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1/ Tree and shrub planting plans will contain and specify all the procedures for items I-X that are applicable to the site. These procedures are considered components of the tree/shrub planting practice.

2/ Field Office Technical Guide (FOTG) tree and shrub planting practices and codes are as follows:

- Critical Area Planting (practice code 342)
- Forest Stand Improvement (practice code 666)
- Restoration of Declining Habitats (tree planting portion only, practice code 643)
- Riparian Forest Buffer (practice code 391)
- Tree/Shrub Establishment (practice code 612)
- Upland Wildlife Habitat Management (practice code 645)
- Wetland Wildlife Habitat Management (practice code 644)
- Windbreak/Shelterbelt Establishment (practice code 380)
- Windbreak Renovation (practice code 650)

IMPORTANT!!! The success of any tree planting is dependent upon the site preparation, stock quality, planting and handling techniques, and maintenance used by the planner, vender, planter, and landowner. Procedures in this document illustrate a wide variety of methods that have proven successful for conservation tree and shrub plantings in Nebraska. Refer to the current Nebraska Cooperative Extension Guide for Weed Management in Nebraska and/or product labels when using herbicides:

<http://www.ianrpubs.unl.edu/epublic/live/ec130/build/ec130.pdf>.

- I. PREPARATION OF PLANTING SITES:** Establishing a conservation tree planting can be a challenge in Nebraska, where annual precipitation varies widely. Tree planting failure commonly occurs as a result of poor site preparation, coupled with inadequate weed and grass control, the first three to five years after planting. If erosion is a concern, adequate erosion control measures, including cover crops, will be utilized.

Planting sites should be properly prepared AT LEAST THE FALL PRIOR TO SPRING TREE/SHRUB PLANTINGS AND AT LEAST 3 MONTHS PRIOR TO FALL PLANTINGS to help young trees survive and grow in several ways by:

- Increasing soil moisture needed for firm compaction, thereby reducing the risk of air pockets drying out and killing tree roots;
- Reducing present and future weed and grass competition, resulting in extra soil moisture, nutrients and sunlight for trees;
- Conditioning and mellowing the soil, making it easier to plant trees by machine and/or hand;
- Improving the effectiveness of follow-up weed and grass control practices; and
- Enhancing rodent control measures which deter feeding damage on trees.

- A. Grass, Alfalfa, or Other Herbaceous Vegetation:** Aggressive dense sod-forming grasses, like smooth brome grass and reed canarygrass and alfalfa, can severely reduce the growth rate of trees and shrubs. Where these grasses or alfalfa are present, they should be eliminated from the entire tree planting site, unless fabric mulch is being utilized or the sod is killed back from the tree row at least twice a year until the trees shade out the grass. Tall native warm season grasses like big bluestem, Indiangrass, and switchgrass will also adversely impact the growth rate of seedling trees and shrubs. The most appropriate method of site preparation from the following options should be used prior to planting trees.

1. Aggressive sod-forming grasses and alfalfa (The following methods may be used):

- a. Spray the entire site the season prior to tree planting with a non-selective herbicide according to label requirements and/or till (tillage/spraying must be adequate to kill vegetation).
 - (1) Seed a cover crop of sudan, sorghum, or millet if needed to control erosion. Small grain cover crops such as rye and wheat can also be used as a cover crop, but must be killed with a non-selective herbicide while in a vegetative state (prior to making a seed head) to avoid allelopathic effects from mature straw.
 - (2) Plant the trees into the cover crop residue the following spring (refer to Range Planting 550 for guidance on cover crops).
 - (3) Summer fallow one year or longer, if necessary, to kill the sod. Till in the spring before planting the trees. A fall-sown crop of oats may be used where needed to control soil erosion.

- (3) Mow a strip and remove residue prior to tree planting that is at least the same width as the fabric mulch for Option 2 of anchoring fabric mulch (mowing only applies to Option 2).

Figure 1. Strip Tillage on Native Sod



3. Sites with aggressive sod-forming grasses (i.e., brome grass, reed canary grass and alfalfa)
 - a. Where it is not possible to operate equipment to kill all vegetation on the entire site prior to planting, fabric mulch must be installed when planting on sites that contain aggressive sod forming grasses or alfalfa.
 - b. Kill sod by tilling, or spraying a strip with non-selective herbicide according to label requirements the season prior to tree planting. Sod must be killed that is at least 2 feet wider than the fabric mulch for Option 1 of anchoring fabric mulch and the same width as the fabric mulch for Option 2. Tillage and/or spraying must be adequate to kill vegetation.
 - c. Residue from sod killed by a non-selective herbicide shall be mowed and removed prior to tree planting when it interferes with the placement of fabric mulch.
- B. Row Crop and Small Grain Sites:** (Caution: **avoid** cropland sites with recent applications of herbicides that could be harmful to the selected trees or shrubs.)
 1. If the site is in row crop stubble, trees may be planted directly into crop stubble unless residue is too heavy or ridges need to be leveled to ensure successful tree planting. When residue is too heavy or ridges need to be leveled, till in the fall prior to planting the trees when possible. Deep chiseling prior to disking may be needed to break potential hard or plow pans. When tillage is necessary, a fall-sown crop of oats may be used where needed to control erosion.
 2. If the site is in soybean stubble, the trees may be planted in the spring without further preparation, unless ridges need to be leveled.
 3. If the site is in small grain stubble, the trees may be planted in the spring without further preparation. Grass plantings may need to be delayed due to allelopathic effects.
 4. On sandy soils, crop residue or a planted cover crop between the rows may be necessary to prevent wind erosion.
 - 5, On steep slopes, tillage operations shall be on the contour or with terraces where practical. Crop residue or a planted cover crop between the rows may be necessary to prevent excessive erosion and/or siltation.

Reference for Site Preparation:

Nickerson, Doak. February 2002. Site Preparation: Key to Successful Conservation Tree Planting in Western Nebraska. University of Nebraska NebGuide G1417. 4 p. Lincoln, NE. <http://www.ianrpubs.unl.edu/epublic/live/g1417/build/g1417.pdf>.

II. PLANTING STOCK

This guide is to be used as a reference when advising cooperators as to the size and quality of nursery stock desirable for use in tree plantings. Larger stock or containerized stock is also acceptable for use. Do not use undersized, poorly rooted, diseased or otherwise poor quality trees or shrubs in a planting.

A. Plant Size

1. Broadleaf species
 - a. Seedlings not less than 7/32 inch or more than 3/8 inch in caliper and 1 inch above the root collar are recommended.
 - b. Planting stock offered by most commercial nurseries that is 18 to 24-inches tall would meet this standard.
2. Coniferous species
 - a. Planting stock must have a good balance between top and root.
 - b. Seedlings shall be 2 to 3 years old (2-0 or 2-1 stock) and 5 to 12 inches tall. Seedlings shall be either transplants or bed root pruned. One year old eastern red cedar seedlings (1-0 stock) may be used when 2-0 stock is not available, if they are not less than 1/8 inch in caliper and 1 inch above the root collar.
3. Greenhouse container-grown seedlings that meet the size requirements above are adequate for field planting.

B. Seed Sources

1. All planting stock shall be purchased from nurseries that are known to be using locally adapted seed or cuttings of known origin.
2. Species that are not native to the site or similar sites, shall be from seedlings produced from seed collected from localities having climate, latitude, and altitude similar to the site, or from known seed sources that have been selected and tested in tree improvement programs for adaptability.
3. Planting stock must be certified disease and insect free (special caution shall be taken for out-of state seed stock).

C. Handling and Storage

1. Seedlings shall be kept in a dormant stage until planted. They shall be stored in a cool, moist environment (preferred temperature of 34-40 degrees Fahrenheit).
2. If regulated cool storage is not available, the plants may be "heeled in" by temporarily covering the roots with damp soil in a cool shaded area.
3. During all stages of handling and storage, the roots will be kept moist and cool. Do not plant seedlings showing signs of heat stress, dried out roots or mold.
4. Poor quality or damaged stock should be destroyed.

III. PLANTING DATES (bare root and containerized/potted plants)

- A. Plant only when the soils are free of frost.
- B. Use bare root plants only when they are in a dormant stage.
- C. Planting seasons:

1. **Spring** -Plant no later than the following for individual vegetative zones:

Vegetative Zone *	Conifer	Broadleafs
I	June 1	June 1
II	May 22	June 1
III and IV	May 15	May 22

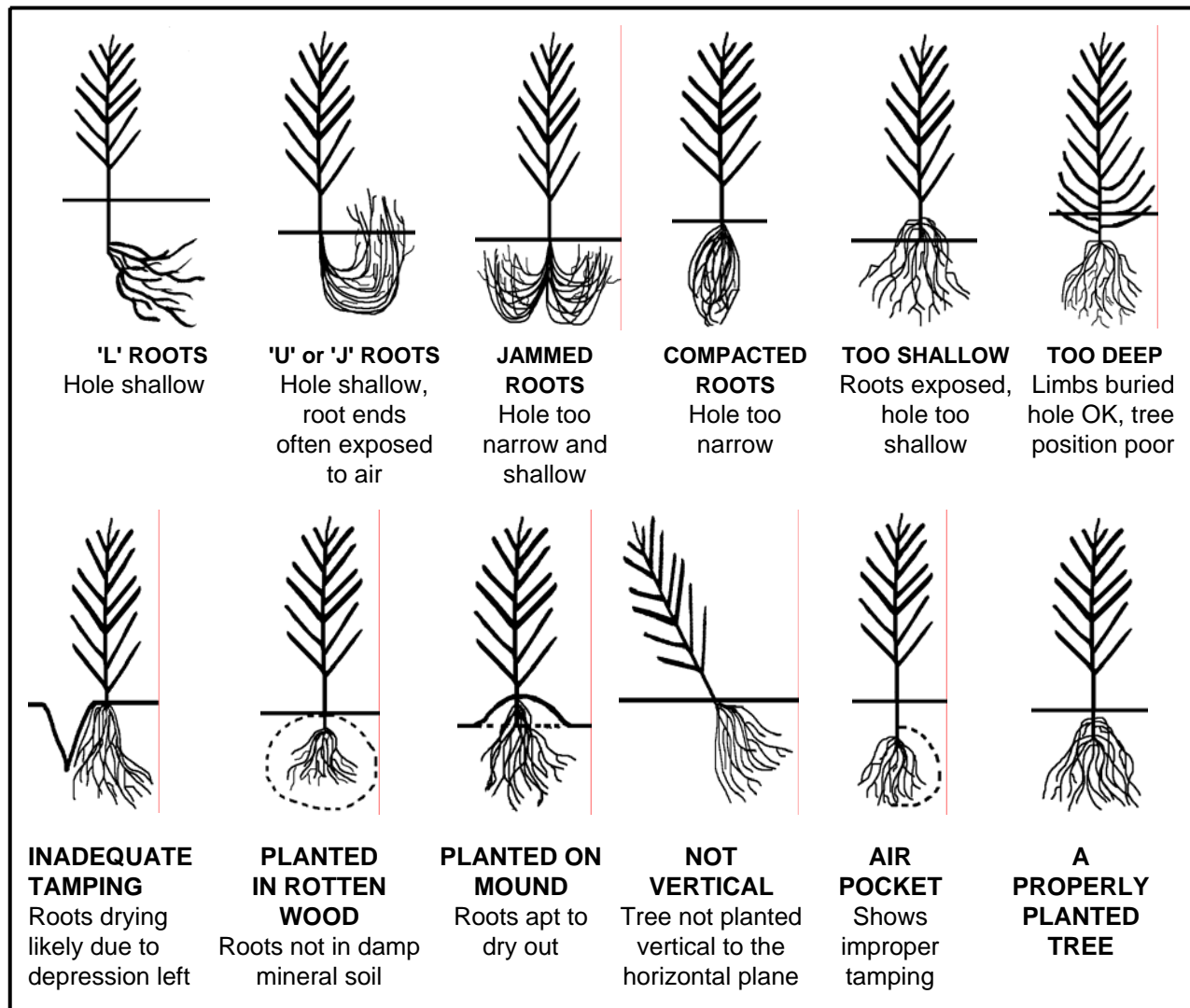
* Planting dates may be extended up to one week if weather and site conditions are adequate.

- 2. **Fall** – Planting Statewide:
 - a. From September 15 until the ground freezes.
 - b. Use only potted/containerized plants in the fall (no bare root).
 - c. Adequate soil moisture conditions or supplemental watering that thoroughly soaks the soil profile must be supplied.

IV. PLANTING OPERATION Planting conditions, seedling care, and proper planting methods are very important (Figure 2). The following guidelines should be followed:

- A. During the planting operation, **roots** of trees or shrubs must be **protected** from **drying out**. Have water on site to soak and keep roots wet. Plantings should not be done when weather conditions exceed 80 degrees F and/or wind speed exceeds 20 mph. When it is not possible to delay planting where weather conditions exceed 80 degrees or wind speed is greater than 20 mph, a root-dipping polymer should be used in addition to having water on-site to soak roots.
- B. Trees and shrubs should not be planted when the **temperature** is at or below freezing.
- C. Trees and shrubs should be planted in a vertical **position** with the root collars at or approximately one-inch below the soil surface (Figure 2).
- D. The trench or hole for planting must be **deep and wide** enough to permit the roots to be spread out as naturally as possible.
- E. Sufficient soil **compaction** is needed to assure good root-soil contact and to eliminate air pockets that allow the soil and roots to dry.

Figure 2. Various ways that trees should NOT be planted illustrated in drawings 1-11; the ideal planting is shown in drawing 12.



V. CONTROL OF COMPETITIVE VEGETATION AFTER PLANTING

Refer to the current Nebraska Cooperative Extension Guide for Weed Management in Nebraska and/or product labels when using herbicides:

<http://www.ianrpubs.unl.edu/epublic/live/ec130/build/ec130.pdf>.

Competitive vegetation shall be controlled for a **minimum of 3 years** and thereafter as needed to successfully establish the tree planting. Competitive vegetation includes competitive annual and perennial broadleaf and grass weeds, aggressive sod forming grasses, and alfalfa. Aggressive sod forming grasses, such as smooth brome grass, reed canarygrass, and alfalfa, need to be eliminated between the tree rows; or the operation and maintenance plan should provide for keeping competitive vegetation at least three feet outside the drip line of the trees or shrubs by mechanical, chemical, or physical control (refer to TPPG, Section I, Preparation of Planting Sites, for requirements on controlling perennial

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vegetation prior to planting). Erosion control must be addressed on erosive sites. Select the appropriate site conditions and alternative(s) from the following.

A. Non-Erosive Sites shall have competitive vegetation controlled by one or more of the following methods:

1. Between tree rows

- a. Clear cultivation with a spring tooth harrow, sweep chisel plow (duckfoot), disk (tandem disk only), shovel cultivator, or other tillage implement. Tillage depth would be 2 to 4 inches to avoid damage to tree roots.
- b. Plant an annual cover crop like grain sorghum or forage sorghum. Approximately 4 feet should be mowed or left between the cover crop and the tree row.
- c. In some cases, spraying herbicides on the entire tree planting area is necessary to control competitive vegetation. If this method is used, caution must be taken to avoid erosion and concentration of the herbicides from runoff or damage to trees from drift or overspray.
- d. Mow between the rows approximately once each month during the growing season.

2. Within tree rows (within 4 feet of the tree row)

- a. Hand hoeing.
- b. Tractor-mounted row hoes.
- c. Over-the-row cultivation with a flexible tine or finger-type weeder (when weeds are in less than the 3-leaf stage).
- d. Use an appropriate herbicide to control competitive vegetation in a 1.5 to 2 feet band adjacent to each side of the tree row or 3 to 4 feet diameter circle around each tree (refer to the current Nebraska Cooperative Extension, Guide for Weed Management in Nebraska, and/or product labels).
<http://www.ianrpubs.unl.edu/eublic/live/ec130/build/ec130.pdf>
- e. A rototiller or other small tillage device may be used.
- f. Install polypropylene fabric mulch in rolls or fabric squares according to requirements in TPPG, Section IX, and Fabric Mulch Installation.
- g. Utilize organic mulch consisting of clean corncobs, woodchips, or bark. Do not use hay or straw mulch; these materials harbor rodents that can girdle the trees. Refer to the Mulching Standard (484) for other requirements when installing these types of organic mulch.

B. Erosive sites with competitive vegetation should use one or more of the following control methods:

1. Between tree rows

- a. Plant an annual cover crop like grain sorghum, or forage sorghum. Approximately 4 feet should be left between the cover crop and the tree row.
- b. Use appropriate herbicides to minimize weed growth.
- c. Mow between the rows approximately once each month during the growing season.

2. Within tree rows

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- a. Hand hoeing
 - b. Tractor-mounted row hoes (avoid on steep erosive slopes)
 - c. Over-the-row cultivation with a flexible tine or finger- type weeder (when weeds are in less than the 3-leaf stage).
 - d. Use an appropriate herbicide to control competitive vegetation in a 1.5 to 2 feet band adjacent to each side of the tree row or a 3 to 4 feet diameter circle around each tree (refer to the current Nebraska Cooperative Extension “Guide for Weed Management in Nebraska” and/or product label).
<http://www.ianrpubs.unl.edu/epublic/live/ec130/build/ec130.pdf>
 - e. Rototill at least a 12 inch wide strip, 2 to 4 inches deep along each side and in the row approximately once each month during the growing season (avoid on steep erosive slopes).
 - f. Polypropylene fabric mulch in rolls or fabric squares installed according to TPPG, Section IX, Fabric Mulch Installation.
 - g. Organic mulch consisting of clean corncobs, woodchips, or bark. Do not use hay or straw mulch; these materials harbor rodents that can girdle the trees. Refer to the Mulching standard (484) for other requirements when installing these types of organic mulch.
- C. Erosive sites with non-competitive native grasses** should limit competition from grasses with one of the following methods:
1. Mow directly adjacent to the tree row at least 4 feet outside of the drip lines twice during the growing season.
 2. Hand hoe or weed around each tree.
 3. Rototill a 12 to 24 inch wide strip 2 to 3 inches deep along each side and in the row approximately once each month during the growing season.
 4. Use an appropriate herbicide to control competitive vegetation in a 1.5 to 2 feet band adjacent to each side of the tree row or 3 to 4 feet circle around each tree (refer to the current Nebraska Cooperative Extension Guide for Weed Management in Nebraska and/or product labels).
<http://www.ianrpubs.unl.edu/epublic/live/ec130/build/ec130.pdf>
 5. Polypropylene fabric mulch in rolls or fabric squares installed according to TPPG, Section IX, Fabric Mulch Installation.
 6. Organic mulch consisting of clean corncobs, woodchips, or bark. Do not use hay or straw mulch; these materials harbor rodents that can girdle the trees. Refer to the Mulching Standard (484) for other requirements when installing these types of organic mulch.

VI. VEGETATIVE COVER BETWEEN TREE/SHRUB ROWS - Low Maintenance Grass Seedings (refer to the current Nebraska Cooperative Extension Guide for Weed Management in Nebraska and/or product labels).
<http://www.ianrpubs.unl.edu/epublic/live/ec130/build/ec130.pdf>

A. Site selection (when permanent cover is needed):

1. Plant appropriate cover where a low- or mid-size cover is desired for aesthetic reasons.
2. Plant appropriate cover when erosion cannot be controlled with other methods and/or when the area between tree rows will not have tree canopy cover in the desired time frame.
3. Plant appropriate cover (including non-competitive forbs or legumes) where additional wildlife benefits are desired (Table 1).

B. Site preparation and planting:

1. Grasses/legumes such as smooth brome grass, reed canarygrass, and alfalfa must be eliminated prior to planting less competitive vegetative cover. Planting may be done directly into chemically killed sod or a clean tilled seedbed.
2. Plant directly into crop stubble or plant a cover crop, i.e., grain sorghum, sudan grass, millet, etc., between the tree rows the growing season prior to seeding grass. Refer to the Pasture and Hayland Planting (512) and/or Range Seeding (550) standards and specifications for the proper method of using a cover crop for seedbed preparation.

C. Species selection and seeding requirements:

1. Refer to Tables 2 and 3 for example mixtures and a list of potential grass species to be utilized for permanent vegetation cover plantings.
2. Species selected must be adapted for the site. Refer to FOTG Section II-Pastureland and Hayland Interpretations, "Certified Grass Varieties for Nebraska," for guidance on the appropriate species and grass varieties.
3. Seed at least 30 pure live seeds (PLS) per square foot of grass or grass/legume.
4. Plant mixtures of predominately native grasses directly into a cover crop residue or other properly prepared seedbed during the time period November 1 to May 31 (optimum - March 1 - May 15). Refer to Range Seeding (550) standard and specification for more guidance.
5. Plant mixtures of predominately cool season grasses into a properly prepared seedbed from August 1 to September 15 and November 15 to May 1. Refer to Pasture/Hayland Planting (512) standard for more guidance.

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TABLE 1. Examples of Permanent, Low Maintenance, Vegetation Cover Mixtures to Provide Good Wildlife Habitat (species must be adapted to the site)

Vegetative Zones	Cool or Warm Season	Species/Mixture	Percent of Mixture	PLS lbs/ac
I, II	Cool and Warm Season	Green needlegrass	30	2.2
		Sideoats grama	30	2.0
		Little bluestem	25	1.7
		Western yarrow	5	0.03
		Upright coneflower	5	0.10
		Purple prairieclover	5	0.24
II, III	Warm Season	Sideoats grama	35	2.4
		Little bluestem	35	1.8
		Blue grama	15	0.2
		Blackeyed Susan	5	0.05
		Upright coneflower	5	0.10
		White prairieclover	5	0.17
III, IV	Cool and Warm Season	Canada wildrye	20	2.3
		Prairie junegrass	15	0.1
		Sideoats grama	25	1.3
		Little bluestem	25	1.7
		Blackeyed Susan	5	0.05
		Grayhead coneflower	5	0.10
		Showy partridgepea	5	1.3

Note: The following introduced legume mixture can be substituted for native forbs listed in Vegetative Zones III and IV – Red clover 0.5 and White clover 0.2.

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TABLE 2. Examples of Permanent, Low Maintenance, Vegetation Cover Mixtures (species must be adapted to the site)

Vegetative Zones	Cool or Warm Season	Species/Mixture	Percent of Mixture	PLS lbs/ac
I, II, III, IV	Warm Season	Sideoats grama	100	6.8
I, II, III, IV	Warm Season	Sideoats grama	60	4.1
		Blue grama	40	0.6
I, II, III, IV	Warm Season	Sideoats grama	35	2.4
		Little bluestem	32	1.6
		Blue grama	32	0.5
I, II, III, IV	Warm Season	Sideoats grama	60	4.1
		Blue grama	30	0.5
		Buffalo grass	10	2.3
I, II, III, IV	Warm Season	Buffalograss	100	23.3
I, II, III, IV	Warm Season	Buffalograss	37	8.5
		Blue grama	63	1.0
I	Cool and Warm Season	Green needlegrass	27	2.0
		Sideoats grama	29	2.0
		Little bluestem	19	1.0
		Blue grama	25	0.4
IV	Cool Season	Orchardgrass	90	1.8
		Red clover	10	0.5

TABLE 3. Potential Species for Permanent, Low Maintenance, Vegetation Cover Mixtures (species must be adapted to the site)

Vegetative Zones	Potential Species
I, II, III	Prairie junegrass, Green needlegrass, Sideoats grama, Little bluestem, Buffalograss, Blue grama, Hairy grama and all other short native warm season grasses, and adapted native forbs and legumes
IV	Orchardgrass, Red clover, White clover, Canada Wildrye, Prairie junegrass, Sideoats grama, Little bluestem, Buffalograss, Blue grama, Hairy grama and all other short native warm season grasses, and adapted native forbs and legumes

D. Other alternatives to low maintenance grass seedings:

1. Tall to mid height native grasses (i.e. big bluestem, western wheatgrass, switchgrass, etc.) not listed in Table 3 and adapted to the site according to the Range Planting (550) or Pasture and Hayland Planting (512) standards can be utilized **only** if fabric mulch is installed. When tall native grasses are utilized, they shall be kept at least 4 feet away from the drip line of trees by annual mowing or other appropriate measures.
2. Annual cover crops, such as milo, millet, or sudangrass, may be planted each year as long as they are managed to avoid excessive damage from rodents, deer, etc. For guidance on planting requirements, refer to the Cover Crop Standard (340).

E. Operation and maintenance and management of vegetative cover between tree rows:

1. Weed control in tree/shrub rows or adjacent to individual tree/shrub plants can be done by spot or band spraying, mowing, cultivation or the application of fabric or wood chip mulch.
2. Short and mid-size grass mixtures will need to be mowed at least once a year at the appropriate time of the growing season if non-desirable species begin to invade. Sites planted to short grasses that are naturally tall grass prairies shall be mowed at least twice a year to keep non-desirable species from invading.
3. Mowing or shredding to enhance grass establishment is most effective for broadleaf weed control and is less effective on grassy weeds. Mowing or shredding height shall be above the height of the grass seedlings and start early enough that tree/shrub rows are still distinguishable. When residue is excessive it will be removed to avoid smothering grass seedlings. Mowing for broadleaf weed control is most effective when done prior to July 1.
4. When it is necessary to mow established native warm season grasses, it must cease six weeks prior to a killing frost on native warm season grasses to allow for adequate regrowth. Care should also be taken not to mow grasses too low. Mowing cool season grasses should occur no later than September 15. Note: Mowing should only be done when necessary and should be delayed until after July 15 to avoid detrimental effects on nests of upland game birds and grassland songbirds.
5. Read and follow all label directions before using herbicides to ensure that it is compatible with the tree/shrub planting. Refer to the "Guide for Weed Management-Trees and Shrubs, Including Shelterbelts" for herbicide application in the tree/shrub row or near individual plants. If the herbicide is not compatible with tree/shrub plantings do not apply it in the area where tree/shrubs will be planted, or directly on the leaf surface of existing trees/shrubs. Shields/covers may provide adequate protection to avoid herbicide contact with the leaf surface of existing trees/shrubs. Spot spraying a 2 to 4 feet diameter around newly planted trees/shrubs is normally sufficient.

VII. CARE AND MAINTENANCE

A. Replanting

1. Dead or damaged trees will be replaced by replanting as needed within 3 years after the planting, unless there is a major failure that would require planting the first and/or second year. Replanting must ensure the planned density or purpose of the tree planting practice can be achieved. Refer to Nebraska Forestry Technical Note No. 63, Guide for Evaluation of Survival for Conservation Tree and Shrub Plantings, for detailed replanting requirements.
2. Replanting will be made with the same species or a species with a similar habit of growth.

B. Protection

1. Livestock will be prevented from damaging the tree planting. Fencing should be used to exclude livestock if necessary.
2. Prevent fire hazards by keeping the area between rows and isolation strip (area on outside edges) cultivated or mowed. Crop residue, weeds, trash, or other materials that accumulate within the tree planting should be removed.
3. When excessive damage to young trees is expected from browsing rabbits, deer or other wild animals, the most appropriate measure to prevent this damage should be used.
 - a. Measures can include individual tree protection devices (tubes or other devices), animal repellents, and/or fencing.
 - b. Refer to Woodland Technical Note 51, Mammal Repellents, for detailed information on animal repellents.
 - c. Contact your local forester for guidelines on utilizing fence to prevent wildlife damage.
 - d. Tree protection devices should be at least 12 inches tall for conifers and at least 18 inches tall for deciduous trees. When used to protect deciduous trees solid tree protection devices shall be used to gain added benefits of improved survival and growth. When mesh is used it shall be small enough to keep rabbits out, and, if desired, mesh should be small enough to keep voles and mice out. Since most shrubs can resprout it is not as critical to utilize control devices to protect against browsing damage. Devices must to be securely staked to the ground to protect against damage from rodents and other animals and to keep the protection devices in place. Contact your local forester for more guidance in determining the most effective and practical tree protection device.
4. Mice, gophers, and other undesirable rodents can be controlled by the use of poison baits. Mouse baits should be placed in tin cans nailed to a board. Gopher baits are best placed with a machine of the "gopher-getter" type.
5. Keep trees/shrubs reasonably free of trash such as residue, weeds, or other materials that can harbor rodents. Do not use hay or straw mulch; these materials harbor rodents that can girdle the trees. If organic mulch is desired, clean corncobs, woodchips, or bark are recommended. Refer to the Mulching standard (484) for other requirements when installing these types of organic mulch. Fabric mulch installed according to Section IX Fabric Mulch Installation may also be utilized to control rodents.

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6. To prevent, detect, and treat for insects and diseases, trees should be examined monthly. Seek professional assistance for diagnosis and control measures.

C. Management

1. Management of tree plantings is oriented toward maintaining a dense and vigorous stand of trees/shrubs. The following practices help accomplish this goal:
 - a. Competitive vegetation, including annual weeds and perennial vegetation, will be controlled before and after planting (refer to TPPG, Section I, Preparation of Planting Sites, and Section V, Control of Competitive Vegetation After Planting). For maintenance of vegetation planted between tree rows refer to TPPG, Section VI, Pt. E, Operation and Maintenance and Management of Vegetative Cover between Tree Rows.
 - b. Prune to remove dead, dying, and broken branches.
 - c. Thin trees prior to maturity to prevent overcrowding and stagnation. Refer to Forest Stand Improvement Standard (666DP) to determine when and how much thinning is needed.
 - d. Old windbreaks that are ineffective should be renovated by removing diseased and dead trees, and filling in voids by replanting new trees/shrubs to maintain their planned density and effectiveness. Refer to Windbreak Renovation Standard (650) for guidance.
 - e. Root pruning may be needed to prevent crop yield reduction adjacent to windbreaks. Refer to Windbreak Renovation Standard (650).

D. Supplemental Watering

It is impractical to give a standard recommendation on watering rates or water requirements because of varied soil types and variations in weather conditions. The following general guidelines should be followed.

1. Soak the soil profile thoroughly to a depth of 3 to 5 feet for established trees and 2 to 3 feet for newly planted seedlings. Do not water again until the profile has dried for established trees and the upper 12 inches has dried for newly planted seedlings. Thorough watering at less frequent intervals is more desirable for root development than frequent, light watering.
2. Watering one or two times per week will probably be needed for newly planted trees. Two to five gallons of water per plant per watering should be applied to small trees and five to ten gallons for large established trees.
3. After the first year, it is desirable to decrease watering frequency and increase the amount of water applied per watering.
4. The first watering in the spring after the last frost and the last watering in the fall before the first frost are most important to maintain plant vigor.

VIII. DRIP WATERING SYSTEM

A. General Considerations

1. The inclusion of a drip watering system as a component part of a tree planting should be considered a temporary part of the planting. It will help insure survival of new plantings and provide supplemental water during periods of drought and promote faster growth for more protection and wildlife cover.

2. Drip watering is based on the concept that prevention of moisture stress (as opposed to correcting moisture stress) will be realized by maintaining favorable soil moisture conditions on only a portion of the root system. Water is applied at slow rates (1 to 2 gallons per hour) for a sufficient period of time to maintain part of the soil at or near field capacity.
3. The installation of a drip watering system is for establishment purposes and is normally limited to new plantings 3 years or less in age.
4. An adequate water supply shall be required before the system is installed.

B. Design and Installation

A drip system must be designed in accordance with the Irrigation Systems Micro-irrigation System Standard (441). The following factors shall be considered.

1. A drip watering system is designed to provide equal delivery of water from all emitters after considering pressure, friction or line loss, elevation changes, and any other factor that influence flow of water.
2. Minimum pressure must be provided at the critical point of the system. The critical point is the point in the system where the difference in elevation between the ground and the hydraulic gradient is the least. For systems requiring over 15 psi, pressure-compensating emitters will be used unless an even discharge rate can be obtained with non-compensating emitters.
3. The emitter shall be placed within 12 inches of the plant.
4. All pipelines shall be designed to permit draining to prevent freezing damage and permit flushing to remove foreign matter, such as algae, etc., which could clog the emitters.
5. A pressure regulator shall be installed when needed.
6. A filtration system shall be provided at the system inlet that meets manufacturer's requirements for the emitter being installed. The filtration system will not be less than a 100 mesh or its equivalent.
7. A pressure gauge is required in the line at the outlet end beyond the filter. A pressure gauge installed in front of the filter may be desirable, but it is not required.
8. An injector may be provided ahead of the filter so that chlorine can be injected into the system to prevent algae or organisms from plugging the emitters. Fertilizer can also be injected into the irrigation system through the device.
9. An automatic timer is desirable, but not required.
10. The header line should go to the high point or critical point, where practical, and the laterals attached to run downgrade.
11. During installation lateral lines shall be snaked (never stretched tight) not less than 1 foot per 100 feet or more than 5 feet per 100 feet to allow for contraction and expansion. Lateral lines should be extended approximately 5 feet past the last emitter in the row with end cap or flush valve to flush sediment.
12. Friction Loss Charts found in the National Engineering Handbook, Section 15, Irrigation, Chapter 7, Trickle Irrigation, may be used for design of main and lateral lines. Effects of multiple outlets (emitters) on friction loss shall be considered. Velocity in any lateral, manifold, or main shall not exceed 5 feet/second.
13. The basic layout and installation is as follows: From the main supply line or hydrant, an injector, filter, and pressure regulator (when needed) are installed. Following the

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filter, a pressure gauge is installed. From there the line is extended to the planting and continued across the rows as a header (sometimes called a sub-main or manifold). This line may be as small as 0.75 inches if it will carry the designed flow. Attached to the header line, 0.5 inches or larger black plastic laterals are snaked in the row with emitters placed within 12 inches of the plants. Lateral lines are extended at least 5 feet beyond the last plant and a flushing type end plug installed.

IX. FABRIC MULCH INSTALLATION

A. Material Requirements for Fabric Mulch

1. One layer of polypropylene fabric with polyester blend that has the appearance of tightly woven burlap on the soil surface (Figure 3, photo of Option 1 for anchoring fabric mulch).

Figure 3. Example of Option 1 for Anchoring Fabric Mulch



2. When Option 1 is used to anchor mulch and when scalp planting, the minimum width for continuous roll fabric mulch or individually placed fabric squares is 6 feet.
3. When Option 2 is used to anchor mulch the minimum width for continuous roll fabric mulch or individually placed fabric mat squares is 3 feet.
4. Fabric thickness is a minimum of 14 mils.
5. Fabric must be black and/or capable of preventing underlying plant growth.
6. Fabric must be treated with carbon black that provides not more than 70 percent breakdown by UV light after 2500 hours, which prevents breakdown for about 5 years.
7. Staples shall be at least 8 inches in length.

B. Requirements For 'X'-shaped Cuts in Fabric Mulch

1. When planting trees/shrubs after mulch anchoring, make an 'X'-shaped cut in the center of the barrier for access to the soil.
2. Keep the cut as small as possible to plant the tree/shrub and no longer than 12 inches.

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- a. When shading will occur prior to breakdown of fabric mulch, slots must be cut wide enough for mature trees to avoid girdling of trees/shrubs, or the client must agree to implement an operation and maintenance plan for making the slots wider after the third growing season.
- b. If slots are cut wide enough for a mature tree, put degradable stakes or staples in place to hold the flaps of the X-cut down and to limit weed growth next to the tree.

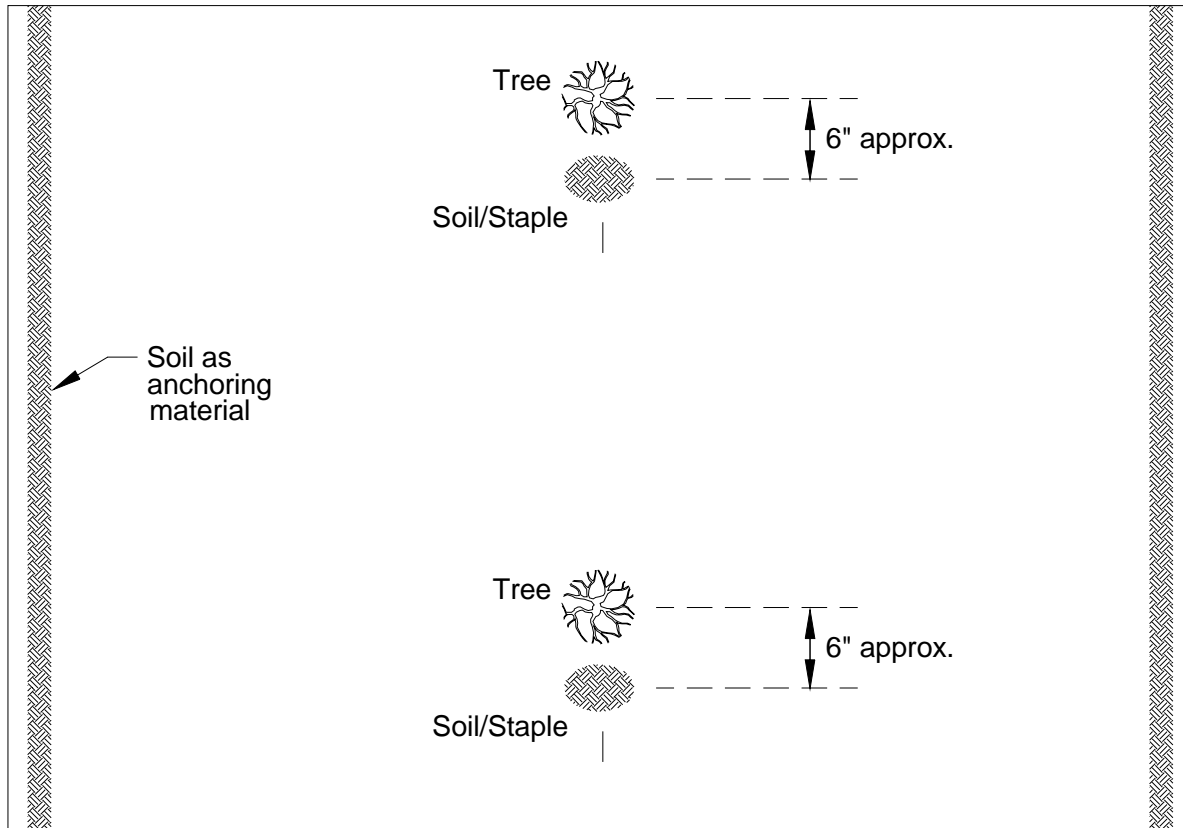
C. Installation Requirements for Fabric Mulch on Continuous Rolls by Machine Installation

1. Site preparation width shall be 2 feet wider than the fabric mulch for option 1 and the same width as the fabric mulch for option 2. Follow site preparation guidelines in TPPG, Section I, Preparation of Planting Sites.
2. On sites where non-aggressive vegetation is present (i.e., mid- and low-growing native grass sod and/or those species listed in TPPG, Section VI, Vegetative Cover between Tree/Shrub Rows), fabric mulch can be installed over existing vegetation. Vegetation should be mowed and removed first.
3. Fabric mulch installation shall occur **no later than 30 days** after trees are planted to insure adequate weed control and/or water conservation. For best results, the fabric should be installed right after the trees/shrubs are planted.
4. Fabric mulch will be centered over planted trees. During installation, an 'X'-shaped cut is made in the fabric (refer to requirements for X shaped cuts above); and the tree is pulled into an upright position through the fabric mulch. Seedlings shall be pulled out from under the fabric mulch as soon as possible to avoid heat-damage.
5. For renovation sites, 2 of 3 feet widths of continuous roll fabric mulch may be used. Cut and lay the material around the base of the trees/shrubs. Fabric mulch should be overlapped 6 inches in the center and anchored using manufacturer's staples. Staples should be placed within 6 to 12 inches of the base of each tree/shrub.
6. If fabric mulch overlaps due to row spacing, use manufacturer's staples (Option 2); otherwise, either option is acceptable.

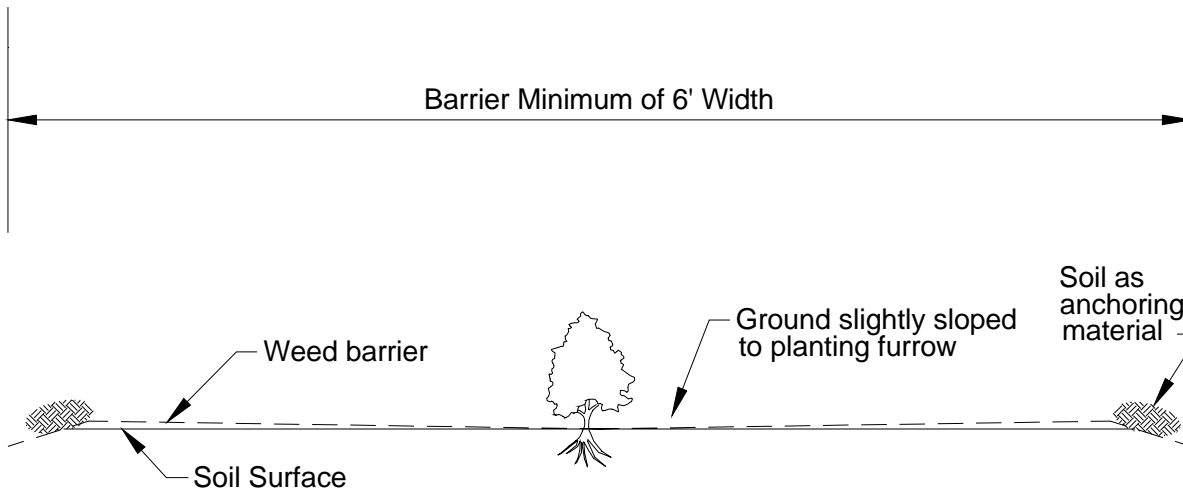
D. Anchoring Fabric Mulch (two options based on width of fabric)

1. Option 1 – Continuous roll fabric mulch or fabric squares that are at least 6 feet wide may be anchored by placing soil over the entire edge of the fabric. Placed soil is required to cover at least one foot of each edge of the material (squares will need all four edges covered). A shovel of soil or staple will be placed near the center of the fabric approximately 6 inches from each tree/shrub (Figures 3 and 4). Center stapling the fabric is preferred over using soil because soil washes away after time, soil covering the fabric impedes fabric deterioration, and soil use makes it more difficult to cut the fabric hole larger as needed as the tree grows.
2. Option 2 – Continuous roll fabric mulch or fabric squares that are at least 3 feet wide will be anchored by using staples. Staples will be placed along each edge and down the middle of the material. Maximum placement of the staples will be at three-foot intervals, or closer when specified by the manufacturer. A middle staple will alternate with the edge staples. The middle staple is not required on renovation sites where 2 of 3 feet wide rolls are used. When using fabric squares, each corner and the center will be anchored with staples and soil should be put along the middle of the edges between the staples to keep wind from lifting the squares off the staples.

Figure 4. Polypropylene Fabric Mulch (Option 1)



Top View



Side View

E. Special Planning Considerations When Installing Fabric Mulch

1. If installed, place drip systems on top of the fabric mulch for easier maintenance.

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2. Good site preparation (according guidelines found in TPPG, Section I, Preparation of Planting Sites) the year prior to installing mulch is essential to store moisture in the soil, especially on sod-bound sites (e.g., smooth brome) and during droughty conditions.
3. Mulch will repel water for 3-4 weeks due to chemical surfactant applied to the fabric during manufacturing. Installing mulch so runoff water will gravitate towards trees/shrubs in order to maximize moisture collection will reduce supplemental watering that may be needed.
4. For maximum moisture collection, it is best to have that portion of the fabric mulch near seedlings lower than the outer edges. When machine planting, this can be accomplished by deepening the planter furrow and pushing the fabric center into this depression by walking on it while pulling seedling tops through the X-shaped cut.
5. If the soil is very dry at planting time, watering may be done before fabric installation.
6. When using Option 1 to anchor fabric mulch on slopes greater than 5 percent, consideration should be given to placing staples in addition to soil anchor next to the base of each tree as an additional anchor.
7. Tree and shrub planting plans will specify site preparation requirements, tree/shrub rows where mulch is to be installed, total length and width of mulch required, and specific anchoring requirements.
8. On slopes greater than 10% and very long slopes allow for a 10-foot gap in the continuous roll fabric mulch and ensure water is diverted away from mulch, every time a new roll is started to reduce the risk of water washing the fabric away and causing erosion.
9. Plan to visit the windbreak site in years 3, 4, or 5 to cut the holes larger in order to avoid the trees being girdled as they grow larger than the original fabric openings.
10. Use of fabric mulch is generally not needed in the eastern half of the state to ensure windbreak survivability. Use of fabric mulch on suckering shrubs is not recommended as it impedes the ability of the shrub to grow properly. If cost is an issue use of fabric mulch on trees should be given priority to use on shrubs in the windbreak.

X. DIRECT TREE/SHRUB SEEDING (Does not apply to Windbreak/Shelterbelt Establishment (380) and Windbreak Renovation (650) or Critical Area Planting (342)).

A. Adapted Species

1. Tree and shrub species utilized for direct seeding methods must be suited to the site according to Field Office Tech Guide, Section II, Windbreak Interpretations (Tables 1-10 in Conservation Tree/Shrub Groups).
2. The following species are some that are well-suited for direct seeding methods:

Heavy Seeds

- Black walnut
- Oaks (preference on native species)
- Hickories (preference on native species)
- Pecan (eastern Nebraska only)
- Horsechestnut/Ohio buckeye
- Hazelnut
- American plum
- Chokecherry

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- Dogwood

Light Seeds

- Green ash
- Maple species
- Ponderosa pine

B. Rate of Seeding

1. Broadcasting - minimum of 8,000 heavy seeds per acre and a minimum of 30,000 light seeds per acre. Species such as oak, walnut, hickory, etc., have heavy seeds (nuts and acorns) and species such as ash, maple, pine, etc., have light seeds.
2. Machine and/or hand planting – Plant a minimum of 4,000 heavy seeds per acre (seed will be placed from 6 to 24 inches in the row and from 8 to 25 feet between rows, based on species, landowner objectives and maintenance equipment).

C. Seed Collection and Quality

1. Seed should be obtained from natural/well adapted stands within 120 miles of the planting location or from a reliable seed source that will ensure adaptability.
2. Germination is best for most species when the seed is collected and planted the same fall. Seed should not be allowed to completely dry. Black walnuts can be held over the winter (stratified) and planted in the spring. Silver maple and white oak species should be planted immediately after seeds mature and fall.

D. Preparation of Planting Sites

1. Prepare the planting site according to guidelines in TPPG, Section I, Preparation of Planting Sites. **Direct seeding sites should have little or no vegetation.** If aggressive sod-forming grasses, such as Smooth brome grass or alfalfa are present, all vegetation will need to be killed according to site preparation guidelines. Seeding directly into aggressive sod-forming grasses without killing them in advance greatly reduces the probability of a successful planting.
2. For light seeds, such as ash, maple and pine, eliminate vegetation and cultivate the ground to provide bare, exposed soil. If sod is present, kill the sod on the entire site prior to seeding according to guidelines in TPPG, Section I, Preparation of Planting Sites.
3. For heavy seeds, such as oak, hickory, pecan and walnut eliminate vegetation to allow seeds to be planted into the soil. If sod is present, kill the sod on the entire site prior to seeding according to guidelines in TPPG, Section I, Preparation of Planting Sites.
4. Sites facing north or east are generally better suited for direct seedings, while south or west facing sites, which are exposed to intense summer sunlight and winds, may be less suited to certain species.

E. Methods of Seeding

1. **Broadcasting** – Seeds are broadcast evenly over the planting area and covered with a disk or other similar implement. Bare soil is essential for light seeds (ash, maple, and pine). If light seeds are used with heavy seeds, spread the heavy seeds first, disk 2 to 4 inches deep, sow the light seed, and then disk 1 inch deep. Heavy seeds, like walnuts and acorns, need to be planted 2 to 4 inches in the soil. Broadcast seedings should be cultipacked to ensure a firm-planting seedbed.

2. **Machine planting (heavy seeds only)** – Plant in furrows twice as deep as the nut/acorn diameter. Plant mixtures of hardwood seeds in a furrow 2 to 4 inches deep. Plant mixtures of shrub seeds in a furrow 1-inch deep. Plant trees in rows that are no more than 25-feet apart to ensure adequate density; plant shrub rows no more than 10-feet apart.
3. **Hand planting (heavy seeds only)** – Place nuts/acorns twice as deep as the nut/acorn diameter (approximately 2-inches deep) and firm the soil over the hole.

G. Planting Dates

1. Seeds shall be planted in the fall.
2. Seed as soon as nuts are available in the fall and seed until the ground is frozen. Fall seeding will be more successful if squirrels and other rodents are controlled. Seeds should not be allowed to dry out.
3. Black walnuts can be held over the winter (stratified) and planted in the spring prior to May 1.
4. Most fall-planted seeds will begin to germinate and emerge about May 1 in most years.

H. Replanting

1. Reseed areas that fail to survive or grow for the first 2 years following seeding.
2. Refer to Nebraska Forestry Technical Note No. 63 for detailed replanting requirements.

I. Protection of Planted Seed and Seedlings

1. Rodents must be controlled to eliminate predation on planted seeds and seedlings. Deer may need to be deterred.
2. Livestock will be excluded from the planting area. Fencing may be necessary.
3. The planting will be protected from fire.
4. Consider placing animal control devices on the best 100 seedlings per acre after the first growing season to protect from being eaten by rabbits and/or deer.

J. Maintenance

1. Grass sod and other competitive vegetation that escaped control methods during site preparation will be controlled for a minimum of 3 years after the date of seeding. Refer to TPPG, Section V, and Control of Competitive Vegetation after Planting, for guidelines for controlling competitive vegetation after planting. Refer to current Nebraska Herbicide Guide for guidelines on herbicides that can be utilized.
2. Non-selective herbicides can be used to control weeds/grasses prior to seedling emergence (usually about May 1).
3. Shredding above the height of germinated tree/shrub seedlings may be utilized to allow sunlight to reach the seedlings.
4. Refer to TPPG, Section VII, Care and Maintenance, for detailed operation and maintenance guidelines.

K. Management

1. Refer to Tree and Shrub Pruning Standard (660) and Forest Stand Improvement Standard (666) for long-term guidance on forestry management.

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2. Contact your local forester for assistance in developing a long-range forestry management plan.

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Rasmussen, Steve, Scott J. Josiah, and Jon Wilson. August 2003. Establishing Conservation Plantings of Nut Trees and Shrubs by Direct Seeding Methods. University of Nebraska NebGuide G1512, 4 p. Lincoln, NE.

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