR ON SITE STORAGE

On Site Storage

On Site Storage

SATISFACTORY & MARGINAL

- √ Store the seedlings in shaded location **at all times**.
- √ If no shade is available at planting site, improvise a portable shelter with a **1 foot** air space between bags/bundles/boxes and shelter.
- √ A reflective tree planting tarp is preferred.
- √ Bags/bundles should not be stacked in layers more than **2 deep** without spacers
- √ If roots begin to dry, dip roots in gel or other coating if available. It is preferred that a gel or a kaolin clay slurry be used to moisten roots.

- √ **Inspect and repair** torn bags immediately.
- √ Keep opened bags closed tightly and stored in the shade.
- √ Keep opened bundles in the shade and covered at all times. **If kept over 2 days, heel-in seedlings.**
- √ If opened bags of seedlings must be kept for over 2 days, roots must be dipped and **bag tightly closed**, or heel-in seedlings.
- √ Store trays and boxes of containerized seedlings in shade and **keep root plugs moist** until seedlings are planted.
- √ During storage check moisture of root plugs periodically to determine condition.

On Site Storage

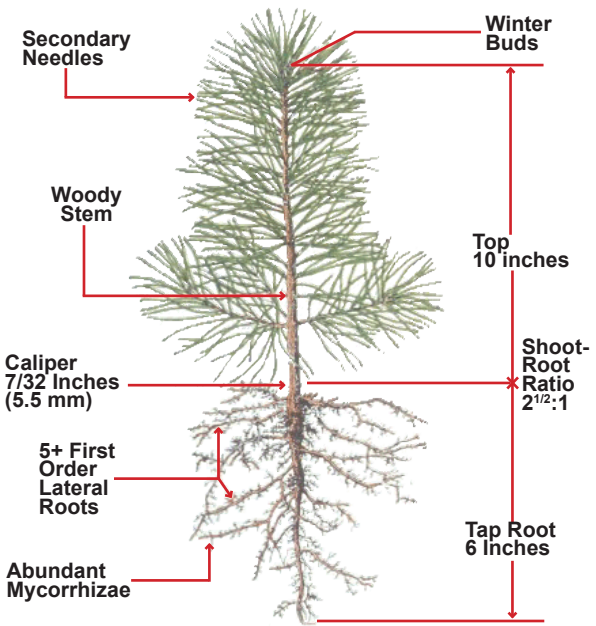
On Site Storage

SEVERE

√ Seedlings will not be stored at planting site under these conditions unless in buildings, sheds, etc. that will protect them from freezing and/or heating.

TREE PLANTING STANDARDS FOR CULLING

THE OPTIMUM LOBLLOLY PINE SEEDLING



USFS Management Bulletin R8-MB399

Culling Standards

SATISFACTORY & MARGINAL

- √ Open only **1 bag/bundle/box at a time**.
- √ When handling, **carefully separate seedlings** to minimize damage to root system. Do not strike seedling root system on any object. This may remove beneficial root coating or mycorrhizae.
- √ Remove **only a small number** (handful) of seedlings at a time. Do not allow the roots to be exposed to the sun or wind any longer than **3 minutes.**
- √ Bareroot longleaf seedlings should not be exposed to sun, freezing temperatures, and wind for longer than **30 seconds**.
- √ Roots must be kept **visibly moist** at all times. If not, dip roots in gel or other suitable wetting agent.

√ Assign properly trained person to be responsible for culling seedlings. Closely supervise the operation to maintain standards.

SEVERE

√ Culling will **not** take place at the planting site unless in a building, shed, or other protected area; then follow the same standards for marginal conditions.

BARE ROOT CULLING STANDARDS

Cull bare root 1-0 Loblolly, Shortleaf, or 2-0 White Pine that have:

√ Broken, skinned or weak stem.

√ Fermented smell.

√ Mold on needles.

√ Slippery bark.

√ Root collar **smaller than 3/16 inch.**

Culling Standards

- √ Root collar **larger than 3/8 inch**.
- √ Large seedlings must have a balanced root-to-shoot ratio by volume. This ratio should not exceed **1:2 ½ (root:shoot)**.
- √ Root systems **less than 4½ to 5 inches** long 4½" roots are allowable as long as the seedling is balanced)
- √ Root systems **longer than 12 inches,** if more than **25%** of the laterals, must be pruned in order to plant.
- √ Broken or skinned tap root.

Cull bare root Longleaf seedlings that have:

- √ Root collar diameter **less** than **3/8 inch.**
- √ Tap root **shorter than 6 inches.**
- √ Less than **5 first order lateral** roots (1mm or more in diameter).

CONTAINERIZED CULLING STANDARDS

Cull containerized seedlings that have:

- √ Plugs should be grown in containers no less than **5.5 cubic inches in volume** (example: 1" x 1" x 5.5") and at least 3.5 inches deep (4.5" is preferred for better survival).
- √ Lost potting medium. (Plugs where the roots have grown down the side of the potting medium are OK).
- √ Plugs with partial or complete loss or exposure of adequate root system.
- √ Dry roots or damage to the root system.
- √ Loose potting medium that easily washes off during watering or during handling.
- √ Presence of excessive contaminating substances such as weed and grass seeds and/or sprouting in the potting medium.
- √ Completly dead, brown or yellow needles (some at the bottom of the seedling are OK).

Culling Standards

Cull containerized Longleaf pine that have:

√ Needle length **less than 4" long.**

√ Root collar diameter **less than 0.20".**

√ 2-0 container stock due to root bound issues.

Cull Longleaf container (M. Hainds)

Ideal Longleaf container (B. Pickens)

Cull containerized Loblolly Pine that have:

- √ Minimum root collar diameter **less than 4mm or 5/32".**
- √ Shoot height of **less than 8".**

Cull containerized <u>Shortleaf Pine</u> that have:

- √ Minimum root collar diameter **less than 4mm or 5/32"**.
- √ Shoot height of **less than 6"**.

Cull containerized <u>Atlantic White Cedar</u> that have:

- √ Minimum root collar **diameter less than 1/8"**.
- √ Shoot height of **less than 4"**.

TREE PLANTING STANDARDS FOR ROOT PRUNING

SATISFACTORY

LOBLOLLY, WHITE PINE, SHORTLEAF
Do not prune tap roots of these seedlings shorter than 4½ inches in length.

- √ Do not root prune unless necessary to plant seedlings at proper depth and to avoid J-rooting, especially on difficult sites.
- √ If excessively long laterals are pruned, they should not be pruned shorter than 5-7 inches.
- √ Prune roots to uniform lengths. Align root collars in bunches before pruning roots.
- √ Use a sharp axe or hatchet for root pruning. Never break or twist roots off by hand.
- √ Assign only properly trained persons to be responsible for root pruning. Closely supervise the operation.

Root Pruning Standards

LONGLEAF PINE
Do not prune the tap roots!
Do not top clip needles shorter than 7”
Long lateral roots can be root pruned to no less than 6”

MARGINAL

- √ Do not expose roots of seedlings to sun and wind for longer than 3 minutes.
- √ Keep roots visibly moist at all times.
- √ Prior to placing seedlings back in bag or planting container, dip roots in planting gel, clay slurry or water.
- √ Otherwise, very closely follow same standards for satisfactory conditions.

DO NOT PRUNE UNLESS NECESSARY

SEVERE

- √ Pruning will not take place at planting site unless in a building, shed, or other protected area.
- √ When pruning in such an area, follow very closely the same standards for marginal conditions.

DO NOT PRUNE UNLESS NECESSARY

TREE PLANTING STANDARDS FOR THE PLANTING OPERATION

SATISFACTORY

- √ **Train all new personnel** prior to planting season. Provide refresher training to experienced planters periodically and if poor techniques are commonly observed.
- √ Organize hand crews to have a crew leader for every 5-6 planters. The crew leader should supervise the planting operation and correct any improper tree planting.
- √ While **hand planting**, carry seedlings in a canvas bag, bucket, etc. to protect the roots. **Do not carry seedlings in hand**.
- √ Be sure roots are visibly moist before placing in container. If not, dip seedling roots in gel or other coating.
- √ Verify that the seedlings are the correct species from the appropriate geographic seed source and genetic stock prior to planting.

Tree Planting Operations

- √ **When hand planting, do not use dibbles or other tools that will not make a hole or slit at least 8 inches deep.**
- √ Remove only 1 seedling at a time from container.
- √ Insert root system to bottom of hole and lift seedling to proper planting depth.
- √ When **hand planting bareroot longleaf**, use a planting shovel, pointed KBC planting bar, or other suitable planting tool that will permit the complete planting of the large longleaf seedling root system.
- √ If **machine planting**, be sure roots are visibly moist before placing in seedling box on planter. Cover roots in seedling box with wet burlap or moist sawdust to protect from exposure.
- √ **Carefully separate seedlings** to reduce damage and prevent the breaking of lateral roots (damage to laterals will reduce survival).
- √ **Tap root should be planted straight** using proper planting techniques and depty (see pg. 77).

See pg. 77

- √ L-roots that occur within **6 inches** of the soil surface and L-roots that result in broken or ruptured root tissue are unacceptable.
- √ If planting **at least 8" deep** creates a **minor J-root** condition (upturned root no longer than **¼- ½" at the bottom of the 8" hole**), then this condition is acceptable (See Page 77).
- √ **Do not** plant seedlings in standing water or excessively wet soils. (Exception bald cypress seedlings)
- √ **Adjust planting depth** according to site drainage or soil types
- √ **On Well Drained Sites** (sandy loams and sandy soils) plant root collars 2 to 3 inches below ground line, (except for longleaf).
- √ **On Poorly Drained Sites** (silt and clay soils) plant root collars one inch below ground line (except for longleaf).

Tree Planting Operations

Deep planting Loblolly and Shortleaf seedlings may help increase seedling survival, as long as J-rooting is avoided.

- √ Planting bareroot or containerized Longleaf seedlings requires careful attention to planting depth, or seedling survival may be affected.
- √ Plant seedling **vertical**. Do not exceed 30 degrees from vertical.

  Close hole **tightly**. Make sure hole is closed at **bottom and top**.
- √ Check for seedling tightness by grabbing 3 needles with two fingers and tugging on the needles using only wrist leverage. The seedling should not move.

- √ Periodically **check and adjust planting machine** to insure proper seedling depth and proper packing by the machine. Minimum depth of planting slit is 9 inches. (See page 48).
- √ Space seedlings at approximate spacing prescribed for tract. Avoid planting seedlings in areas of loose soil that cannot be compressed around roots.
- √ Closely supervise and maintain quality control of planting at all times.

When planting shortleaf pine the basal crook should be located slightly below the surface to maintain the ability to sprout following burning.

Tree Planting Operations

MARGINAL

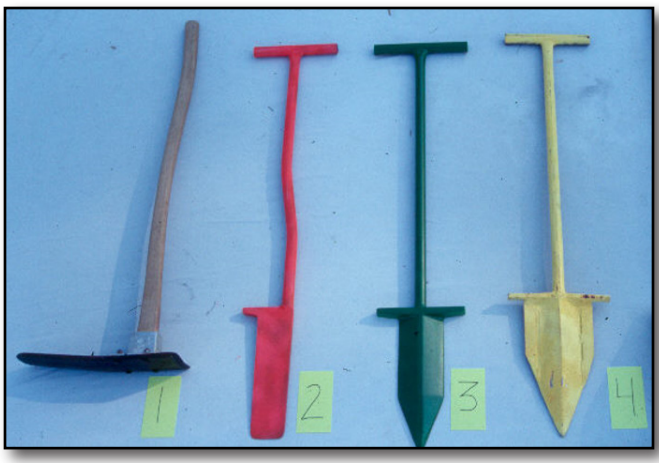
- √ Seedling roots must be coated with gel, clay, or water. Also, tops of seedlings should be wet (reduces transpiration).
- √ Otherwise, very closely follow **same** instructions for satisfactory conditions.

SEVERE

- √ **All planting should STOP**, unless localized on-site weather & soil conditions warrant an exception. On-site weather conditions must be documented to verify that planting can occur on a Severe Day.

Do not plant seedlings if cold temperatures that will freeze ground are forecasted <u>for several days</u> following tree planting.

TREE PLANTING TOOLS AND TECHNIQUES



Planting tools, from left to right:
1. Hoedad,
2. Dibble Bar, 3" wide blade.
3. KBC Bar, 4" wide blade.
4. Modified KBC Bar, 6" wide blade.

PLANTING TOOLS

Planting bars are suited to many types of soils and terrain. They are used for planting most bare-root seedlings except those with very large, spreading root systems.

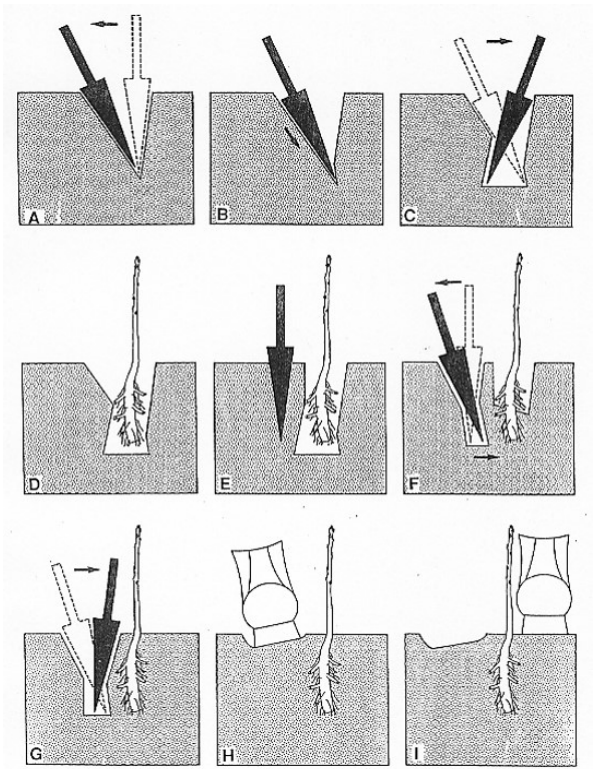
KBC (pointed) bars are preferred for penetrating hard or rocky soils.

OST (flat) bars work best in loamy soils.

These are examples of two dibble bars. The one on the left is a shorty bad bar

Replace planting bars shorter than 8”

Planting with Dibble, OST, and KBC Bars



Process for using a Planting Bar:

Step A. Insert bar straight down. Pull backwards.

Step B. Push down tip of bar into the hole.

Step C. Push bar forward (away from you), slightly past vertical to widen out the hole.

Step D. Remove bar. Insert seedling in center of hole.

Step E. Insert bar straight down about 2 to 3 inches behind the seedling.

Step F. Pull bar backwards (towards you) to close-off the bottom of the hole.

Step G. Keeping the bar in the hole, now push the bar forwards (away from you), to close-off the top of the hole.

Steps H and I. Lightly pack down soil around seedling with boot heel.

HOEDAD TREE PLANTING TECHNIQUES

The Hoedad is a scalping and planting tool particularly suitable for planting hillsides and rough terrain.

The blade must enter the ground vertically to insure proper placement of the seedling. Two brackets are available.

- The Earp bracket sets the blade at a 100-degree angle and is recommended for flat or gently rolling terrain.
- The standard bracket sets the blade at a 90-degree angle and is more suitable for mountainous terrain.

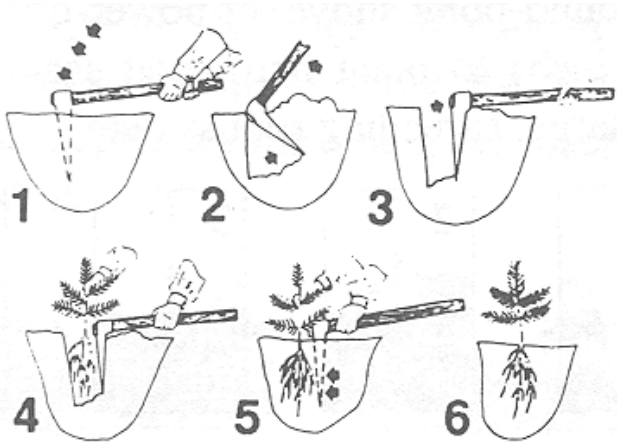
Hoedads are restricted by heavy brush or slash where they cannot be swung freely for clean, deep penetration.

Extra efforts are required to plant seedlings correctly under these conditions and in rocky and heavy clay soils.

When hoedads are used to plant longleaf pine seedlings, extra care must be taken to insure seedling is correctly planted.

Tree Planting Operations

Planting with a Hoedad



Process for Using a Hoedad

1. Swing hoedad from overhead downward, sinking the blade its full length vertically into the soil. Minimum depth of slot is eight inches.

2. Pull the blade upward slightly by lifting the end of handle.

3. Push the handle downward while pulling back to open hole.

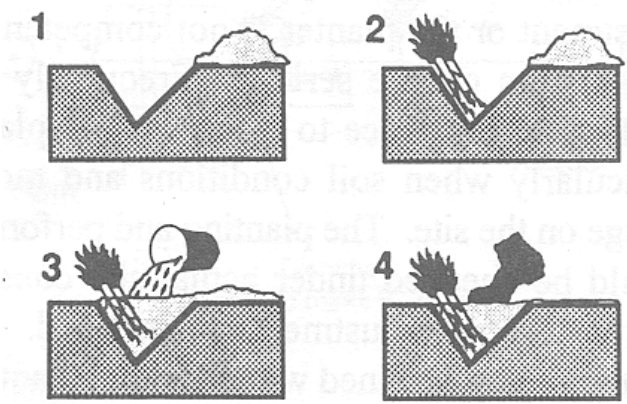
4. With blade in cavity to hold back loose soil, carefully place seedling in hole making sure roots are fully extended, then remove the blade.

5. Close the hole by inserting hoedad behind the seedling to tighten soil by lifting up and pushing down on the handle. Also push soil toward seedling.

6. Close the planting hole completely.

Seedling Storage "Healing In"

Heeling-in can provide on-site short-term storage of seedlings. If opened bags of seedlings must be kept for more than 2 days or if a bag is damaged beyond repair, the seedlings can be heeled-in.



1. Dig a V-shaped trench in a moist shady place.
2. Spread out the seedlings evenly in the trench.
3. Backfill the trench to completely cover the root system of the seedlings.
4. If possible, water the soil then firm with feet.

Handling Treated Seedlings

Some conifer seedlings are treated with a chemical spray at the nursery for protection from Pales Weevil and/or browsing by deer.

Safety Precautions

- √ Wear rubber gloves when handling, culling and planting treated seedlings.
- √ Do not rub eyes when handling treated seedlings.
- √ Keep hand washing soap and water at the planting site or any other area where treated seedlings are handled.
- √ Thoroughly wash hands with soap and water after handling treated seedlings, and prior to eating, drinking, smoking or chewing.

MACHINE PLANTING TECHNIQUES

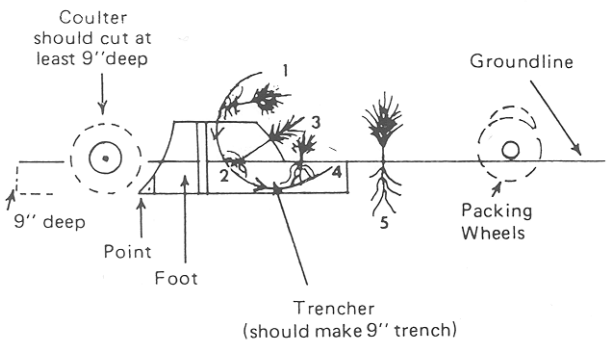
MACHINE PLANTING

Tractor-drawn planting machines offer production advantages on relatively flat, well-prepared sites and fields. Improved survival rates have been attributed to the reduction in root competition and to consistent soil packing.

If the machine is out of adjustment or the planter is not competent, root deformation can be serious. Frequently check planting performance to insure proper planting, particularly when soil conditions and moisture change on the site. The planting and performance should be checked under actual site conditions and the proper adjustments maintained.

Good success can be obtained with machine planting of bareroot stock longleaf seedlings however great care must be employed to prevent the common mistake of deep planting these seedlings. Some hardwood seedlings can be successfully machine planted but many cannot.

Machine Planting



1. **Hold seedling horizontal at top of trencher.**
2. **Start downward arc motion.**
3. **Place seedling roots at maximum depth.**
4. **Start an upward motion to pull any J-Roots or L-Roots out of the seedling.**
5. **Hold seedling in vertical position (where root collar is 1”-2” below ground line) until soil closes around roots.**

TROUBLE SHOOTER'S GUIDE FOR MACHINE PLANTING[1]

SYMPTOM	POSSIBLE CAUSES
L or J- Root	• Insufficient weight or hydraulic pressure on frame or planting box. • Need hydraulic fluid. • Worn coulter (riding on hub.) • Gap between coulter and foot or shoe too great (buildup of debris). • Worn planting foot or shoe. • Soil too dry. • Planting seedling too deep in trench.
Seedlings damaged by packing wheels	• Packing wheel misaligned. • Packing wheels too close.
Seedlings at an angle or thrown out of ground.	• Angle of packing wheels too flat. • Releasing seedling too late. • Mud build up on packing wheels.
Seedlings not well packed.	• Not enough weight or pressure on packing wheel or coulter. • Hitch not adjusted correctly. • Packing wheels too far apart. • Ground too hard.

TROUBLE SHOOTER'S GUIDE FOR MACHINE PLANTING (cont'd)

SYMPTOM	POSSIBLE CAUSES
Debris in hole.	• Need scalper or V-Blade.
Seedlings too shallow.	• Releasing seedling too soon. • Top link on planter not adjusted properly allowing planter foot to draft. • Coulter worn or not adjusted properly; coulter edge below foot point preventing foot from drafting. • Ground hard, add weight over coulter. • Site prepared soil not settled.

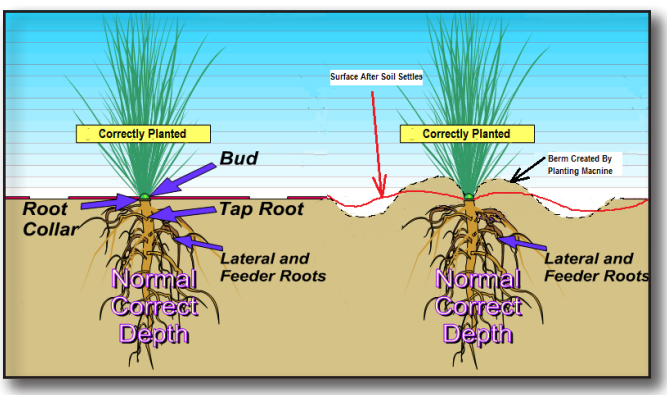
1 Forest Farmer Manual, March 1975, p.55

LONGLEAF PINE

Longleaf Pine

Longleaf Pine Planting Depth

Whether planted by hand or machine, it is important to place longleaf seedlings at the proper depth. Proper planting depth for bareroot longleaf seedlings is where the base of the bud is at or slightly below ground level. Do not plant bareroot seedlings shallow. It is even more important to plant containerized longleaf seedlings with the bud above the ground level. Unlike bareroot stock, container seedlings survive and grow well when the plug is planted shallow leaving the bud exposed.



SPECIAL TECHNIQUES FOR CONTAINERIZED LONGLEAF

- √ When flat planting containerized longleaf seedlings insure that the root collar is at or **no more than ½" above ground level**.
- √ Do not cover the bud.
- √ When planting in scalped rows, insure the root collar is no more than 1" above ground level.

SPECIAL TECHNIQUES FOR MACHINE PLANTING LONGLEAF

When machine planting either bareroot or container longleaf seedlings you must anticipate where the bud will be after soil has settled and adjust the depth as needed. The depth will vary depending on soil type. In lighter sandy soils, the tip of the bud should not be covered with more than 1/4 inch of soil, while in heavier loam or clay soils the tip of bud should be exposed.

An experienced person should periodically walk behind the planter to suggest necessary changes for each specific site.

Needle pruning is sometimes needed on seedlings with excessively long needles to reduce desiccation on droughty sites. Needles should not be pruned to less than 7 inches in length.

HARDWOOD PLANTING

Hardwood Planting

Hardwood Planting

Planting and Handling Hardwood Seedlings

When planting hardwoods, special attention should be given to matching the appropriate species to the site, planting good quality seedlings, and conducting proper tree planting.

Do not plant small, inferior hardwood seedlings that are below minimum planting standards.

Quality Hardwood Planting Stock

Hardwood seedlings should be graded to select for seedlings with acceptable root collar diameters (RCD) and adequate primary first order lateral roots (FOLR). For timber purposes, most hardwood seedlings should have at least a **3/8" RCD**. Planting for other uses such as wildlife, wetland mitigation, riparian buffers can use smaller seedlings with at least a minimum of ¼" RCD, but the 3/8" RCD is still preferred.

*See **Page 57** for preferred RCD by species.*

Species	Timber Purpose		Wildlife, Riparian, Wetland Use
	Preferred RCD (inch)	Preferred FOLR (#)	Minimum RCD (inch)
N.Red Oak	3/8 to 1/2	4 to 6	1/4 to 3/8
White Oak	1/4 to 3/8	2 to 4	1/4 to 3/8
Sw.Chestnut Oak	3/8 to 1/2	2 to 4	1/4 to 3/8
Cherrybark Oak	3/8 to 1/2	2 to 4	1/4 to 3/8
Laurel Oak	3/8	2 to 4	1/4 to 3/8
Water Oak	1/4 to 3/8	2 to 4	1/4 to 3/8
Willow Oak	1/4 to 3/8	2 to 4	1/4 to 3/8
Green Ash	3/8 to 1/2	2 to 4	1/4 to 3/8
Sycamore	3/8 to 1/2	4 to 6	1/4 to 3/8
Sweetgum	3/8 to 1/2	4 to 6	1/4 to 3/8
Yellow poplar	3/8 to 1/2	4 to 6	1/4 to 3/8
Black Walnut	3/8 to 1/2	4 to 6	1/4 to 3/8
Water Tupelo	1/4 to 3/8	2 to 4	1/4
Swamp Blackgum	3/8	2 to 4	1/4
Overcup Oak	1/4 to 3/8	2 to 4	1/4
Shumard Oak	3/8 to 1/2	2 to 4	1/4 to 3/8
Baldcypress	1/4 to 3/8	2 to 4	1/4

Hardwood Planting

Hardwood Root Pruning Standards

- √ For hardwoods with spreading root systems, limit root pruning to only that required to avoid curled, bunched, or twisted roots in the planting hole.
- √ For hardwoods with a prominent taproot, the taproot should be pruned no shorter than 6 inches in length and the lateral roots should be pruned no shorter than 5 inches in length.
- √ Following seedling grading or root pruning, the tree planter is encouraged to keep the hardwood root system moist by using a planting gel or mycorrhizal root dip. These products may help to reduce the effects from transplant shock to the seedling.

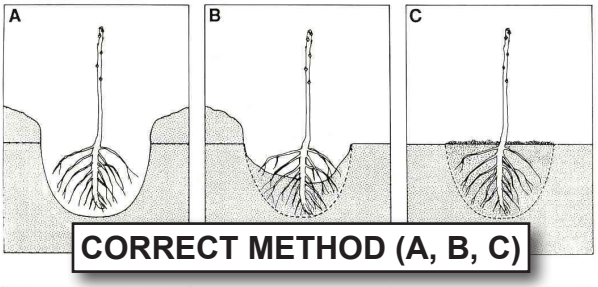
Make the Hole Fit the Seedling,
Not the Seedling Fit the Hole.

Hand Planting Hardwood Seedlings

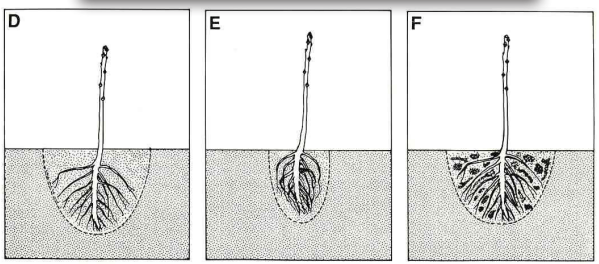
- √ The tree planter should select the most appropriate planting tool for the species to be planted. If multiple species of hardwoods are to be planted, select the planting tool that will accommodate the seedling with the largest root system.
- √ The dibble bar has limited use for many of the larger sized hardwoods.

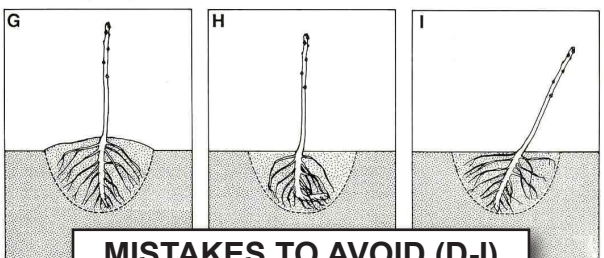
Preferred tools for hardwood seedlings, from left to right: KBC Bar, modified KBC Bar, shovel..

Hardwood Planting



CORRECT METHOD (A, B, C)





MISTAKES TO AVOID (D-I)

Use a shovel or power-driven auger (10 to 14 inch diameter bit) to plant hardwood seedlings that have a large or wide spreading root system.

Correct method:

Step A. Dig hole slightly larger (wider) than the root system is, when spread out.

Step B. Place the seedling in the center of the hole and spread the roots in a natural manner. Roots should not be bunched or twisted. Seedlings should be planted about 1-inch deeper than they grew in the nursery.

Step C. Backfill the hole and firmly pack soil around the roots to eliminate air pockets.

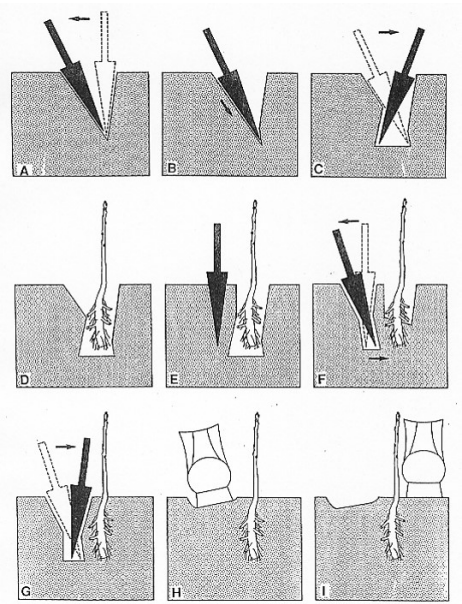
Common mistakes to avoid:

Fig. D- Hole is too deep.
Fig. E- Hole is too narrow, roots are bound.
Fig. F- Air pockets or debris remain in the hole.
Fig. G- Hole is too shallow or roots are exposed.
Fig. H- Taproot is bent in the hole.
Fig. I- Excessive leaning of seedling.

Hardwood Planting

Hardwood Planting

- √ Some hardwood seedlings can be satisfactorily planted with a planting bar. These species typically have a prominent tap root and a more compact root system.
- √ A KBC type planting bar should be used.



Machine Planting Hardwood Seedlings

- √ Machine planting of selected hardwoods is acceptable on appropriate soil types. These sites must allow the planter to operate at a coulter depth of at least 9". Adjust the packing wheels to completely close the planting trench from top to bottom. Adjustments may be needed as soil type and moisture changes
- √ Hardwood species with large, spreading root systems (Northern red oak, cherrybark oak, black cherry, yellow poplar, black walnut) are not recommended for machine planting unless you have the specialized planter to accommodate the tall seedlings with larger root systems.

Checking Hardwood Tree Planting

- √ Hardwood seedlings should be planted with the RCD at ground line or 1" below the soil surface. The main stem and root system will be planted vertically upright, with no lateral roots exposed above the soil. Ensure that the planting hole is fully closed with the planting tool and the soil is firmly packed around the roots to eliminate air pockets.

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PRS

PRODUCTIVITY RATING SYSTEM

P = Productivity

R = Rust resistance

S = Straightness

NCFS Loblolly Pine Performance Rating System

The North Carolina State University Tree Improvement Cooperative provides performance characteristics of loblolly pine seedlings grown from tested families. These selections are scored on Productivity, Fusiform Rust Resistance and Straightness.

www.treeimprovement.org

DEPLOYMENT ZONE

What geographic area the seedlings can be safely planted in:

- **Coastal NC**
- **Piedmont NC**
- **Northern NC and Virginia**

PRODUCTIVITY

This is a percentage increase in volume at age six compared to a standard checklot for the deployment zone that the seedlings are suitable for.

Example:

- P=71 → Approximately 71% greater stem volume for the North Carolina Coastal Plain.
- P=64 → Approximately 64% greater stem volume for the North Carolina Piedmont.
- P=69 → Approximately 69% greater stem volume for the Northern Deployment Zone.

RUST RESISTANCE

A letter grade of A through E that indicates the selection's resistance to Fusiform Rust infection. Some selections may be marked with an X.

An X means that there is insufficient data to score the selection for that trait.

Example:

• R=A→ Excellent resistance to Fusiform Rust Disease
• R=B → Above average resistance to Fusiform Rust Disease
• R=C → Average resistance to Fusiform Rust Disease
• R=D → Below average resistance to Fusiform Rust Disease
• R=E → Poor resistance to Fusiform Rust Disease
• R=X → No score available

STRAIGHTNESS

A letter grade of A through E that indicates the selection's improvement in straightness of the stem. Some selections may be marked with an X.

An X means that there is insufficient data to score the selection for that trait.

Example:

- R=A→ Excellent straightness
- R=B → Above average straightness
- R=C → Average straightness
- R=D → Below average straightness
- R=E → Poor straightness
- R=X → No score available

PRS Specification Sheets are available from NCFS nurseries for all loblolly selections we produce. The sheets provide greater detail including, cold hardiness, numerical scores for each trait, and deployment maps.

MISC. & CONTACT INFO

Spacing of Seedlings

Spacing recommendations are determined by site quality, markets, accessibility, insect and disease problems, degree of site preparation and landowner objectives.

Species	Minimum per Acre	Maximum per Acre
Loblolly Pine	300	625
White Pine	300	625
Longleaf Pine	300	725
Shortleaf Pine	350	725
Hardwoods	200	400

Trees / AC by Spacing

Trees per Acre	Spacing (ftxft)	Trees per Acre	Spacing (ftxft)
222	14x14	622	7x10
300	12x12	681	8x8
363	10x12	726	6x10
403	9x12	807	6x9
436	10x10	908	6x8
519	7x12	1,037	6x7
544	8x10	1,089	5x8 or 4x10
605	8x9 or 6x12	1,210	4x9 or 6x6

MISC. & CONTACT INFO

How to Calculate # of Seedlings/Acre by Spacing

1. Multiply the Spacing.
2. Divide 43,560 by the above product.

Example:

7 X 12 Spacing

7 x 12 = 84 sq.ft.

43,560 sq.ft. / 84 sq.ft. = 519 / trees per acre

Circular Plot Dimensions

Plot Size Acres	Radius (feet)
1/1000	3.72
1/100	11.75
1/50	16.64

Note: 1 acre = 43,560 square feet.

NCFS Quality Control Check Procedure

Quality control checks will be made by NCFS personnel on all cost-share projects when NCFS has technical responsibility.

The area will be sampled by taking random plots in a U-shaped walk over the tract.

Plots will be l/100 acre circular plots (radius 11 feet 9 inches), but other plot sizes may be used for plantings on wide spacing.

Number of Plots

- √ Consider the size of the tract and take a minimum of 6 plots, but no more than l5 per tract.
- √ On tracts less than l0 acres in size, take l plot per 2 acres with a minimum of 3 plots.
- √ On very large tracts [100+ acres] 15-20 plots or more should be taken to ensure the planted area is adequately sampled.

In addition to checking the seedlings for above ground defects, check for below ground defects by digging two (2) above ground seedlings in each plot that were rated good.

Approval of Planting Jobs
(For Cost Share Projects)

- √ County Forest Technicians may approve all projects that score 85% and higher.
- √ For projects less than 85%, but at least 75%, the Service Forester needs to approve or disapprove.
- √ For projects that score less than 75%, the tract can only be approved with the Asst. Regional Forester's concurrence.
- √ A minimum of 30 plots should be taken before denying cost-share payment on a project. On tracts less than 10 acres, the minimum is 20 plots.

North Carolina Forest Service Contacts

Claridge Nursery Office

(All Customer Inquiries and Ordering)
919-731-7988, or Toll Free: 1-888-NC-TREES
762 Claridge Nursery Road.
Goldsboro, NC 27530-7965

District Offices

Sylva	828-586-4007	Fayetteville	910-437-2620
Asheville	828-667-5211	Rocky Mount	252-442-1626
Lenoir	828-757-5611	Elizabeth City	252-331-4781
Mount Holly	704-827-7576	Fairfield	252-926-3041
Lexington	336-956-2111	New Bern	252-514-4764
Hillsborough	919-732-8105	Whiteville	910-642-5093
Rockingham	910-997-9220		

NCFS Central Office

North Carolina Forest Service
1616 Mail Service Center
Raleigh, NC 27699-1600

Phone: 919-857-4801

Internet: ncforestservice.gov

MISC. & CONTACT INFO

NCFS COUNTY FOREST RANGER OFFICES

Alamance	336-376-3596	Catawba	828-465-8443
Alexander	828-632-5810	Chatham	919-542-5739
Alleghany	336-372-8142	Cherokee	828-837-5426
Anson	704-848-4705	Chowan	252-482-4554
Ashe	336-846-2471	Clay	828-837-5426
Avery	828-766-8043	Cleveland	704-487-4954
Beaufort	252-946-3944	Columbus	910-654-4739
Bertie	252-794-3725	Craven	252-244-0295
Bladen	910-588-4861	Cumberland	910-483-1535
Brunswick	910-755-7772	Currituck	252-453-6770
Buncombe	828-686-5885	Dare	252-473-2531
Burke	828-438-6269	Davidson	336-859-9171
Cabarrus	980-335-0009	Davie	336-751-5319
Caldwell	828-757-5612	Duplin	910-289-2735
Camden	252-336-4332	Durham	919-560-0562
Carteret	252-728-3793	Ed'combe	252-823-8346
Caswell	336-694-6131	Forsyth	336-767-7269

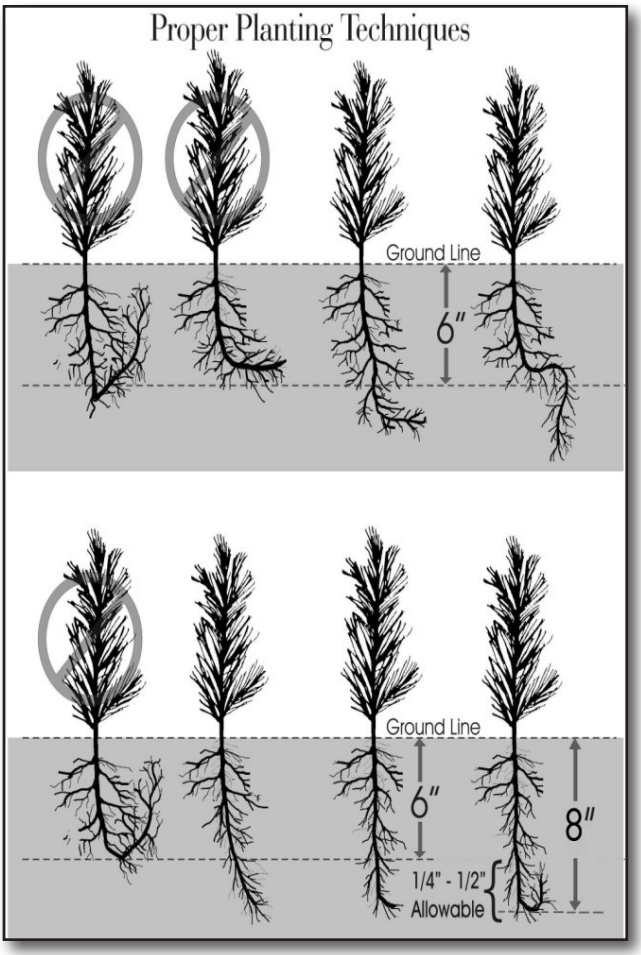
NCFS COUNTY FOREST RANGER OFFICES

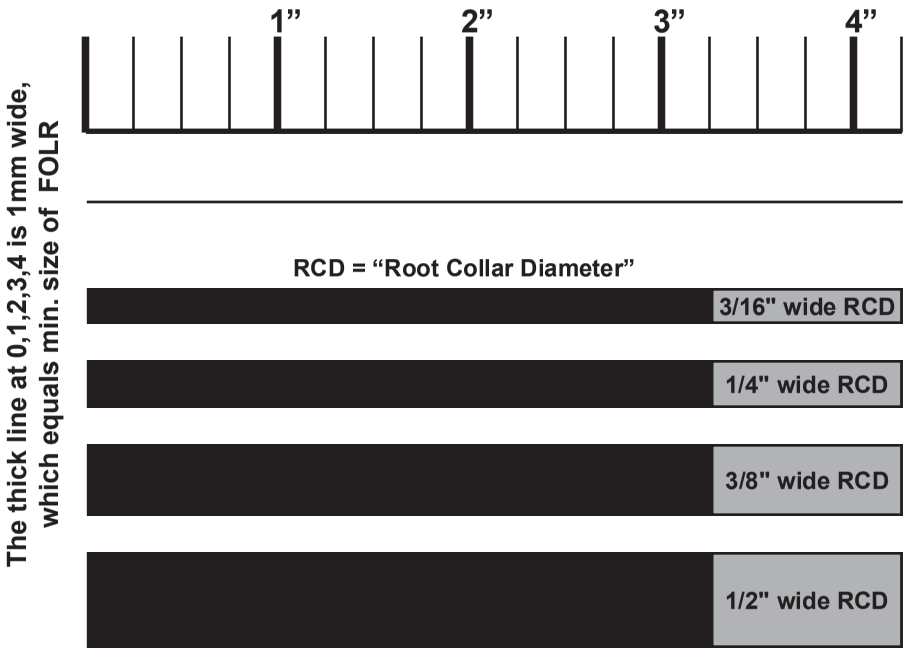
Franklin	919-496-3665	Lenoir	252-520-2400
Gaston	704-922-0719	Lincoln	704-922-0719
Gates	252-357-0123	Macon	828-369-8677
Graham	828-479-6341	Madison	828-649-3821
Granville	919-693-3154	Martin	252-792-3183
Greene	252-747-3879	McDowell	828-652-2636
Guilford	336-375-3631	Mecklenberg	980-335-0009
Halifax	252-826-3219	Mitchell	828-688-9405
Harnett	910-893-4391	Montgomery	910-576-5481
Haywood	828-627-6551	Moore	910-235-0216
Henderson	828-891-3957	Nash	252-459-7338
Hertford	252-358-3761	North Hanover	910-251-5750
Hoke	910-875-2808	NorthHampton	252-534-4741
Hyde	252-926-9201	Onslow	910-324-3633
Iredell	704-878-4216	Orange	919-732-8152
Jackson	828-631-9316	Pamlico	252-745-3775
Johnston	919-989-1925	Pasquotank	252-331-7401
Jones	252-448-5531	Pender	910-259-7251
Lee	919-775-5214	Perquimans	252-426-5551

MISC. & CONTACT INFO

NCFS COUNTY FOREST RANGER OFFICES

Richmond	910-582-7029	Stanly	704-982-5317
Person	336-599-5111	Transylvania	828-884-3212
Pitt	252-355-9079	Tyrrell	252-796-5841
Polk	828-894-8020	Union	704-233-1437
Randolph	336-879-1773	Vance	252-438-7249
Robeson	910-618-5540	Wake	919-841-4046
Rockingham	336-634-3021	Warren	252-257-5960
Rowan	704-216-8993	Washington	252-797-4722
Rutherford	828-286-9201	Watauga	828-265-5375
Sampson	910-592-4515	Wayne	919-731-2010
Scotland	910-276-0455	Wilkes	336-973-4104
Stokes	336-593-8154	Wilson	252-237-0914
Surry	336-356-8177	Yadkin	336-679-8941
Swain	828-488-3932	Yancey	828-682-6788


Proper Planting Techniques
Ground Line
6"
Ground Line
6"
8"
1/4" - 1/2"
Allowable


1”
2”
3”
4”
The thick line at 0,1,2,3,4 is 1mm wide, which equals min. size of FOLR
RCD = “Root Collar Diameter”
3/16" wide RCD
1/4" wide RCD
3/8" wide RCD
1/2" wide RCD

Notes:

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