Fall Conifer Needle Loss

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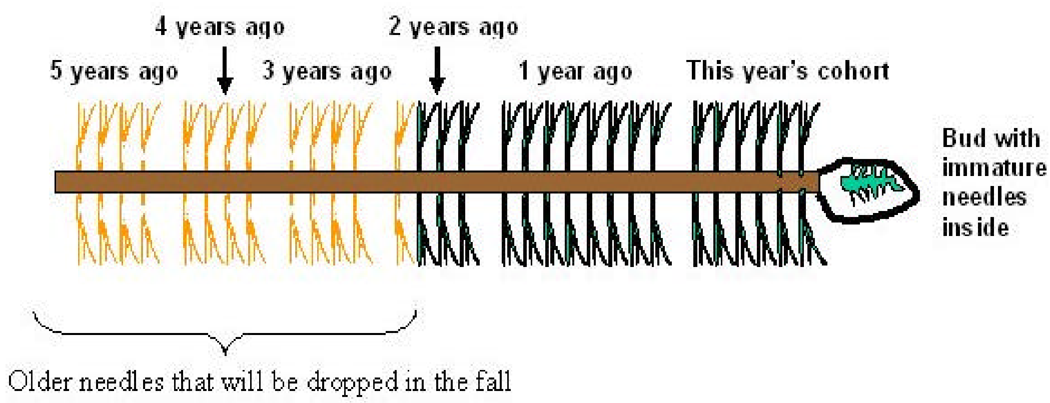
Every fall a lot of concern arises when conifers such as pines, spruces and firs start to drop their older needle cohorts in preparation for winter. This is essentially an energy conservation mechanism for surviving the winter as all living tissue on trees require stored sugars and water to survive during cold and dark periods.

Conifers, depending on species typically hold on to needles for 3 to 7 years. Pines up to 5 years with 3 years retention considered healthy and spruces and firs up to 7 years with 4 years considered healthy. As needles age, they typically become less efficient at photosynthesis due to excess wax buildup and shading from newer branch and needle formation. The wax formation increases needle resistance to water loss, an essential design component for surviving in low humidity and strong winds, but also restricts carbon dioxide flow into the needle. Similarly, conifer needles are designed to reflect excess sunlight and avoid overheating during hot summer months. Photosynthesis for northern hemisphere C_3 plants typically reaches its maximum capacity at 25% of full sunlight and 75º Fahrenheit during the summer solstice. Shade from the same branches reduces sunlight intensity by an average 90%. Needles designed to shed excess sunlight, therefore, only get approximately 3% full sunlight in the shade, not enough to make them positive producers for the tree. The final result is that trees shed their most inefficient needles in the fall.

(photo from Wes Gibbs, MSU County Agent, Judith Basin County)

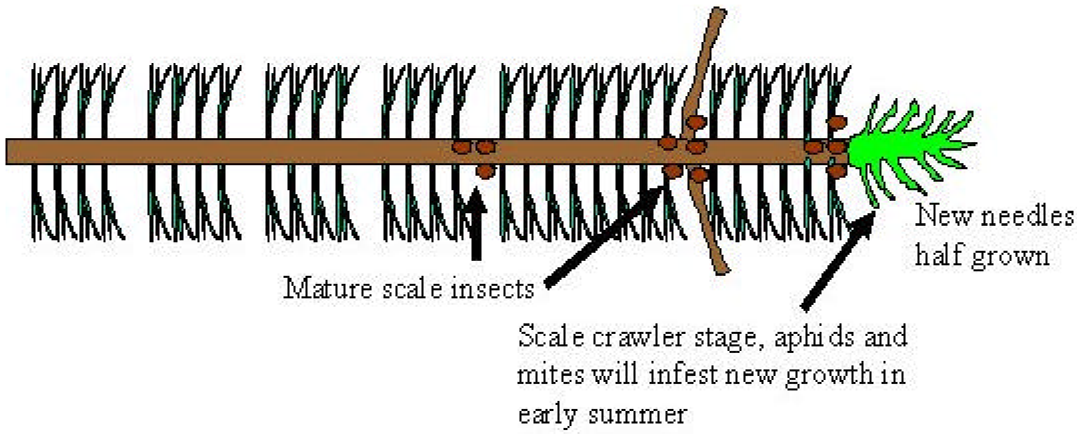
The number of years a tree holds onto its needles can also be an indicator of overall vigor. The more vigorous a tree, the longer it will hold onto marginally efficient needles. This also gives the tree a full or dense appearance. As a tree's energy budget becomes limited, due to drought causing low photosynthesis rates and hence energy production, insects feeding on the needles, or most common, sucking insects such as mites and aphids feeding directly on the trees sugar production, the tree will retain fewer of its less efficient needles. A tree that has been growing vigorously, and has retained 5 to 7 years worth of needles, may suddenly be infested by aphids, or become drought stressed. In response, the tree will suddenly drop 2-4 years worth of old needles, causing a great deal of alarm to the property owner.



What to Look For

Drought and insect damage often will coincide since most pests prefer to feed on stressed trees. The first step is to determine the reason for needle drop. Every years needle cohort is separated from the previous or past years cohort by a small gap in needle spacing, and sometimes lateral branching. For pines, spruces and firs this usually results in 8 to 16 inches of branch with needles. If the tree looks relatively dense there probably is nothing to worry about. If the tree looks thin, it is most likely losing too many needles and is stressed.

The next step is to look for evidence of insect feeding. Defoliating insects such as sawflies, spruce budworm of tussock moth will actually eat the needles. They prefer younger and softer needles thus needle loss will be from the tip of the branch leaving older needles intact. These pests are active in the spring and early summer and produce visible caterpillars that can be dealt with using conventional insecticides. Sucking insects such as aphids and scale insects, and mites, are harder to detect. Of the several species that infect Montana conifers, most are small enough to go unnoticed, even with a hand lens. Scale insects are in the crawler stage in early summer when they move to new twigs. There they fasten themselves to the stem, shed their legs and develop a hard reddish-brown covering that looks identical to a newly forming tree bud. They are almost always found on the twig intersections with lateral twigs and can be distinguished from real buds because they are relatively soft and can easily by squished with a fingernail, exuding insect guts rather than the woody green plant tissue. In the fall they are often dried up shells with eggs underneath that are easily dislodged. Each mature scale can produce thousands of crawlers. Other evidence of feeding by sucking insects are tiny white or yellow pinprick spots on the needles, the result of feeding by mites and aphids, or black sooty mold covering branches. The later is the result of mold colonizing the sugary honeydew that aphids excrete. During the summer ants commonly cover infested trees, eating honeydew and protecting aphids.



If insect damage in found, controlling these pests is an important part of restoring vigor to the trees. The best control of conifer needle pests can be gained by treating newly emerging needles in the spring and early summer. Insecticide or oil spraying spaced 2-4 weeks apart when new needles are half and fully developed has proven the most effective. Scale insects are more difficult to treat once they have dropped their legs and formed a protective shell.

Whether or not insect damage is found on the tree, poor needle retention is also most likely a result of drought. Again, drought stress and pest infestation often occur simultaneously. Trees that are drought stressed are forced to stop photosynthesizing during the summer and therefore start to starve. The first energy component that a tree loses is its ability to produce secondary defense chemicals. This results in it becoming and easy target for pests. The second component a tree loses is its older and less efficient needles. This leads to excessive fall needle drop or in severe cases, early needle drop in August. The third component is top dieback often followed by complete tree death.

Watering

Watering conifers that are located in windbreaks, shelterbelts and community settings during drought years is essential for maintaining their health and longevity. Consider that these species are growing in an environment where low humidity, wind, poor soils, and low precipitation have naturally excluded them. The only component that can be manipulated that allows trees to grow on these locations is their water supply.

Trees can only absorb water through their root system, which occupies a soil volume roughly equivalent to the individual tree's leaf area. The goal of watering, or any other cultural practices around trees such as cultivation and grass and weed control is to recharge the soil with water. Consider that a 10 foot tall spruce tree that is 7 feet in diameter at the base will have roughly 128 ft^2 of leaf area and a root system that occupies a soil volume 4 feet deep and 10 feet wide from the base of the tree, or 1257 ft^3 of soil. Each cubic foot of soil can hold approximately ½pint (sand) to ½gallon (clay-loam) of water for the tree to use when recharged, which equates to 78 - 628 gallons of water available to the entire root system. During the summer when the relative humidity is close to 20% that spruce tree can lose 20-30 gallons of water a day and depending on the soil, will have enough water to function for 4 – 30 days. Drought resistant trees can sense when water becomes less available and will start shutting down during the hottest part of the day to avoid water loss. Although this tactic stretches soil water reserves, prolonged drought often results in a total depletion of soil water around trees.

To recharge soil water, several factors regarding the soils need to be considered. Water infiltration rate, which determines how fast water can be absorbed into the soil, is among the most important. The table below shows the relative rates of water infiltration into different textured soils.

SOIL TYPE	INFILTRATION RATE (inches/hr)
Sands	> 1 inch per hour
Silts	1/3 to ¾inch per hour
Loams	1/8 to 1/3 inch per hour
Clays	1/20 to 1/8 inch per hour
Sodic clays	< 1/20 inch per hour

(from Introduction to Soil Physics, Daniel Hillel, 1982, Academic Press)

From this chart it becomes obvious that for all soil except sands, water needs to be applied to the soils around trees for long periods. In our previous spruce tree example, water would need to be continuously applied to a 20 foot diameter circle for 48 hours in sand, 64 – 160 hours for silt, 160 – 240 hours for loam, 240 – 960 hours for clay, and at least 960 hours (40 days!!!) for sodic clays to recharge soils to a 4 foot depth. Because normal soil infiltration rates are so slow, most water applied to the soil surface will evaporate or runoff to another location, unless drip irrigation systems are used. For emergency watering, a normal garden hose attached to a soaker hose or left on a trickle and applied for long periods of time (every night) are the most effective.

The issue of late summer and early fall watering and the effects on tree dormancy or cold hardiness also arise every year. From the above calculations it should be evident that it takes a very long time to adequately recharge soil water around trees. Soil water does not stay in one place as recharged soil will be drained by adjacent dry soil and used by other plants such as grasses. It is almost impossible to recharge soil water by artificial watering alone. Across central and eastern Montana it is therefore recommended to apply water to trees any time of year when the soil can absorb it, especially during drought. Trees adapted to grow in Montana's climate are not affected in their winter hardening process by water alone. They are affected by day-length, and fertilizer. The later case sometimes can make fall watering appear to cause dormancy problems, especially if the trees have not been watered all season long and are suffering from drought stress. Accumulated soil nitrogen will become more available when water is applied thus causing a flush of growth. This will not be a problem if watering has been occurring all season long. A caution must be applied to clay soils. Since infiltration rates are so slow it is possible to flood the soil surface causing an anaerobic situation to occur in the rooting zone. Since roots require oxygen to respire, it is possible to drown tree roots. In such circumstances, water should be applied in two day intervals, allowing for proper soil aeration to occur between water applications.