UTAH PESTS fact sheet

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Spruce Health in Utah Landscapes

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DO YOU KNOW?

- Spruces tend to prefer abundant moisture and may not do well on droughty sites.
- Water stress caused by too little soil moisture or too much heat can predispose spruces to insect attack.
- 80% of spruce trees submitted to the UPPDL are diagnosed with stress due to abiotic conditions such as drought stress and deep planting.
- Spruces are fairly shade tolerant.

BACKGROUND

Spruces are common trees in cultivated landscapes in Utah. They have varied shapes, attractive foliage color, and can be fairly long-lived. They have pests, but not overly so, and are not very messy. Overall, the spruce genus (*Picea*) is commonly planted because it is a good tree for many landscape situations. There also are many native spruces in our mountains, and some of these come under cultivation when someone builds a cabin or other development occurs.

Blue spruce (*Picea pungens* 'Glauca Procumbens')[1].

Blue spruce (*Picea pungens* 'Iseli Fastigiata')[1].

SPRUCES IN UTAH

Five species of spruce are commonly found in Utah, and are listed below in order of their commonality in the landscape. A few other species can be found but are very rare, examples include Brewer's spruce (*Picea breweriana*), black spruce (*Picea mariana*), and Oriental spruce (*Picea orientalis*)

Blue Spruce (***Picea pungens***)

Our most common planted spruce; highly desirable because of its silver-blue color and dense conical form. Also grows in Utah's mountains on wetter sites, though it is not as common as Engelmann spruce. This is Utah's official state tree. Crown form can vary from fairly open, to dense and conical, to shrubby. Many cultivars exist that tend to focus on

Common spruce trees left to right: Norway spruce (*Picea abies*)[2], white spruce (*PIcea glauca* 'Densata'), and Engelmann spruce (*Picea engelmannii*)[1].

form and blue color. Many blue spruces are not blue at all, but green. Many of those with pronounced blue color are grafted.

Norway Spruce (***Picea abies***)

The most common Norway spruce varieties are very large trees with a dark green color and broad, spreading branches with long branchlets that hang down a foot or two and sway in the breeze. Many cultivars exist though, and shrub or strongly weeping forms are common. Faster growing than most of the other spruces.

Engelmann Spruce (***Picea engelmannii***)

This is Utah's most common spruce, but it exists almost entirely as native trees in wildland locations. Nearly all of the spruces you see in Utah's mountains are Engelmann spruce. It gets quite large and can live for hundreds of years, but many of our large native spruces have been killed by spruce beetles in the last two decades. Engelmann spruce is rarely planted, but native trees end up in cultivated landscapes when urban encroachment happens in places like Park City. No cultivars exist.

White Spruce (***Picea glauca***)

This species is fairly rare in Utah landscapes except for a particular cultivar. Dwarf Alberta spruce (cultivar 'Conica') is the small conical spruce one often sees in Utah landscapes and it is still quite popular. Non-dwarf white spruce varieties get fairly tall; the tallest in Utah is on the USU campus and it is 75 feet tall. White spruce is fairly narrow-crowned for its height. Cultivar 'Densata', also called Blackhills spruce, is a fairly slow-growing narrow-conical tree that, as the name suggests, was originally collected in the Blackhills (now it is grafted). It is supposed to have greater drought and heat tolerance than sources from farther north. Needles are fairly short compared to blue, Norway, and Engelmann spruces and are curved inward.

Serbian Spruce (***Picea omorika***)

The rarest of the five Utah spruces described here, remarkable for its attractive needles that are dark green on top and almost white beneath and its narrow conical crown shape. They can be found growing in Utah and sometimes are available in nurseries, but are not common. Cultivars are available that have broader crowns, shrubby or weeping forms.

Left to right: White spruce (*Picea glauca* 'Conica'), and Serbian spruce (*Picea omorika* 'Nana')[1].

Common spruce trees top to bottom: whtie spruce (*Picea abies* 'Arocona'), whtie spruce (*Picea abies* 'Pumila'), and blue spruce (*Picea pungens* 'Mesa Verde')[1].

CULTURE AND LIMITATIONS

Spruces have intermediate shade tolerance, being more shade tolerant than pines but less-so than true firs. Unless they are pruned up they often will have live branches and foliage all the way to the ground, possibly because of their shade tolerance. They are not very drought tolerant, which causes potential problems when we plant them in hot dry valley sites, though it seems that water stress, rather than heat, is the problem. Spruces are very cold tolerant, usually being from high latitudes and high elevations. Their tolerance of high soil pH is very good, which is a big advantage in Utah. Iron chlorosis in spruces is fairly rare. Wind is not a problem except that spruce root systems can be especially shallow and thus windthrow can happen in storms, especially when root systems have been damaged or disturbed, or the soil becomes saturated with water.

Spruce growth is fairly slow; good terminal shoot growth of an established blue spruce on a good site won't be much more than 12 inches a year. Spruces can be over 100 feet tall, but prostrate forms exist that crawl along a few inches off the ground and dwarf varieties may get a foot high in 15 years. The largest known spruce in Utah is a native Engelmann spruce near Tony Grove Lake in Cache County that is 152 feet tall with a trunk diameter at breast height (4½ feet up) of over 5 feet. The largest known cultivated spruce in Utah is a Norway spruce in Logan that is 86 feet tall and about 3 feet in trunk diameter.

The best low elevation sites for spruces in Utah have good, deep soil and preferably have other large trees so they give mutual protection from hot dry wind and strong sunlight. Spruces are not suitable for most xeriscaping (low water landscaping) because they will experience water stress that can predispose them to insect attack. If you want to xeriscape and have spruces, zone your landscape so that the areas around spruces and other water-loving plants are moist, while other areas are drier. Spruces generally don't need to be fertilized and are fairly carefree except for the need to irrigate. Pruning needs are minimal unless you want to raise the crown by removing lower branches.

Spruce or Fir?

The tree group most commonly misidentified as spruce trees are the firs (*Abies* spp.). Both trees have needles arranged singly on the twig, but spruce needles are angular and are easily rolled between the thumb and middle finger. Fir needles are flat, and can't be easily rolled. Another major difference is the cones. Spruce cones hang down, while fir cones stick straight up, and fall apart later in the season.

INSECT AND MITE PESTS OF SPRUCE

There are many insects and mites that can affect the health of spruces in Utah. Most pests, however, are indicators of environmental stress such as over or under watering, soil compaction, competition with turf, root damage, etc. While the pest organism itself can be controlled, the underlying problems must be corrected to assure long-term tree health and minimize the need for continuous chemical applications.

In Utah, the three most common pests affecting spruce are Cooley's spruce gall adelgid (*Adelges cooleyi*), ips bark beetles (*Ips hunteri*; *Ips pilifrons*), and spruce spider mite (*Oligonychus ununguis*). While other pests can occur, they are less frequent. This section summarizes common spruce pests by group.

Adelgids and Aphids

The most common pest of spruce in Utah is the Cooley's spruce gall adelgid (*Adelges cooleyi*). Damage can be recognized by the presence of dry, pine cone-like galls found at the ends of branches. On spruce, this aphid-like insect overwinters as immature stages at the bases of needles. As temperatures warm, feeding begins and the immatures grow to adults and lay a white, cottony egg mass on the underside of the previous year's growth. Spruce bud break and adelgid egg hatch occur simultaneously. Hatchlings move to the expanding foliage and feed, creating a gall around themselves. The gall will remain green until mid summer when it begins to dry out and turn brown. The now mature adelgids in the gall emerge and fly to their secondary host, Douglas-fir, in late June - July. They will remain on that host until winged adults fly to spruce in the fall to lay eggs and start the life cycle over again. Other aphids commonly seen on spruce include the giant conifer aphids in the genus *Cinara*, and balsam twig aphid (*Mindarus abietinus*) on blue spruce.

New "green" galls created by Cooley's spruce gall adelgid can be seen in spring (top left) [3]; Cooley's spruce gall adelgid egg sac (top right) [4]; by fall, green galls dry out and take on a "pine cone" appearance (bottom left)[5].

Top kill of spruce by ips (left)[6]; spruce ips galleries under bark (top right)[7]; ips beetles compared to the size of a penny (middle right)[8], typical bark beetle larvae can be found in galleries beneath the bark (middle right insert)[9], bark beetle "pitched out" by defensive tree resin (botton middle)[10], reddish sawdust-like "frass" created by the burrowing action of bark beetles (bottom right)[11].

Bark Beetles:

If your tree is dying from the top down, bark beetles should be suspected. In Utah, two species of ips are responsible for most of the bark beetle-related spruce death--the spruce ips (*Ips hunteri*) and Engelmann spruce ips (*Ips pillifrons*). Both beetles overwinter under the bark of trees killed the previous fall as older larvae, pupae, and adults. When temperatures warm in the spring (above 50°F) their development under the tree bark begins. Ips beetles can emerge from their host trees when temperatures are consistently over 50°F, usually some time between April and June.

Signs of bark beetles include yellowing (fading) of the foliage (crown), brown to red sawdust-like material (frass) in bark crevices or at the base of the tree, and pitch tubes. Even trees with healthy looking foliage

should be inspected throughout the spring, summer, and fall months for the presence of frass and pitch tubes, as crown fading may not be obvious until after the beetles have left the tree and infested new ones. Staying ahead of the beetles is essential for control. If a tree is already dead, remove a section of bark and examine the patterns (galleries) on the underside of the bark. Ips galleries have one central chamber with three squiggly lines radiating outward from there (sometime more or less may be seen). Pictures of the galleries can be taken and submitted to the UPPDL for identification. Ips beetles can have up to three generations per year in Utah, depending on location (i.e., an extra generation in southern Utah). At higher elevations, spruce bark beetle (*Dendroctonus rufipennis*) can become a major pest of Engelmann spruce in Utah.

Mites:

Spruce spider mites (*Oligonychus ununguis*) overwinter as small red eggs on the bark of small branches; egg hatch occurs in March and April. Old foliage is targeted in spring and new foliage will be fed upon after it hardens in the summer. Mites most actively feed between 60-70°F. When temperatures are consistently over 80°F they become inactive; if temperatures exceed 90°F for an extended period, oversummer eggs may be laid that will hatch in the fall when conditions are favorable.

Mites feed by sucking the contents out of individual cells causing a yellow stippling pattern which can turn into brown foliage. Eventually you may see reduced tree vigor, and limb or tree death. Viewed with a 20x hand lens, tiny mites, their eggs, webbing, and small yellow feeding spots (stippling) can be seen. Damage is usually not noticed until summer when damaged needles begin to dry out. The presence of spider mites is often accompanied by a dirty appearance to the foliage/branches. This is due to dust, debris, and caste skins collected by the mites' webbing. Mite presence can be tested for by placing a sheet of white paper under an affected branch and tapping on the branch. If you see small dark dots moving on the paper they are likely mites. If uncertain, crush and smear the dots. Mites will produce a brown streak when smashed.

Woodborers:

Longhorned woodboring beetles can cause damage to spruce trees, but are usually secondary pests of environmentally stressed trees, or of trees that have already been attacked by another pest such as Ips bark beetles or mites.

Spruce spider mite adult (top left)[12]; spruce spider mite webbing and adults (top right)[13]; pine sawyer longhorned borer adult (middle left)[5]; white pine weevil adult (middle right)[14]; tip dieback on spruce from white pine weevil (bottom left)[3]; gregarious feeding of white pine weevil in spruce terminal (bottom right)[15].

The galleries of woodborers are easily identified under the bark as wide, frass-filled tunnels with no obvious pattern. Longhorn beetle larvae feed primarily deeper in the wood (xylem). Adult beetles emerge through holes which are circular to oval in shape. An active woodborer infestation can been diagnosed by the presence of white frass in bark crevices or at the base of the tree. This is in contrast to ips and bark beetle frass which is more brown or reddish in color. Woodboring beetles can be in flight throughout the summer; they have one generation every one to three years depending on the species. Insecticide applications made for ips bark beetles will offer protection against woodborers.

Weevils:

White pine weevil (*Pissodes strobi*) can be a pest of blue and Engelman spruce in the landscape, especially at higher elevations. Typical damage is observed in June or July on the terminal leader (the very top) of the tree as a dead, curling branch (shepherd's crook); side branches are infrequently attacked. Damage can give a tree an unaesthetic bushy appearance due to loss of terminal dominance.

Adults overwinter in leaf litter and sheltered areas, and emerge from March to May depending on temperatures. Adults locate a host tree and feed on the terminal leader causing small notches and oozing. Eggs are inserted into the feeding notches. Upon egg hatch, the larvae burrow under the bark of the leader, eventually girdling and killing it. Larvae burrow further into the stem and pupate. When the adults emerge they may feed on needles and buds causing minor damage, eventually moving down the tree to look for overwintering sites.

Scales:

The major hard or armored scale occurring on spruce in Utah is the white pine needle scale (*Chionaspis pinifoliae*); black pineleaf scale (*Nuclaspis californica*) rarely occurs on spruce. Pine needle scale overwinters primarily as eggs or egg-bearing females. Egg hatch into the crawler stage occurs between mid May to mid June, but could occur earlier in warmer southern counties (Washington). Once the crawlers have selected a location on the needles they will remain there for the rest of their lives, covered by the white, oystershell-shaped covering. Eggs will be laid under the scale in the fall, winter, or early spring. There is one generation per year. Chemical products containing the active ingredient (AI) "imidacloprid" should not be used to control hard scales. Instead, use the AI dinotefuran.

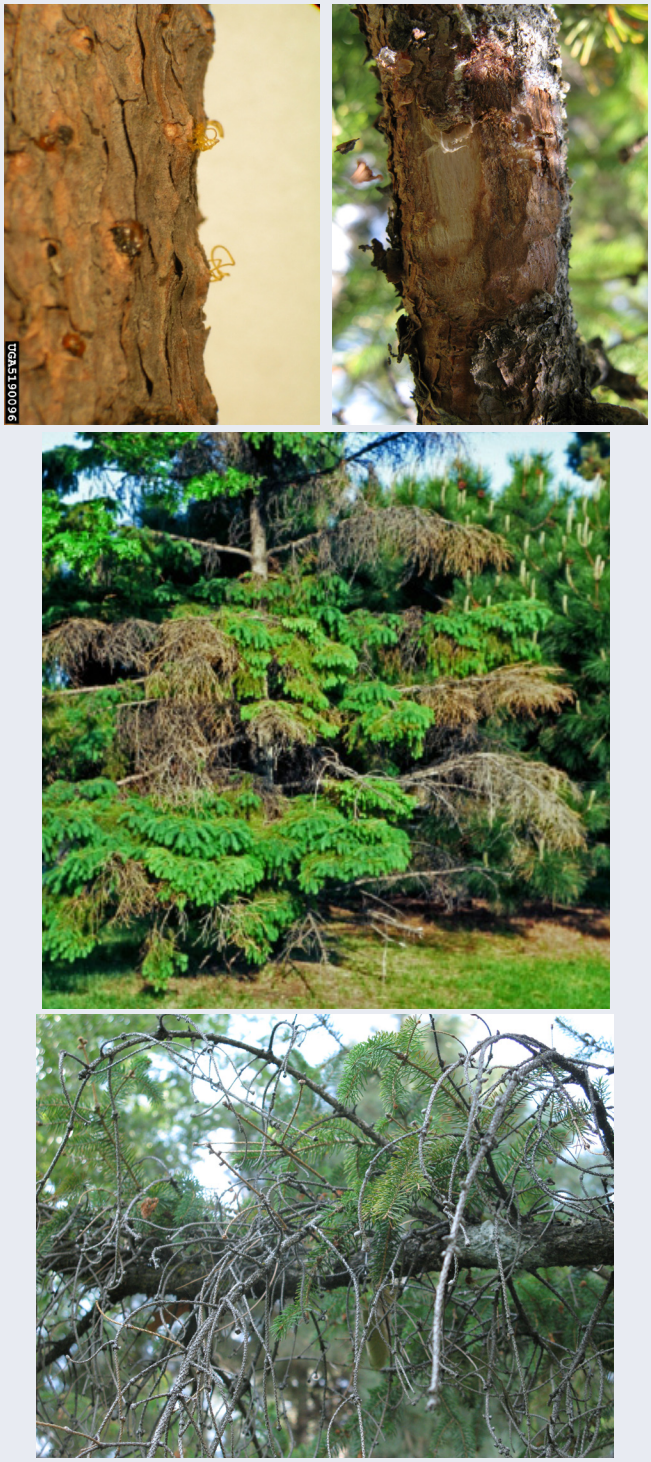
Spruce bud scale (*Physokermes piceae*) is the major soft scale affecting spruce in Utah. This reddish-brown globular scale feeds on the twigs of spruce, producing honeydew, which can lead to the formation of black sooty mold growing on the spruce foliage. The overwintering stage is an immature scale on spruce needles. When feeding resumes in spring, the immature scales return to the twigs to feed, where they will spend the rest of their lives. Adult females will lay eggs in June with egg hatch occurring in late June to mid July.

Pine needle scale (top left)[16]; spruce bud scale resembles actual buds and can be difficult to see (top right)[14]; pine needle scale on spruce (second row left)[5]; spruce budworm larva (second row right)[3]; wingless female tussock moth on egg sac (third row left)[17]; adult spruce budworm (bottom right)[3]; tussock moth larvae have long tufts of white hairs on the back and long black tufts on both ends (bottom right)[18].

Moths:

Larvae of the western spruce budworm (*Choristenoura occidentalis*) overwinter in silken retreats under bark scales and lichens. In late May into June the larvae emerge and mine old needles until the buds swell and then bore into the buds and feed on expanding needles. Entrance holes in the buds, webbing, and excrement around the buds are all indicators of their presence. Webbing can also be seen on new and older foliage as they feed. The newer needles, and possibly the older needles, will turn brown in July from feeding damage. Pupation occurs some time in mid to late July, and adult females lay small green eggs on the underside of needles in late July into August. There is one generation per year.

Douglas-fir tussock moth (*Orgyia pseudotsugata*) can be a major pest of spruce trees in the urban environment. They overwinter as egg masses on trees, which are laid on top of female pupal cases and are covered in hairs and a frothy substance from the wingless mother; up to 300 eggs can be laid in layers within the egg mass. Eggs hatch occurs from late May through early June coinciding with



Sporulating cytospora cankers (top left)[19]; discoloration of cambium tussue from cytospora canker (top right)[20]; branch dieback caused by cytospora canker (middle)[21]; cytsopora canker on branch (bottom)[20].

bud break and stem elongation. Newborn caterpillars move to feed on expanding foliage. Once new foliage is consumed, older foliage is fed upon. Feeding damage usually occurs on the top of the tree causing defoliation and/or top kill, and it may make trees more susceptible to bark beetle attack. Some hatchlings climb to the top of the tree where they wind disperse to new feeding sites on silken threads. Near mid July into August, full-grown larvae drop from the tree and disperse. Pupation may occur on the foliage, trunk, or on objects around trees. There is one generation per year.

Other:

Other, less frequently occurring insect pests of spruces in Utah include the bagworms, Douglas-fir pitch moth (*Synanthedon novaroensis*), webspinning sawfly (*Neurotoma fasciata*), spruce needleminer, and twig beetles (*Pityophthorus, Pityogenes*, etc.)

DISEASES

Few pathogens in Utah cause diseases on spruce. The main cause of dieback symptoms on spruce are abiotic, such as drought, poor site conditions, improper planting, and other environmental factors when spruces are planted outside their typical habitat type.

Leucostoma or Cytospora Canker:

This disease mainly occurs in the Midwest and eastern part of the United States on a variety of spruces and firs including blue, Norway, and Engelmann spruce. However, it can also occur in the western states. *Leucostoma kunzei* (or *Valsa kunzei*) (asexual state *Cytospora kunzei*) is a weak fungal pathogen that only attacks stressed trees. Stress can be due to drought, frost, or unsuitable planting sites. Blue spruce can be stressed when grown outside its native range where environmental conditions are poor, making it susceptible to the pathogen. This is especially true of spruces planted in Utah's valleys where it is hot and dry.

Leucostoma and *Cytospora* usually show up on trees 10 to15 years old and seldom occur on younger trees. *Leucostoma* generally does not kill the trees, but will kill individual branches, affecting the aesthetic value of the tree. In spring and summer, needles on individual branches will turn yellow and then brown after the branch has been girdled by a canker. During the winter the dead needles fall off leaving bare branches behind. Older branches of blue spruce are more susceptible to infection with *L. kunzei* than younger branches and the disease usually starts at the lower branches and moves up the tree in subsequent years. Sometimes infections start in the top of the tree, killing the top with the remaining tree staying green and healthy (Sinclair and Lyon, 2005). The killing of branches gives the tree an asymmetric, scruffy

look. The aesthetic value is also affected by resin oozing from diamond-shaped or elliptical perennial cankers or lesions that start at the base of twigs. The internal bark of the cankered area has a brown to reddish-brown discoloration. The sapwood below the bark is also killed, but will rarely be discolored. Resin oozes profusely from the margins of the canker, dripping onto branches and running down the bark. Oozing of resin is often the only indication of a canker as they are difficult to see for many years because the bark does not come off (Sinclair and Lyon, 2005).

Signs of the fungus are usually the tiny (1-2mm) cone-shaped pycnidial stromata of the *Cytospora* state from which yellow spore tendrils emerge under wet conditions. The fruiting bodies with spores are produced on the dead bark of cankers and outside of cankers. The spores are single-celled, sausage-shaped, and about 4-6 x 0.5-1 micrometers in size. Perithecia, the fruiting of the sexual state (*Leucostoma* state), can be found in the bark in the spring. The fruiting bodies are embedded in a fungal stroma and just their long necks will emerge from the stroma. The ascospores (sexual spores) are colorless, single celled and 5-8 x 1-2 µm in size.

Disease Cycle:

The fungus can be found on the bark of healthy trees but it needs wounds from insects, tools, wind or frost damage to initially infect the inner bark. Most infections are assumed to occur in the spring. The spores survive freezing in the winter and germinate at temperatures ranging from 68 F to 91 F. The spores are dispersed by splashing water onto neighboring branches, but have also been detected in air near trees.

Management:

The following management strategies are preventative and will reduce the chances of infection with *Leucostoma kunzei*. It is very important to avoid any kind of wounding on branches and stems that would allow the fungus to infect the tree. Control of insects such as spruce gall adelgids and spider mites reduces stress on the trees and reduces wounding. Stress can also be reduced by proper fertilization and irrigation of the tree during extended dry periods. Watering should be deep at least 18 to 24 inches. Once infection has occurred, infected branches should be removed. They will die and cannot be saved and removing infected branches removes inoculum that could otherwise lead to in new infections (Nameth et al. 1996).

Needle dieback with green tips, undiagnosed cause (top left)[7]; purpling of spruce needles from over or under watering (top right)[4]; herbicide damage (middle left)[4]; magnesium deficiency (middle right)[22], wind dessication (bottom left)[23],

Other:

Other, less frequently occurring spruce diseases in Utah include brown felt blight, yellow witches' broom or spruce broom rust, needle casts, and armillaria root rot.

ABIOTIC DISORDERS

Spruces, especially blue spruce, are trees that grow naturally in moist areas usually at high elevations. Planting spruces in low-elevation sites in Utah's valleys is common and problems frequently arise due to water stress. Water stress occurs when trees do not get enough water from underwatering or competition with turf or other plants. Even when spruces are well watered in valley locations, because humidity is so much lower and temperatures are so much higher than they are adapted to, water can leave the needles faster than it can be replaced from root uptake. About 80% of spruce samples submitted to the UPPDL are diagnosed with abiotic issues.

Common abiotic problems include improper planting depth (usually too deep), mounding mulch around the trunk, transplant shock, mechanical damage from lawn

Guide to Chemical Control of Utah Spruce Pests

Pest, Disease, Abiotic Condition	Chemical Application Directions	Pesticides: Active Ingredients*
Spruce bud scale (soft scale) Cooley's spruce gall adelgid Giant conifer aphids/aphids Balsam twig aphid	Apply a systemic insecticide (imidacloprid or dinotefuran) in fall or early spring to allow uptake. Or, monitor for scale crawler stages throughout spring and summer; apply foliar spray when scale crawlers are present on tree.	bifenthrin* (Bifen[H], Hi Yield Bug Blaster Bifenthrin 2.4 RTS[H], Talstar Select[R]); carbaryl (Sevin SL, Sevin Concentrate Bug Killer[H]; Carbaryl 4L); imidacloprid (Bayer Advanced 12-Month Tree and Shrub[H], Merit[H]); dinotefuran (Safari; Greenlight[H]); permethrin (Astro, Hi-Yield 38[H]); insecticidal soap** [H]; lambda-cyhalothrin (Spectracide Triazicide[H], Demand EZ) horticultural oil** (dormant and summer)[H]; acephate (Orthene[H], Tenkoz Acephate 97)
Pine needle scale (hard scale)	Apply systemic dinotefuran for easiest control; do ***not*** use imidacloprid for control of hard scales. All other foliar sprays must target the scale crawler stage. Monitoring is necessary. Oils can smother scales, crawlers and eggs.	dinotefuran (Safari; Greenlight[H]); bifenthrin (Bifen[H], Hi Yield Bug Blaster Bifenthrin 2.4 RTS[H], Talstar Select[R]); carbaryl (Sevin SL, Sevin Concentrate Bug Killer[H]; Carbaryl 4L); permethrin (Astro, Hi-Yield 38[H]); insecticidal soap**[H]; horticultural oil** (dormant and summer[H]); lambda-cyhalothrin (Spectracide Triazicide[H], Demand EZ); acephate (Orthene[H], Tenkoz Acephate 97)
Bark beetles (*Ips* and *Dendroctonus*) Woodborers (metallic and longhorn)	Spray trunk and main branches BEFORE beetle flight: Preventative.	bifenthrin (BaseLine, Onyx); carbaryl (Sevin SL, Sevin XLR [for use in non-urban forested areas]; permethrin (Astro, Hi-Yield 38[H])
White pine weevil	Chemical applications are targeted at exposed adults on terminals in spring (and fall); other life stages are spent protected inside the shoots. Use systemic insecticides in fall to allow adequate uptake of chemical.	imidacloprid (Bayer Advanced 12-Month Tree and Shrub[H], Merit[H]); bifenthrin (Bifen[H], Hi Yield Bug Blaster Bifenthrin 2.4 RTS[H], Talstar Select[R]); lambda-cyhalothrin (Spectracide Triazicide[H]); permethrin (Astro, Hi-Yield 38[H]); cyfluthrin (Tempo[H])
Spruce spider mite	Homeowner products limited. Spray mites when present (early spring or late fall). Hiring a licensed company is necessary if restricted-use products are needed, or if small quantities of product cannot be found for the homeowner.	insecticidal soap**[H]; horticultural oil**[H]; abamectin (Avid 0.15 EC, Qaulipro Abamectin 0.15 EC); bifenazate (Floramite SC Ornamental[H]); hexythiazox (Hexygon DF)
Tussock moth	Insecticides best applied immediately following egg hatch (May-June) to kill small larvae. Larger larvae are more difficult to kill. Monitor for egg sacs and time spray for egg hatch.	permethrin (Astro, Hi-Yield 38[H]); cyfluthrin (Tempo); bifenthrin (Talstar Select[R], Onyx); lambda-cyhalothrin (Spectracide Triazicide[H], Demand EZ, Scimitar CS); carbaryl (Sevin[H], Carbaryl 4L); tebufenozide (Confirm 2F, Mimic 2LV); spinosad (Conserve); Bacillus thruingiensis (Foray, Dipel[H]); diflubenzuron (Dimilin[R])

Table 1. Guide to Utah Spruce Pest Control. Some pesticides require application by a licensed individual; products with an [R] are restricted-use products requiring a pesticide applicator license for use; products with an [H] are not restricted and are readily available in garden stores (in most cases) for purchase in smaller quantities. Products without a designation are not restricted-use, but are more difficult for homeowners to find, generally more expensive, and come in larger quantities. Recommendations made in this table are for use on "Ornamental Trees." Using a pesticide in a manner inconsistent with the label is illegal.

*An active ingredient (AI) is the working chemical in any given product (e.g., bifenthrin). Take a list of recommended AI's to your local lawn and garden store and select products containing the AI, and that are labeled for the treatment site, e.g., ornamental trees. Using a pesticide in a manner that is inconsistent with the label is illegal. Ask a knowledgable employee for help in selecting the proper product.

**When using insecticidal soaps, test your soap solution on a small portion of the tree to see if needle death or discoloration occurs before applying to the whole tree. Insecticidal soaps and horticultural oils can remove the bluish hue of a blue spruce.

To prevent insect and mite resistance to insecticides, rotate insecticides from different mode of action groups when repeatedly treating for the same pest. This can be done every time a new generation of pests is present, or every year to 2 years. Active ingredients listed in the table can be organized into mode of action groups: GROUP 1A [carbaryl]; GROUP 1B [acephate]; GROUP 3A [bifenthrin, cyhalothrin, cyfluthrin, lambda-cyhalothrin, permethrin]; GROUP 4A [imidacloprid, dinotefuran]; GROUP 5 [spinosad]; GROUP 6 [abamectin]; GROUP 10A [hexythiazox]; GROUP 11 [*bacillus thuringiensis*]; GROUP 15 [diflubenzuron], GROUP 18 [tebufenozide], GROUP Unknown [bifenazate]; Physical Toxicant [insecticidal soap, horticultural oil].

equipment, water stress, nutrient deficiency, shading of branches, heat damage, winter dessication, under or over watering, sun scald, frost damage, hail damage, salt toxicity, and herbicide damage.

In Utah, most insect and disease issues in spruce are caused by tree stress due to under or improper watering. Keep trees healthy and stress free with proper deep watering and fertilization, especially for old, stressed trees. Trees have deeper root systems than turf and must be watered less frequently for longer durations. Soil should contain adequate moisture to a depth of about 18 to 24 inches. Soil moisture can be tested by pushing a long screw driver or slim metal rod into the soil. The metal will easily penetrate moist soil, and will stop when dry soil is reached. Deep watering should be done once a week during hot summer months (July, August) and less frequently in the cooler months. The amount of water it takes to deep irrigate to 24 inches will depend on your soil type (less water for sandy soils, more for clay soils), so experiment with watering times until your screwdriver test shows moisture to a depth of 20 inches. Irrigation at normal turf volumes is not adequate for tree irrigation. Supplemental or additional sprinkler irrigation is necessary.

Creating a mulch zone out to the dripline of the tree can minimize competition with grasses and other plants, eliminate the need for using herbicides around the tree, and will keep it from being injured by lawn equipment. Mulch can also help hold moisture in the soil to keep spruce roots moist. If turfgrass must be removed to install a mulch zone, consider using permeable, cloth landscaping fabric on top of the existing grass, and mulch on top of that. This will inhibit grass growth without chemicals or machines, and is less time and effort intensive. Water will still permeate through the fabric barrier into the root zone; do not use plastic barriers for this purpose.

For issues with soil nutrients, soil and foliage can be tested for deficiencies. Visit the USU Analytical lab for more information on testing costs and procedures.

PHOTOS

[1]Michael Kuhns, Utah State University Extension.
[2]Robert Videki, Bugwood.org.
[3]Scott Tunnock, USDA Forest Service, Bugwood.org.
[4]Marion Murray, Utah State University Extension.
[5]Whitney Cranshaw, Colorado State University, Bugwood.org.
[6]William M. Ciesla, Forest Health International, Bugwood.org.
[7]R.Ryan S. Davis, Utah State University Extension.
[8]USDA Forest Service Ogden Archive, Bugwood.org.
[9]Gerald J. Lenhard, Lousiana State University, Bugwood.org
[10]Darren Blackford, USDA Forest Service, Bugwood.org.
[11]Brytten Steed, USDA Forest Service, Bugwood.org.
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