Production and Establishment of Trees in the Great Plains: A Question and Answer Session

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Questions posed by members of the South Dakota Association of Conservation Districts are answered. Topics include tree species identification and physiology, as well as nursery seedling production, handling, and outplanting techniques for the Great Plains. Tree Planters' Notes 50(1): 5-8; 2003.

I was asked to review the tree planting programs of 2 South Dakota Conservation Districts. As a result of my visit and report to them, I gave a presentation at the annual convention of the South Dakota Association of Conservation Districts in Pierre, SD. My talk was based on questions submitted by the districts. Although the questions were specific to South Dakota, the answers were widely applicable. Where questions or answers overlapped, I consolidated them for *Tree Planters' Notes.*

Q: Can evergreens take up water through their leaves? A: Yes. This is how foliar feeding works and how sprayed-on herbicides get into plants. Because of the foliar structure and waxy coatings, conifers take up less water this way than do hardwoods. The amount of water that enters through the foliage is tiny compared to the needs of trees. Can trees do without roots? Absolutely not!

Q: How do you tell Rocky Mountain juniper *(Juniperus scopulorum* Sarg.) and eastern redcedar *(Juniperus virginiana L.)* apart?
A: Eastern redcedar and Rocky Mountain juniper are closely related and hybridize where their ranges meet in South Dakota and Nebraska, making them hard to distinguish. As seedlings, both species have sharp pointed juvenile leaves 0.18 to 0.25 in (4.8 to 6.4 mm) long that project from the branchlet almost perpendicularly. The foliage of the two overlaps in color, except in winter when eastern redcedar takes on a reddish purple color. The mature foliage of eastern redcedar is about 0.06 in (1.6 mm) long with rounded tips, and the branchlets are smooth to the touch. Mature foliage of Rocky Mountain juniper is about 0.12 in (3.2 mm) long, and the sharp tips diverge from the branchlet making it feel rough.

The cones are about 0.25 to 0.30 in (6.4 to 8.5 mm) in diameter and look like green (unripe) or blue (ripe) berries. Eastern redcedar cones ripen in 1 y, but Rocky Mountain juniper cones ripen in 2 y. If you see 2 age classes of cones, it is Rocky Mountain juniper. If there is only 1 age class, it is probably eastern redcedar. However, junipers are either male or female, but not both. This means that only half of the trees will ever have cones. Identifying trees in a shelterbelt is not as difficult as identifying individual trees because a few cone-bearing trees are almost certainly present, and all of the junipers in question are likely from the same seedlot.

Q: Are cottonless cottonwoods more susceptible to disease than cottonwoods with seeds?
A: No. Cottonwoods *(Populus deltoides* Bartr.) that produce no cotton are either males or sterile females, and this has no bearing on their disease resistance. However, new cottonless trees vegetatively propagated for distribution in the retail market have been selected based on high survival in test plantings, rapid growth, lack of dieback, and insect and disease resistance. So, I would expect the new cottonless cottonwoods to be more disease resistant than the average wild native would.

Q: How long a life span should we expect from cottonwoods?
A: On the Great Plains, life span depends primarily on the site on which they are planted. On a rich bottomland soil with a water table within 6 ft (2 m) of the surface, cottonwoods are very fast growing and reach a large size. Expect deterioration to begin over age 60, although they may live twice that long. On a typical upland site, cottonwoods are surprisingly drought resistant, but growth will be slower and the life span about half what it would be on an ideal site. Cottonwoods planted on saline sites perform poorly and may not survive the 1st year.

Q: Is it normal for hybrid poplar to lose its foliage in early August, while cottonwood still has full foliage?

A: It depends on why the hybrid poplar *(Populus deltoides* x P. sp.) loses its foliage. One possibility is based on genetically determined physiology. The response of trees to day length depends on the latitude of their origin, and trees from high latitudes tend to finish their summer growth and go dormant earlier than trees from lower latitudes. The parents of hybrid poplars come from many places and may be from farther north than the cottonwood. Alternatively, that particular hybrid

poplar may be less drought resistant than the cottonwood. Premature leaf drop is a common response to drought. Another possibility is that the hybrid poplar is susceptible to a leaf rust that the cottonwood is not. Late summer defoliation will reduce growth, but is usually not serious.

Q: How should we care for trees in the cooler at the district, prior to giving them to producers?
A: When the bareroot trees arrive from the Big Sioux Nursery (Watertown, SD; owned by the districts) in waxed boxes, open a sample of the boxes and check for proper moisture. The tops should be dry. The roots should be damp to the touch, but not sopping wet. If beginning to dry, water the roots with a mist nozzle, being careful not to get them too wet. Keep the amount of water applied to a minimum. There should not be any free water in the box. Do not try to humidify the whole cooler. Letting the humidity go down in the cooler greatly lessens the load on the refrigeration system, making it more reliable and cheaper to operate. Continue to check the seedlings twice a week after their arrival. If they are drying out in that length of time, check them more often. The boxes should retain the moisture. Keep the seedlings in their boxes and the boxes closed and in the cooler until the day they are to be planted.

When the seedlings are to be planted, thoroughly wet the roots or soak them for a few hours. Soaking overnight is acceptable, but no longer. The purpose of soaking the roots is to bring the seedlings to full hydration. Soaking for a few hours will be beneficial, but they will be fully hydrated in 12 h or less, so longer is not better. Furthermore, roots need to breathe, so it is important that the water not become anaerobic. Species differ greatly in their ability to tolerate low oxygen, so it is hard to say how long they can soak without damage.

When taken to the planting site, the roots should be wet, and the whole tree protected from direct sun and wind until planted.

Q: What is the best temperature for a tree storage cooler?
A: Most coolers work fine when set at 34 to 36 °F (1 to 2 °C). The Big Sioux Nursery stores trees over winter at about 26 °F (-3.3 °C), but by the time the districts get them in the spring, they should be thawed. After thawing, they should not be refrozen because this may cause injury. Temperatures in the cooler fluctuate as the evaporator cycles on and off, and the temperature will vary a bit in different parts of the cooler depending on airflow patterns. This means that some margin for error is needed so none of the seedlings freeze. At the other end of the range, air temperature should not rise above 40 °F (4.4 °C).

Q: How do you prevent mold from growing on the seedlings in the cooler?
A: The best way is by proper temperature and moisture control. Upon arrival, open and examine a sample of boxes to check on the condition of the seedlings. If there is any mold present, look at it carefully. Some molds are saprophytes growing on dead tissue on the surface and don't injure the seedlings. If the fungus has entered the seedlings, there will be rot present, and that is not good. If the seedlings still look adequate, get them outplanted as quickly as possible.

A little shingletoe (shavings from the manufacture of wooden shingles) in the box is helpful to keep the trees off the bottom of the box and to acidify the water present. Mold is inhibited by acid conditions. With the trees in the boxes, there is no reason to add moisture to the cooler. The lower humidity will enable the cooling system to maintain a more stable temperature so it can operate reliably closer to freezing. The lower and more stable the temperature, the less the likelihood of mold proliferation.

Q: Is a root dip beneficial?
A: Sometimes. There are mixed reports on whether or not a root dip is helpful, but it may give some margin for error when handling is not as good as it should be. While it can be used on any tree or shrub, many nurseries use it only as a preventive measure or at the insistence of their customers. If everything is done right in storing, handling, and planting, it should not be necessary. It is messy for the planters to handle. The trick is to keep it on the roots and off the tops.

Q: We plant in both clay and sandy soils. Is it better to use a root dip in the sandy soils to help maintain moisture?
A: Yes. You are much more likely to get a positive effect in sandy soils than in clay. There are 2 kinds of dip. One is kaolinite, which is a clay, and clay soils don't need more clay. The other is a polyacrylamide, which is very hydrophilic and forms a syrup or gel when dissolved in water. It helps the water adhere to the roots while the seedlings are being handled. Once in the ground, it helps retain moisture near the roots. However, this is beneficial only if the soil has a low moisture holding capacity. If the moisture holding capacity is already high, as in a clay soil, more moisture will mean less air, and the roots may suffer from lack of oxygen.

Q: Which is more detrimental to the tree: deep planting or shallow planting?

A: Shallow planting is generally more detrimental than deep planting. Ideally, the groundline after outplanting should be somewhat deeper than it was in the nursery, by how much depends on the size of the stock and the species. After planting, the groundline is likely to change. In most instances, it will be lowered by settling and washing of the loose soil, and that is why deep planting is beneficial. By "deep planting," I mean placement of the ground line 1 to 3 in (2.5 to 7.6 cm) below where it was in the nursery. Excessive burial of the root system is, of course, detrimental.

Species differences in optimum planting depth do exist. Many hardwoods can be planted several inches deeper than the original ground line. Spruce can be planted up to the lowermost live branches and will grow adventitious roots on the buried stem. Junipers can be planted with some of the lowermost branches buried. But pines native to the Dakotas should be planted no more than 1 in (2.5 cm) deeper than the original ground line.

General guidelines for all species would include the following. Do not leave any roots exposed. The exposed roots will die, leaving the tree with a smaller root system, less wind firmness, and less chance for survival. On the other hand, do not wad up the roots to fit the hole. Dig the hole to fit the roots. Prune only the occasional long root if necessary so the root system can be planted straight.

Q: Can dark fabric weed barrier cause heat stress injuries that jeopardize survival?
A: I expect it is no different than dark colored bare soil. Most heat stress injuries to seedlings occur on the stem at the ground line. There would have to be a substantial transfer of heat from the fabric to the stem to cause damage after fabric installation. However, when weed fabric is laid out over the tops of the seedlings on a sunny day, you have only a matter of minutes to cut the slits and pull the tops upright before they overheat.

Q: What are the pros and cons of 3- X 3-ft (1- X 1-m) tree mats versus the rolled fabric?
A: The 1st consideration is how big an area around the newly planted seedling needs to be weed free. West of the Missouri River, a 3- x 3-ft (1- X 1-m) patch should be big enough, but as you move east and the weeds get bigger, it may not be. On the other hand, the rolled fabric may be covering more ground than you need to cover, and the fabric is expensive.

The other consideration is logistics. A 500-ft (152-m) roll of fabric is heavy and almost has to be laid out by machine with a crew of 2 or more, although with the right equipment, it goes on rather quickly. Alternately, patches are installed by hand, which is slower and more labor intensive, but this can be done by 1 person with no special machinery.

Q: Is 1 fabric better than another?
A: There are 2 materials used. One is a fiberglass mat and the other is woven polypropylene. Fiberglass will probably last longer exposed to the weather, but polypropylene is probably cheaper and will last long enough for the trees to get above the weeds and shade them out.

Q: When wooden shingles are used for tree protection, on which sides of the tree should they be placed?
A: Shingles serve 2 purposes. They protect the seedling from intense sunlight to reduce the moisture stress until the roots can begin supplying adequate water, and they protect the stem at the ground line from overheating until the seedling can grow thicker bark. So, a shingle on the south side would be a good start. Two shingles on the southeast and southwest sides at right angles to each other with the open "V" facing north would provide even better shade. For more protection, I would use a plastic tube tree protector.

Q: How long should plastic tube tree protectors stay around the tree?
A: A protector should remain until the seedling grows above it. That may be a year for most hardwoods, but possibly several years for conifers. Conifers probably benefit more from tubes than most hardwoods for this reason.

Q: What is the difference in survival between fall-lifted and spring-lifted conifers?
A: My answer applies to climates with cold winters and not to the Deep South. For successful spring lifting, stock must still be dormant, that is, with no root or bud activity. Both fall- and spring-lifted stock can theoretically be in that proper physiological condition. The differences in survival often have to do with logistics at the nursery and whether achieving that condition is possible and practical.

In the fall, trees cannot be lifted until they have reached an adequate level of dormancy and cold hardiness; otherwise, they will not store well over winter. Then it is a race against time to get them lifted and into storage before the ground freezes. For long-term storage, trees need to be properly packaged to retain moisture and stored in a reliable cooler or freezer. Some species store better than others do over the winter.

In the spring, the nursery cannot begin lifting until the ground thaws. This is important to districts in milder climates than the nursery climate because they may be ready to plant before the nursery can begin

spring lifting. Once lifting begins, it is a race against time to lift everything before it loses dormancy and breaks bud. After budbreak, field survival can be expected to be poor. Some species, such as larch *(Larix* spp.), are very difficult to lift before budbreak. These are best fall-lifted or grown as container stock. Spring-lifted stock is stored only a matter of weeks and cannot be frozen. Districts in colder climates than the nursery climate must be concerned about planting delays that extend spring storage for durations that result in loss of stock quality.

Q: Can we plant in the fall? If so, what species should we try?
A: The time to plant is when the weather and soil conditions are favorable for establishment, and the stock is physiologically ready. In the northern Great Plains, the peak rainfall months are May and June, with lots of year-to-year variation. Because the soil is warming and the rains keep it moist, spring is a good time to plant so the trees become established and grow. Fall is normally drier and soil temperatures are falling. Fall planting needs to be done using stock with active roots but with buds that will not break until the following year. Planting must be early enough so that there will be at least a few weeks with soil temperature above 45 °F (7 °C) for roots to grow and gain access to soil moisture before winter. This is best attempted on wetter sites.

The species to fall plant is not nearly as important as the stock type. Bareroot stock needs to harden off in the fall before it can be lifted and transplanted successfully. By the time it is ready to lift, the fall planting season is about over. However, container stock that has been hardened in the late summer in a climate similar to where it will be planted is ready to plant whenever the soil moisture *is* adequate and there is still time to grow new roots before winter.

Q: Why is mortality higher for outplanted cedar *juniperus* spp.) and pine *(Pin us* spp.) than for outplanted hardwoods?
A: Conifers are more difficult to establish on the Great Plains than hardwoods because they have different strategies for survival. Outplanting produces drought stress until the roots grow into the soil and are able to deliver enough water to meet the needs of the plant. In response to this stress, hardwoods die back; they abandon what they cannot support in order to save the rest. After new roots are able to supply enough water again, they sprout and grow back. In addition, spring-planted hardwoods do not lose much moisture because they have no leaves when planted (or should not have).

Most of the conifers we plant are evergreens, and they do have foliage when outplanted. Conifer leaves lose less water than leaves of deciduous trees because of their structure and waxy coatings, but conifers do not sprout readily. Their strategy is to close the stomata tightly and try to avoid dying back. On the Great Plains, the hardwood strategy seems to work better.

Q: What causes eastern redcedar to turn brown and dead-looking shortly after planting; then, when rechecked in the fall, it is found to be green and lush? Is this some type of dormancy?
A: The color change is a response to drought stress and is the same color that redcedar develops in response to cold stress in the winter. After root growth reestablishes water supply to the leaves, they turn green again. The deep red-to-purple color is caused by an anthocyanin pigment that is formed from sugars when the leaves cannot export sugars as fast as they are accumulating. This occurs when the trees are under stress.

To determine whether the trees are dead or just under stress, look carefully at the branchlets. The branchlets of dead trees will be brittle and break off when flexed. They will be tan, rust colored, or light brown, but not red or purple. If cut in cross section and examined with a hand lens, dead branchlets will look dry, whereas live ones will be moist on the cut surface and flexible.

Q: Are fertilizer sticks beneficial for yard trees?
A: Generally, yes. As with any crop, it pays to know what the soil has and what it lacks, but homeowners rarely have their soil analyzed. For trees that are just being planted, it is better to dig the hole deeper than necessary and backfill to the bottom of the root ball with amended soil, rather than using fertilizer sticks. It is usually advantageous to amend the back fill with phosphate (because it is not mobile) and nitrogen (because it is usually low). However, the first thing a newly planted tree needs is water. It will grow roots down into the fertilized soil over time.

For established yard trees, fertilizer sticks may be a convenient way of applying a slow release fertilizer in such a way that it becomes more available to the tree and less so to weeds, grass, or other shallow rooted vegetation. Whether newly planted or established, irrigation water may not be too salty. There are many places in western South Dakota where the water may be drinkable, but it should not be used to water plants. If this is your situation, collect rainwater for supplemental irrigation of trees.

Note from the Editor: This is the first 'Ask the Experts' article. If your organization has questions it would like to ask an expert, please contact the USDA Forest Service Cooperative Forestry Programs Staff, national nursery specialists at < http:://www.rngr.fs.fed.us/contacts.html >.