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Tree Talk

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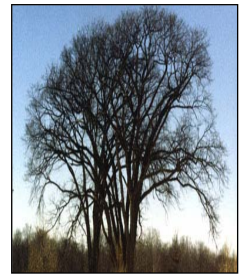

“A people without children would face a hopeless future; a country without trees is almost as hopeless ... ”
-- Theodore Roosevelt

The Wind in the Trees

By Joseph Zeleznik, Extension Forester

Trees in North Dakota are tough. Trees put up with brutal temperatures in summer and winter, droughts and floods and sometimes fire. And let’s not forget the wind …

When outsiders think of the Great Plains, they often picture a treeless prairie, scoured by constant winds. Admittedly, there’s quite a bit of truth in that stereotype. How do trees survive the constant onslaught? At what point do stressed and strained branches and stems structurally fail? This article looks at the structural mechanisms that allow trees to survive brutal winds and the limits of those systems when Mother Nature instantly turns 100 years of growth and history into a pile of firewood.

The weakest link

Three main features give a tree the ability to withstand the forces of wind – its roots, taper and flexibility. These vary from species to species and among individual trees within a species. In a forest setting, the trees often support each other, distributing the wind load across the group, minimizing the effects on any one tree. The weakest point in the root-stem-branch system is where structural failure will occur. This point can change depending on soil moisture, if the tree recently has been released from competition, and even may change with different wind directions. The two main types of types of wind-caused damage are windthrow (uprooting) and snapping.

Figure 1. The “root plate” – the cohesive unit of roots and soil together – at the base of this windthrown tree formed the weakest point in the root/stem/crown system of this tree. It fell during a recent windstorm that went through Langdon, N.D. Photo by Tom Berg, N.D. Forest Service.

Very rarely does a root system fail by itself. Instead, the roots and soil will hold together at the base of a tree, with breakage occurring further out where the roots are smaller. This cohesive unit of roots and soil is called the root plate (Figure 1). This type of wind-induced failure occurs more commonly in trees that are shallow rooted, for example where soils are compacted (Kozlowski et al. 1991). A tree that suffers this fate is said to be “windthrown.” Windthrow also is common when high winds occur after heavy rains have saturated the soil (Kozlowski et al. 1991, Harris et al. 2004). Roots are much stronger than soil and stretch more than soil does before they break (Kozlowski et al. 1991). If soil is frozen, however, trees are more likely to break rather than uproot (Peltola et al. 2000).

Windthrow also is interesting from an ecological standpoint. The soil of the root plate will slowly wash away from the wood and eventually the roots will decay (Figure 2). This situation creates the “pit and mound” microtopography commonly found in many forests. Trees and other plants may then germinate on the mounds, quickly filling in the newly-created canopy gap. Additionally, the large logs that lay on the forest floor are important habitat components for many species of wildlife. Hollow logs on the forest floor are used by ruffed grouse for “drumming” during the spring mating season.

Figure 2. The soil has washed away from this root plate, leaving only the roots which will take longer to decay. This tree was growing in a native forest in the Adirondack Mountains of New York on very shallow soils. Photo by Joe Zeleznik.

Stem taper is another characteristic that gives trees the ability to withstand the lateral forces of high winds. Taper is the gradual decrease in stem diameter, with increasing stem height. The more taper a tree stem has, the more resistant it is to windthrow. Trees that have large buttress roots also may be considered as being highly tapered (Figure 3).

Taper varies from species to species. For example, compare the taper of a native cottonwood tree with the minimal taper found in a columnar European aspen. The cottonwood can grow extremely large and needs the taper and buttresses to support its immense crown, while the aspen, with its narrow crown and relatively short stature, has little taper or buttresses.

Figure 3. Compare the large buttress roots in the native cottonwood tree on the left with the buttress-free, and minimally-tapered, columnar European aspen tree on the right. The cottonwood is much more windfirm than the aspen. Photos by Joe Zeleznik.

Exposure, however, has the largest influence on taper. Trees that are open-grown are more tapered than those that grow in the forest, surrounded by other trees. When a forest is thinned, the remaining trees are more susceptible to being snapped off in a storm until they develop more taper in their lower stems. For example, Myers (1963) studied the annual diameter growth along the entire length of the stems of ponderosa pine trees. Before thinning, the majority of new diameter growth was near the top of the tree, where there was the most movement. After thinning, the majority of stem diameter growth was in the bottom portion of the stem. Many other studies have shown that wind reduces height growth, while increasing diameter growth and, therefore, stem taper. Taper also is important for trees in urban environments. Newly-planted shade trees often are staked for one or two years after planting. Straps should be attached somewhat loosely, allowing the tree to gently sway in the wind. If the straps are attached tightly and the stem is not allowed to sway, no taper will develop and the weak stem will be prone to falling over or snapping off.

The third mechanism that helps trees deal with the wind is their flexibility. Even the strongest, stiffest oak tree must be able to sway with the wind. As one country song says, it must be "strong enough to bend." Flexibility of the tree components is greatest for individual leaves and gradually decreases to its minimum in the stem. The leaf blades of many tree species will roll up into cones like a windsock, which reduces wind resistance (Harris et al. 2004). The flexible branches also will move in the direction of the wind in a process called streamlining. This reduces the area of the crown and, therefore, drag on the crown as a whole. Rudnicki et al. (2004) showed that streamlining reduced the frontal area of lodgepole pine trees by 36 percent at a windspeed of 45 miles per hour. The reduction in frontal area was even higher for western redcedar and western hemlock. Most tree stems will move slightly with the wind, but not much.

How much is too much?

The maximum windspeed that trees can withstand depends on many things as outlined above. However, many scientists have attempted to define a precise value. Wind speeds as low as 34 miles per hour are sufficient to cause windthrow (Oliver and Mayhead 1974). Where trees are accustomed to prevailing winds from one direction, even gentle winds from the opposite direction may cause structural failure in the stems.

While analyzing trees after a storm is valuable, scientists cannot always afford to wait around for this situation to arise. Instead, often they rely on a winch and a big truck. These static tests are difficult to correlate with actual windspeed because they are focused more on static forces, including the force of the winch and the weight of the deflected tree crown, rather than on constantly changing wind. Nevertheless, some comparisons can be made. Actual critical wind speeds for uprooting trees are much lower than those predicted from tree-pulling studies. This is because the swaying of trees by strong winds loosens their roots from the soil (Kozlowski et al. 1991). Also, the effects of streamlining do not apply in static-force tests. Many authors use 58 miles per hour as a general rule-of-thumb, which is close to the critical wind speed for tree failure.

Sometimes trees will partially tip over, with several large roots pulled from the ground (Figure 4). Although the tree will lose a portion of its water-gathering capacity, it may survive and thrive for many years. Leaning trees form "reaction wood" in response to tipping. Reaction wood is formed on the lower side of leaning conifer stems, and the upper side of the stems of leaning deciduous trees. Boards cut from this wood have less strength than boards sawn from normal wood and may be subject to warping.

Figure 4. The large structural roots of this spruce tree were pulled from the soil and exposed many years ago when the tree tipped in a wind storm. However, the tree did not structurally fail completely and it is in good health today. This tree is at the NDSU Williston Research and Extension Center. Photo taken by Lorna Bradbury, NDSU.

Thigmomorphogenesis

Thigmomorphogenesis is a fancy term meaning growth and development in response to touch or constant mechanical stimulation. In this case, the stimulation is provided by the wind, but other sources include moving water or simple touch. As mentioned above, wind will cause trees to become more tapered as they grow, and it increases the amount of reaction wood, especially in trees that have been tipped.

When the wind is from the same direction and strong, a different growth response occurs. One-sided or "flagged" trees commonly are seen at high elevations where steady winds tend to kill developing buds on one side of the tree (Figure 5).

Only those buds that are on the lee (downwind side) of the tree survive and grow. Buds are killed either by drying out or by abrasion from ice and snow particles.

Figure 5. The one-sided growth of this "flag" tree is common at high elevations, where strong winds are steady from one direction. Buds on the windward side of the tree are killed by desiccation, or from blowing snow and ice. This is an Englemann spruce tree. Photo by Dave Powell, USDA Forest Service, www.forestryimages.org.

The cross section of flag trees is often elliptical. Most of the cambial (diameter) growth occurs on the lee side because (1) that side is directly below the branches, which provide energy for growth, and (2) that's where reaction wood forms to help support the tree. Sometimes, winds may be steady, but from two opposite directions. This may occur, for example, with trees next to buildings. Dr. Frank Telewski at Michigan State University is studying this phenomenon and believes that trees in this situation may have an hourglass-shaped cross section that somewhat resembles an I-beam. This shape is incredibly strong.

Managing for the wind

When storm systems are approaching an area, meteorologists can predict their tracks and determine where tornadoes and other major wind events most likely will hit. While we can't change the weather, there are many things we can do to increase the probability that a tree will survive if it does end up in the path of storm.

One of the most important things to be aware of in tree management is the condition of the root collar, which is the point where the stem tissue transitions into root tissue. Often, this spot is structurally weak because of decay or stem-girdling roots. In one Minnesota study, 73 percent of linden trees that completely failed in storms broke where the stem-girdling roots had compressed the stem. If stem-girdling roots are small, they can be removed with a pair of loppers causing relatively little damage to the tree. If larger roots are girdling the stem, whole tree removal may need to be considered. In such a case, tree failure is bound to happen sooner or later. Either the tree will die from insufficient water absorption when the large root is removed, or it will eventually fall over as the stem weakens where the girdling root is located. At this point, a professional arborist should be consulted to determine the best course of action. Stem-girdling roots are more common in trees that were planted too deep or those that had spiral roots forming in the container at the nursery. Correct these problems at planting to minimize the risk later on.

Rooting depth is largely a function of soil and site characteristics. Shallow rooting is encouraged by compacted soils and waterlogged soils. Decrease compaction by aerating the soil. Adding supplemental drainage is an option for sites that stay wet for long periods of time. If a site is overly compacted or wet, then planting a tree is not the best option.

Decayed areas are also structural weak points that must be considered in proper tree management. While some decay is acceptable in assessing hazard tree risk, large amounts are dangerous and will ultimately end in structural failure (Figure 6). More information on hazard tree analysis is available from the International Society of Arboriculture (ISA).

Figure 6. The downed lead of this elm tree failed during a wind storm that went through Fargo in September 2003. The stem was decayed at the point of the break. Fortunately, no one was injured during the incident. Photo by Joe Zeleznik.

Proper management of the tree crown to increase windfirmness is one area that is still being debated. Many people believe that trees with large crowns are the most susceptible to wind damage because they have the largest "sail area" (Smith et al. 1997). There is some evidence to support this. For example, Duryea et al. (1996) found that live oak (*Quercus virginiana*) trees that were pruned had a greater probability of survival during hurricane Andrew, compared with those that were not pruned. Removing some branches from a tree crown certainly will allow more air movement through the crown. However, some researchers and practitioners are beginning to question whether thinning the crown reduces wind damage (Gilman 2002, Ball 2003). As Smith et al. (1997) point out, "These go hand in hand; the more foliage (sail area), the more strength (taper)." Rudnicki et al.'s study (2004) showed that pruning had little effect on drag per unit of branch mass.

Nevertheless, all of the authorities agree that removing large amounts of branches and foliage does more harm than good. Never remove more than a quarter of the live branches when thinning, and never top a tree. **Topping, for any reason, is the embodiment of improper tree care.** Branches that sprout after a tree has been topped are more likely to break in future storms than those that developed normally. More information about the terrible effects of topping is available from ISA.

Scratching the surface

Many studies have been done on the ability of trees to withstand wind and on the various components of windfirmness. Several different approaches have been taken, including ecological methods, computer modeling and especially mechanics/dynamics. Terms such as "tension," "skin friction" and "resistive turning moment" are common in the literature discussing the dynamics of wind forces. This article barely has scratched the surface of this interesting and highly technical specialty within the broader professions of forestry and arboriculture. More information can be found in the following references:

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Cottony Ash Psyllid in North Dakota

By Justin Knott, N.D. Dept. of Agriculture

A new nonnative insect has been found in North Dakota. Jeff Heintz, Assistant City Forester in Bismarck, first noticed the insect. It was identified by the North Dakota State University Entomology Department and the USDA Systematic Entomology Lab as the cottony ash psyllid *Psyllopsis discrepans* (Flor). The cottony ash psyllid also has been found in Dickinson, Fargo, Grand Forks, Hankinson and Minot. The insect is native to Central Europe and Scandinavia. Several specimens have been collected in North America, including Nova Scotia (1921), Michigan (1955) and Minnesota (1993), although little is known about these specimens. More recently, the aphid-like insect was reported causing damage to black and Manchurian ash trees in Edmonton and Calgary, Alberta, Canada in 2000.

Biology

The insect overwinters as eggs located in the crotch between twigs and buds. These eggs hatch about the time of bud break and feed on the expanding leaves. Nymphal feeding causes the leaves to curl.

The nymphs extrude a white substance, which lends the cottony portion to its common name. Adults are small, about 3 millimeters long. It is yellow with black markings and the wings are clear with shading toward the tips (Figure 1A). These adults produce a second generation from eggs mainly laid on the midrib on top of the leaves (Figure 1B). The second generation of nymphs (Figure 1C) feed in the curled leaves, which were created by the first generation nymphs, as well as along the midrib of the bottom of previously unaffected leaves. Adults of the second generation are expected to be present in early to mid-August. Entomologists in Calgary believe there are two generations per year in their climate. The timing of the life history seems to be a couple weeks earlier in Fargo and Bismarck compared with Calgary. This may allow enough time for a third generation in North Dakota.


A.


B.


C.

Figure 1. Cottony ash psyllid life stages:
A – Adult; **B** – Egg; **C** – Nymph.
All photos by Justin Knott,
N.D. Department of Agriculture.

Feeding

The cottony ash psyllid has piercing-sucking mouthparts. Feeding by the nymphs causes the leaves to curl and crumple (Figure 2). The nymphs and the cottony substance can be found enclosed within the curled leaves. Leaves which are severely distorted have a cauliflower appearance. Cottony ash psyllid feeds on black ash, *Fraxinus nigra*, Manchurian ash, *F. mandshurica*, and hybrids of these two species, such as 'Northern Treasure' and 'Northern Gem.' Cottony ash psyllid apparently does not feed on green or white ash.

A.

B.

C.

Figure 2. Symptoms of cottony ash psyllid infestation:
A – Leaves curled by cottony ash psyllid feeding. Photo by Dave Nelson, N.D. Dept. of Agriculture;
B – Cauliflowering appearance. Photo by Dave Nelson, N.D. Dept. of Agriculture;
C – Second generation nymph feeding along leaf midrib. Photo by Justin Knott, N.D. Dept. of Agriculture.

Management

The impact of the cottony ash psyllid in North Dakota remains to be seen. Entomologists in Calgary feel that the overall health of trees needs to be considered and believe that drought and cottony ash psyllid caused tree mortality in 2000. However, in recent years more rainfall allowed the trees to recover and cottony ash psyllid has had less of an impact. Interestingly, city foresters in St. Albert, a town near Edmonton, believe that the insect is having a more severe impact on trees. They believe that the insect can kill healthy trees within a year or two of heavy feeding.

There currently is little information available about control and management of this insect. Trees should be closely monitored and well taken care of. Watering during dry times will help the trees. City foresters in St. Albert, Canada have had success controlling the insect with acephate (Orthene®) applied as a foliar insecticide. Always read, follow and understand label directions if chemical control measures are pursued.

Diplodia tip blight – Managing the disease in a tree nursery

Roy Laframboise, Nursery Manager, and Michael Kangas, Forest Health Specialist, ND Forest Service

Introduction

Diplodia shoot blight (*Diplodia pinea*, formerly *Sphaeropsis sapinea*) is a fungal disease that has been confirmed in many ponderosa pine plantings throughout North Dakota. This disease is common in the Great Plains on ponderosa, Austrian and other pines planted outside of their natural range. In North Dakota, the disease usually is found in ponderosa pine.

Diplodia kills the tips of branches causing the needles to turn grayish brown (Figure 1). The needles remain on the branch, making the disease very visible. Many branch tips can be infected on a single tree, seriously reducing its health. The disease usually is not fatal, but it may be unsightly and it can predispose infected trees to other pests. Trees that have reached cone-producing age are the most commonly infected.

Figure 1. Ponderosa pine infected with *Diplodia pinea*. Photo by Michael Kangas, N.D. Forest Service.

Diplodia spores penetrate the current year's needles and second year cones under moist spring conditions. Upon penetration, the fungus rapidly destroys tissue resulting in stunted shoots and needles. Small black fruiting bodies emerge from the infected shoots, needles and cones. Spores are dispersed from these fruiting bodies during humid and rainy periods (Peterson and Johnson 1986). The fungus can infect nursery pine seedlings making *Diplodia* a serious pathogen threat in nursery pine production (Palmer et al. 1988).

Background and History

Windbreaks, wildlife plantings, living snow fences and other conservation plantings are important resources in North Dakota. It is estimated that rural conservation plantings encompass 1.5 million acres in the state. Ponderosa pine is a very popular species in tree plantings, particularly in western North Dakota.

The Towner State Nursery, operated by the North Dakota Forest Service, specializes in the production of conifers for conservation plantings. The nursery annually sells 1.2 million seedlings. Approximately 200,000 are ponderosa pine. The nursery started a program in 1983 to annually survey nursery windbreaks for potential insect and disease problems. The pathogen was first detected during a windbreak survey of the Towner State Nursery in 1984 (Walla 1984). *Diplodia* infection of pine windbreaks on the nursery remained low for many years, but has substantially intensified over the past five years as moist, humid conditions have favored shoot infections (Figure 2).

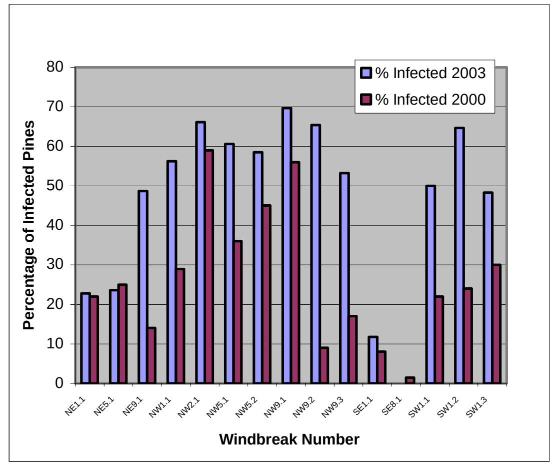

Figure 2. Incidence of *Diplodia* in Towner State Nursery windbreaks in 2000 and 2003. Adapted from Kangas, 2004.

Since shoot blight can infect nursery seedlings, this disease poses a threat to nursery production. Infected seedlings in other states have shown poor first year survival after planting. Infected seedlings can spread the disease across the state. The windbreaks located on the nursery provide the primary risk for seedling infection. When the nursery was established in 1935, many ponderosa pine windbreaks were planted because the species is well suited to the sandy soils.

Disease Management

The 200,000 ponderosa pine trees produced annually at Towner State Nursery are sold as three-year-old seedlings and transplants. If nursery stock becomes infected with *Diplodia*, it would have a serious effect on the supply of pine available for planting. In addition, the fungus may be spread throughout the region by infected nursery stock if the blight is not suppressed or eliminated within the nursery.

The Towner State Nursery has developed an integrated approach to *Diplodia* management. The plan focuses on efforts to minimize infection risks to nursery pine crops. The plan includes:

- Annual monitoring of the disease level in windbreaks by Michael Kangas, ND Forest Service, Forest Health Specialist.

The surveys determine infection levels of windbreak trees, prioritize windbreak removal, and identify areas of high potential inoculum levels within the nursery.

- Systematic removal of ponderosa pine windbreaks and replacement with non-host species. During the past three years, grants from the USDA Forest Service have been used to remove about half of the 19,000 linear feet of ponderosa pine windbreaks at the Towner Nursery.
- Preventive fungicide applications (active ingredient – thiophanate-methyl) are applied to ponderosa pine nursery crops during critical infection periods.
- All ponderosa pine nursery crops are planted in fields with minimum exposure to diseased windbreaks. This reduces the chance of seedlings coming in contact with disease spores.
- Nitrogen fertilizer applications are limited to one application a year to minimize succulent plant growth. Succulent plant tissue is susceptible to infection.
- Soil moisture levels are closely monitored and irrigation is applied as needed to avoid plant stress. Moisture stress encourages *Diplodia* development.
- Irrigation is applied in the morning to allow foliage to dry quickly. Moist foliage conditions favor infection.

In 2005, plant pathologists at the University of Wisconsin tested ponderosa pine crops from the Towner State Nursery to determine levels of latent infection. Of 240 seedlings that were sampled, only two tested positive for *Diplodia*. This is a very low level of infection for nurseries with *Diplodia* problems and indicates the management program is effective.

Conclusions

The success of the *Diplodia* Management Program at the nursery has reduced the potential for nursery stock losses and minimized the possible spread of the disease through tree planting. The management plan will be updated annually to address changes in windbreak infection levels and to implement new methods to reduce the risk of seedling infection.

The survey of nursery windbreaks will be done annually by the Forest Health Specialist. The intent of the surveys is to continue to identify potential problems and suggest ways to reduce nursery crop risks. *Diplodia* is a good example of a threat to nursery stock. Identifying it early has allowed the nursery to implement a management plan before the disease impacted nursery production. A similar strategy will be followed as other risks are identified.

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Common Honeylocust

By Brian Gaschk, Fargo Forestry Department

A somewhat underutilized tree in North Dakota urban forests is honeylocust (*Gleditsia triacanthos*). It is commonly available in nurseries as one of the many thornless honeylocust cultivars (*Gleditsia triacanthos* var. *inermis*). Honeylocust is a medium to large tree, often becoming 2 feet in diameter and 30 to 70 feet tall. In the wild, it can max out at six feet in diameter and 140 feet tall. It has a short bole and an open, narrow or spreading crown with a wide and deep root system. Being intolerant to shade, it occurs in the open or as a dominant tree in the forest in its native range. Its range extends from southeastern South Dakota east to the Appalachians and south into Texas.

Figure 1. Compound leaves of honeylocust tree. Photo by Bryan Gaschk.

Honeylocust is an alternately branched tree with pinnate or bipinnately compound leaves (Figure 1). In summer, the leaflets are glossy green and become a pleasant yellow most falls (Figure 2). The small leaflets produce a dappled shade that allows grass to grow well up to the trunk. Stems are shiny, smooth, reddish to greenish brown (Figure 3) with a sympodial habit (zigzag twigs with no true terminal bud). Bark, which on young trees is smooth grey, on older trees becomes grayish brown with long, narrow, scaly ridges separated by deep furrows. Polygamo-dioecious flowers (sometimes perfect, sometimes unisexual and dioecious) lead to production of a strap shaped reddish brown pod for a fruit.

Figure 2. Bright yellow fall coloration of honeylocust. Photo by Bryan Gaschk.

Honeylocust is a readily transplanted tree. At the Fargo Forestry Department, we often transplant it bare-root. It is relatively fast growing and adapts to most soil types, but does best on rich, moist bottomlands or soils of a limestone origin. It tolerates drought and high pH conditions and is very salt-tolerant as well. It often outperforms other tree species on tough downtown or parking lot sites. As noted earlier, it should be planted in full sun conditions.

Figure 3. Light, dappled shade, that is characteristic of the honeylocust crown, allows grass to grow well right up to the trunk. Bark on young trees is smooth grey, becoming grayish brown with long, narrow scaly ridges. Photo by Bryan Gaschk.

Figure 4. Honeylocust stem with Nectria canker. This canker can enter through fresh pruning wounds and eventually kill trees. Therefore, only prune trees during the dormant season, when the chance of infection is minimal. Photo by Bryan Gaschk.

Honeylocust has a myriad of minor insect and disease problems. There is one major problem that all who utilize this tree must take into account. *Thyronectria austro-americana*, commonly known as “Nectria” canker, is an aggressive canker that can kill branches or whole trees (Figure 4). For this reason, prune honeylocust only during the dormant season because any wound during the growing season may lead to this devastating disease. Also, select stock with wide angled branches because this canker may infest a tight, narrow angled crotch and lead to the death of one or both leads.

Many cultivars of honeylocust are available, but only a few can be recommended for North Dakota cities:
‘Imperial’ – Rounded crown and graceful, spreading branches

‘Skyline’ – Pyramidal form and ascending branches

‘Sunburst’ – Broad pyramidal crown and golden immature foliage

‘Northern Acclaim’ – Hardiest, with fast growth

If you want to increase the diversity of your urban forest, try some honeylocust in your next planting. You may be pleasantly surprised.

Small Talk – July, 2005

The latest in mulching technology and planting depth

A recent article in the Journal of Arboriculture (Arnold et al. 2005. J. Arbor. 31(4): 163-170) documented the negative effects of excessive mulch to tree survival and growth. The authors showed that as little as three inches of pine bark mulch applied at planting time reduced survival and growth of green ash trees, compared to trees that were maintained weed free by herbicides. Thicker mulch (six and nine inches) reduced growth even more. Results were more pronounced when trees were planted three inches below the existing soil grade.

Despite the results of the mulch-depth experiment, current recommendations for planting and post-planting maintenance still stand. Plant trees at grade, or slightly higher. Do not place the root collar of a tree below ground line. Chance of survival will be reduced and growth will decline. Keeping newly-transplanted trees free of weed competition is critical and although herbicides can be very effective in this task, they must be used very cautiously. A three inch layer of mulch can be nearly as effective as herbicides in improving tree survival and growth. Don’t apply a thicker layer of mulch, as this will definitely decrease diameter and height growth of the tree.

The poetry of forestry

A new collection of poetry about forestry, by foresters, is now available on the Society of American Foresters (SAF) website. This beautiful collection of poems, compiled by Bob Wheeler of the Alaskan Society of American Foresters, reflects the culture and heritage of American forestry as practiced over the past 60 years.

This is a wonderful publication to print and share with colleagues, future foresters, and anyone who is interested in the profession. To view the publication, visit the SAF website and click on Forest Scapes.