Using Tree Shelters to Establish Northern Red Oak and Other Hardwoods

Michigan State University Extension Service
Douglas O. Lantagne, Department of Forestry

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Introduction

The northern red oak is a valuable tree species in the forest of the eastern United States. It produces a wood that is in demand for construction of cabinets, furniture and household trim. Increased consumer demand over the past decade has resulted in harvest levels that are straining the ability of the forest to reproduce northern red oak. The lack of natural reproduction is often associated with the removal of scattered single trees in the forest stand, competition from other tree species, animal browsing and a reduction in the occurrence of fire in the forest(2).

In general, northern red oak does not grow well in the shade of other trees. If only the best oak stems in a forest stand are removed, the holes in the canopy are small. The amount of light that reaches the forest floor through these openings is often less than necessary to establish new oak seedlings. The light does, however, encourage the growth of other tree species, such as red maple (9). Harvesting larger numbers of oak stems in a woodlot does not lead directly to more oak regeneration. Research has found that oak seedlings must be present in a stand before harvest occurs. In general, 400 or more oak seedlings per acre over 4.5 feet in height are required for the successful regeneration of northern red oak (13).

An alternative to the natural regeneration of oak is planting (4). Planted oak seedlings often have 80 to 100 percent survival for two to three years after planting, but grow slowly. The combination of faster growing vegetation over-topping slow growing oak seedlings and the repeated browsing by deer and hare results in many planting failures. Similar situations lead to the failure of hardwood plantings of other species as well.

A possible solution is the use of individual plastic tree shelters or mini-greenhouses *(Figure 1)* (16). The placement of shelters on natural or planted seedlings can improve seedling survival and height growth. While appearing simple, tree shelters require considerable thought and planning by the landowner to ensure success.

Figure 1: Tree shelters used with northern red oak. Nets prevent bird entry.

What Are Tree Shelters?

Tree shelters (also sometimes called "Tuley tubes" after their inventor, Graham Tuley) are translucent plastic round or square tubes, 2 - 5 feet high, placed over individual tree seedlings (16). Tree shelters can be used on both planted and naturally occurring seedlings to provide protection from drying winds, stem breakage and animal browse, to increase survival, and often result in accelerated height growth. Each tree shelter can be looked at as a "mini-greenhouse," increasing the temperature and humidity of the growing environment within the shelter (12). The amount of growth response of trees in shelters varies with species (15). In general, tree species appear to reallocate growth from branches and stem diameter into the terminal leader so that height growth is accelerated. Therefore, tree species do not develop enough stem diameter to be self-supporting until after they grow out of the shelter. The protection from physical damage, such as animal browse, also can make trees appear to accelerate height growth. For all species, the response to tree shelters appears to be restricted to the time spent in the shelter.

Tree shelters were developed in 1979 in Great Britain to protect 80 planted sessile oak seedlings from deer browse damage (15). Dramatic height growth increases were noted in this initial experiment, and by 1984 it was estimated that over 1 million tree shelters of various types had been sold and used (10). Estimates of current annual tree shelter production are as high as 10 million worldwide.

The most common tree shelter colors are light blue, light brown and white. White tree shelters are the most conspicuous in the field and are therefore often avoided. Internal dimensions vary, ranging from approximately 3 to 4.5 inches in diameter for circular tree shelters. Square tree shelters have sides that are typically between 3 and 4 inches.

Do Shelters Work for All Tree Species?

The establishment of northern red oak with tree shelters is the main topic of this bulletin, but other tree species have shown some positive response to the use of tree shelters. The amount of information on the response of tree species other than northern red oak and black walnut, however, is limited.

Hardwood tree species typically respond favorably to tree shelters (15). However, the growth of sheltered northern red oak in the United States has not been as dramatic as that recorded for oak in Great Britain. Still, tree shelters in the United States provide an extra edge when establishing northern red oak and other species on exposed sites or where previous failures were due to animal browsing (8). In contrast to the hardwoods, few conifer species survive or grow well when placed in shelters.

Tree shelters have also been extensively used with black walnut by numerous growers in the last few years. Some growers have been satisfied with the results, but many questions also have been raised about the effectiveness of tree shelters on black walnut. Black walnut trees remain susceptible to frost damage in the warmer and more humid environment of the shelter as winter approaches. Die-back of the central stem from frost damage appears to be a major problem for black walnut in tree shelters.

Tree species that have shown positive growth responses to tree shelters in various trials include:

Northern Red Oak	White Oak
Shingle Oak	Bur Oak
Silver Maple	Sugar Maple
Sycamore	Beech *(some insect problems)*
White Ash	Basswood
Black Cherry	Black Walnut *(frost problems)*
American Chestnut	Hybrid Poplar
Northern white cedar	Eastern Red Cedar

Compiled from unpublished information and Tuley, G. 1984. Shelters Improve the Growth of Young Trees. Arboriculture Research Note 49:84. DOE Arboricultural Advisory and Information Service. Forestry Commission Research Station, Surrey England. 5p.

It is recommended that landowners use tree shelters on a trial basis before extensive use, regardless of the tree species planted. There are a number of general points that the landowner must consider before deciding to use tree shelters to establish oak or other species on their planting site.

How Are Tree Shelters Used?

Tree shelters are not the solution to all tree establishment problems. The use of vigorous planting stock, selection and preparation of a good quality planting site, and weed control have substantial impacts on the success or failure of tree planting. Tree shelters will not improve success if basic rules of tree planting are not followed. It should be remembered that the accelera-

tion of height growth occurs only when the seedling is within the tree shelter. Once the plant exits the tree shelter, height growth slows as branches form to create a crown. This is usually not a problem since by then the seedling is above the browse line.

Even under the best of conditions, however, a certain number of sheltered trees do not respond favorably. With northern red oak, experience has shown that upwards of 10 percent of seedlings do not grow any better inside tree shelters than if left unprotected.

Three Common Applications of Tree Shelters

Planted seedlings. High quality oak seedlings have responded the best in tree shelters. High quality northern red oak planting stock has root collar diameters above ⅜ inch, preferably above ½ inch *(Figure 2)* (4). In addition, oak seedling taproots should be undercut at the beginning of the first year in the nursery bed to encourage the development of side roots and finer roots that are important to the seedling's ability to survive and grow quickly after planting (14). Seedling densities in the nursery beds should be less than 12 per square foot to ensure good root collar diameter. In addition, some research suggests that clipping the top back to within 7 inches of ground level is beneficial to the seedling's growth response after planting (6).

Figure 2: Root collar diameters for planted oak seedlings should fall between ⅜ and ½ inch.

Buying oak planting stock of the type described is difficult in most states. Many nurseries do not grow and sell seedlings that meet these criteria. As the purchaser, it is more important that you buy a few high-quality seedlings than a large number of low-quality seedlings. More information on nurseries and tree planting can be found at your county extension office.

Natural seedlings. In some situations, natural regeneration of red oak may be present, but heavy browsing by rabbit and deer prevent its advancement to larger size classes. Tree shelters have been shown to be an excellent method of quickly moving these seedlings beyond the browse line. If natural oak seedlings have a basal diameter larger than ⅛ inch *(Figure 3)*, they can be clipped to within 1.5-inches of the ground to promote vigorous resprouting and then covered with a tree shelter (7). Height growth the first year can be expected to be nearly equivalent to tree shelter height.

Acorns. Tree shelters have been placed over planted acorns to protect them from rodents and to accelerate height growth of the seedling upon germination. At this time, results have been less than satisfactory in a number of trials. In cases where rodents do not find the planted acorns, germination has been spotty and height growth less than spectacular. If acorns planted at a spot do not germinate, the investment in time and materials are wasted for that location. In addition, the height growth of emerging seedlings has not compared favorably to the growth of planted northern red oak seedlings.

The use of pre-germinated acorns may reduce the problem of rodent loss, poor germination, and empty shelters, but it still does not solve the problem of slow height growth of emerging seedlings. Landowners interested in trying this approach should conduct small trials to evaluate their success before large scale planting of acorns is conducted.

Figure 3: The smallest oak seedling likely to respond to clipping and tree shelter protection in areas with heavy animal browsing is ⅛ inch.

Considerations in the Use of Tree Shelters

Type. Tree shelter manufacturers have their approaches to improving early tree shelter designs. Early problems included stem abrasion and breakage, large bulk that complicated shipping and handling, stake attachment mechanisms, and the size and type of stake (10).

Stem abrasion was solved by rounding or folding the top of each shelter to remove the abrasive edge and installing the shelters so that the top of the stake was below the top edge of the shelter. To partially solve the problem of handling bulky shelters in the field, one manufacturer nested three smaller diameter tree shelters into one. Another cuts their round tree shelter longitudinally and rolls it up for shipping. Other manufacturers use square tree shelters that can be shipped and handled flat. The selection of a tree shelter design

depends upon what works best for the site conditions and landowner.

Stake attachments are also an important consideration. Stakes should be easy to use, durable and removable. Initially, wire was used to hold the tree shelter to the stake. As tree shelters disintegrated, the wire loops remained, cutting unprotected stems and requiring removal. Today, the method of stake attachment has generally been solved by using plastic ratchet ties *(Figure 4)*, but there are differences between tree shelter systems that should be evaluated by the landowner.

In summary, there are different types of tree shelters, and new designs may yet be introduced. In all cases, be sure to read and evaluate each manufacturer's literature related to the questions raised above. Significant differences in survival and height growth between tree shelter designs or tree shelters of different diameters or colors generally have not been found (11). Cost and ease of use are the major differences between currently available tree shelter designs.

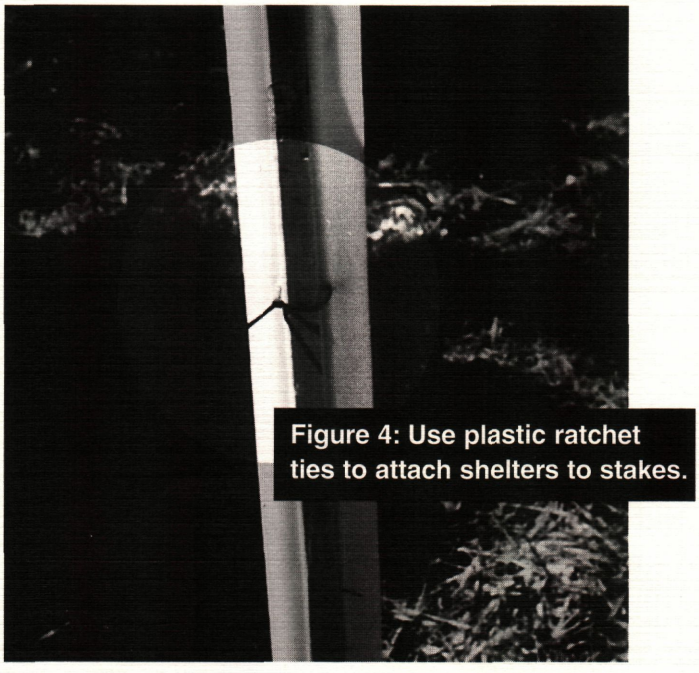

Figure 4: Use plastic ratchet ties to attach shelters to stakes.

Weed control. The need for weed control to improve survival and growth is not eliminated by tree shelters. Weeds also show accelerated height growth within tree shelters. Weeds within 18 to 24 inches of the planting spot must be controlled with mulches or herbicides before planting and placing of tree shelters over seedlings. This level of weed control should be maintained for at least two years after planting.

Weed control is often overlooked in a normal planting program. The lack of significant weed cover at the time of spring planting sometimes leads to the mistaken belief that weed control is not necessary on the site. Trees that receive weed control generally have high survival and grow more rapidly compared to those that are planted without weed control.

On old field sites, it is imperative that grasses be controlled up to 18 inches around seedlings. In harvested areas, herbaceous control may be important the first couple of years, but controlling competing woody brush is often of greater importance. Stump sprouts, especially within 3 to 5 feet of planted oak seedlings, should be controlled.

Other extension bulletins at your local county extension office offer more specific information on methods of mechanical and chemical weed control. Newly developed plastic and fabric mulches are an alternative for controlling herbaceous plants, but chemical sprays and/or cutting are the only alternatives for controlling woody brush.

Size. Tree shelters come in a variety of heights and diameters. The height depends upon the reason for using tree shelters. If animal browse is an important consideration, 2-foot tree shelters may be sufficient for rabbits, but 4- to 5-foot tree shelters are required for deer. The heavier the deer browsing pressure, the more important it is to use the taller tree shelters. For accelerating height growth, 4-foot tree shelters appear to be sufficient for tree establishment. The internal dimensions of the tree shelters currently on the market are not crucial to the success or failure of the seedlings.

Cost. Prices vary with manufacturer, size, and quantities of tree shelters purchased. Added to the cost of tree shelters is the additional cost of stakes and labor required for proper installation. In addition, tree shelters require a significant amount of maintenance that adds to their overall cost. Given these facts, it is best to use tree shelters only when necessary.

In quantities of 20 or more you can expect prices in the following ranges (1996 prices):

2-feet high	$1.20 to $2.65 each
4-feet high	$2.65 to $3.00 each
5-feet high	$2.90 to $3.25 each

Stakes. A variety of materials have been used to stake tree shelters. These include ⅜ inch rebar, ½ inch electri-

cal conduit, fiberglass T fence posts, untreated hardwood and treated softwood stakes. Permanent stakes (metal or treated) will have to be removed at some point to avoid problems later as trees grow larger. Metal stakes have the added problem of not holding tree shelters securely in areas exposed to wind. Untreated hardwood stakes are subject to premature failure due to rot and breakage. Ideally, stakes should last 4 to 5 years.

Stakes should penetrate the ground to a depth of at least 12 inches and extend upwards to at least 4 inches above the top tie on the tree shelter. Stakes should not extend above the top of the tree shelter. In exposed areas, it is beneficial to have the stake on the upwind side of the seedling. This minimizes the movement of the tree shelter and helps reduce the incidence of failure of the stake and stake attachment mechanism (11). Some tree shelter manufacturers sell stakes as well as tree shelters. Improper stake selection can result in a considerable increase in maintenance after installation.

Stake failure is one of the most consistent problems with tree shelters. When the stakes fail and tree shelters fall over, the seedlings within are bent and often broken. The size of the stake is important only from the standpoint that it needs to be sufficient to hold the tree shelter firmly for 4-5 years. Minimum stake dimensions are noted by each manufacturer. A new tree shelter on the market is cone shaped and does not need a stake. It is held in place with large staples pushed into the ground at the base of the cone. These tree shelters do appear to have the advantage of stability; however, there is little information available about growth response.

Maintenance. Regardless of how well the tree shelters are installed, tree shelters require a high level of maintenance. Deer, bear, and winds do an effective job of disturbing tree shelters. An area planted with tree shelters should be checked at least twice per year, spring and fall. If time permits, more frequent checking will help avoid tree loses due to fallen tree shelters. Timely removal of tree shelters is also part of the maintenance procedures.

Although suppliers recommend leaving tree shelters in place until they disintegrate, after seedlings emerge from the shelters the shelters only provide stem support. They no longer accelerate growth or protect the tree from browsing damage. Within a year of exiting the shelters, trees are normally self-supporting or can be tied to the stake and the shelter removed and used on newly planted seedlings.

The reuse of tree shelters helps reduce cost, since the majority of tree shelters can be used at least twice. This approach to tree shelter use also reduces the problem of unsightly plastic litter remaining in the established plantation. Tree shelter plastic does break down in response to ultraviolet radiation, but shelter plastic is not a truly biodegradable product.

Cautions in the Use of Tree Shelters

Diameter growth. Diameter growth of sheltered trees is usually not sufficient to support the seedlings if the shelter is removed too early after the seedling emerges. Trees need 1-2 years of support after emerging from the shelter before they become self-supporting. Plastic ribbon can be used to hold the seedling upright to the stake after tree shelter removal.

Pests. Tree shelters appear to be ideal places for mice, voles, and wasps. Although the wasps are harmless to the trees, their nests may fill the tubes, causing obvious problems for shoots trying to emerge. Mice and voles sometimes girdle the seedlings. Reported losses, however, have never been significant (1).

Birds. Some tree shelters have been found to act as bird traps, especially for bluebirds. Tree shelter manufacturers have different approaches to dealing with this problem. The number of birds killed when they enter the tree shelters and cannot escape can be significant. Please follow manufacturer's instructions for minimizing the loss of birds.

Frost damage. Within the protection of the tree shelter, some tree species do not respond to fall weather as quickly as unsheltered trees. As a result, early frosts can kill much of the current season's growth, canceling any benefit from the use of the tree shelters. The same problem can occur in the spring when the micro-environment in the tree shelter warms quickly, encouraging early bud break and growth. Late spring frosts damage this newly emerging growth. In either case, the tree is stressed and the growth advantage of the tree shelter is diminished or lost entirely. Black walnut appears to be the most susceptible, but northern red oak will sometimes show frost damage.

Dry, sandy sites. Experience in Michigan has shown that under the right conditions, the use of tree shelters can cause stress and result in the death of northern red oak seedlings. This mortality has occurred primarily on sites with deep sandy soils and extended summer dry

periods in central northern Lower Michigan. This problem may not be important in most areas; however, users should be aware that tree shelters may not work effectively under all conditions. Since long-term studies have not yet been completed on tree shelters under all growing conditions, it is important to conduct small trials when using tree shelters in new situations and with new species.

Conclusions

Tree shelters protect seedlings from animal browsing and accelerate height growth of some tree species. Tree shelters, however, are not an alternative to buying and properly planting high quality hardwood nursery stock. The use of tree shelters also does not reduce the need for good weed control on planting sites and does not make up for planting tree species on the wrong soil types. Consult your local county Extension office for more information on appropriate tree planting methods.

Sources of tree shelters

Tree shelters can be purchased from several sources in the United States. The suppliers often advertise in forestry journals and magazines as well as landowner-oriented publications. In some cases, county Extension offices or Soil and Water Conservation District offices may be able to provide you with information on local use of tree shelters.

The following list of suppliers may not be comprehensive, but are the ones currently known by the author. Current price information can be obtained by calling or writing these companies.

Ben Meadows Company
3589 Broad Street
Atlanta, GA 30341
800-241-6401

Blue-X
3120 High Street
Sacramento, CA 95815
916-922-9319

Forestry Suppliers
PO Box 8397
Jackson, MS 39284-8397
800-647-5368

Tree Essentials
Riverview Station
PO Box 7097
St. Paul, MN 55107
800-248-8239

Tree-Pro Tree Protectors
3180 W. 250N
West Lafayette, IN 47906
800-875-8071

Tree Sentry, Inc.
PO Box 607
Perrysburg, OH 43552
419-872-6950
Terra Tech

International Reforestation Suppliers
2100 W Broadway
PO Box 5547
Eugene, OR 97405
800-321-1037

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