

# CROP PROFILE FOR CHRISTMAS TREES IN VIRGINIA

Prepared: June 2010

## GENERAL PRODUCTION INFORMATION



- Virginia was ranked 12<sup>th</sup> in the United States for the commodity group including Christmas trees and short rotation woody crops worth \$6,949,000 in 2007.
- In 2007, there were 352 Christmas tree farms located in 67 counties in Virginia.
- Grayson County produces the greatest number of cut trees (3,178 acres), followed by Floyd County (718 acres), Loudoun County (702 acres), Wythe County (574 acres), Carroll County (422 acres), and Giles County (393 acres).

*Photo Credit: Bill Cook, Michigan State University, Bugwood.org*

## CULTURAL PRACTICES

Virginia is suitable for Christmas tree farming due to its good soils, moderate climate, and proximity to consumer markets. The first consideration when growing Christmas trees is the location. Site selection is critical because, although many tree species are highly adaptable to various conditions, not all trees have the same requirements. It is highly recommended that tree farmers contact their local Virginia Department of Forestry (VDOF) or Soil Conservation Service (SCS) office to obtain free recommendations about which species of trees to plant on their property.

Once a site has been selected, it should be determined how many trees will be planted, where they will be planted, and on what timetable. Many new growers make the mistake of planting their land all at once, which makes it very difficult to maintain the trees as they grow older and taller. A better solution is to plant trees on a rotation schedule. For example, if the chosen tree species takes eight years to reach market height, then only one-eighth of a field should be planted each year. This helps distribute work evenly over the years and provides a steadier stream of income annually. Planting on a rotating basis also allows growers to assess their success and decide whether to expand their efforts or perhaps find another way to earn income.

The land should be prepared in the fall before planting by removing impediments (e.g., stumps, logs, and rocks) and controlling vegetation using chemical or mechanical tools. Herbicide

applications should be made no later than the late summer or early autumn in the year before planting Christmas trees.

Seedlings should be purchased well before January if trees are to be planted in late winter through mid-April as is recommended. Trees should be handled carefully and not allowed to freeze, dry out, or become overheated. Local foresters typically have seedlings for sale and also loan or rent planting equipment.

It is very important to control weeds when seedlings are small; otherwise, undesirable plants can rob the trees of water, nutrients, and light. Weeds can also restrict lower branch growth, which decreases tree value. Herbicides should be applied in early fall or early spring in spots around trees or in bands along the planting row. Mowing is done in the strips between rows around three times per year.

Annual shearing is performed beginning in the third year after planting. Branches are trimmed in an effort to give the trees the traditional inverted-cone, Christmas tree shape. It is crucial that workers know the proper way to shear trees because if done improperly, trees can be rendered unmarketable. Once trees reach 3 feet tall, it can take one person 10 to 30 hours or more to shear 1,000 larger trees. On average, one person can shear a total of 3 acres over the course of three eight-hour-day weekends. There is a very short optimal period for shearing pines in early summer.

Pine trees do not require much fertilization, and on many sites, the cost of fertilizer outweighs any benefit to the tree. However, firs and spruces may be fertilized with just nitrogen or a complete fertilizer, if necessary, each year in the winter or early spring. Local Virginia Cooperative Extension (VCE) offices can provide information on how to obtain a soil analysis and determine which, if any, nutrients are lacking.

Most growers do not treat for arthropod pests or diseases until it becomes absolutely necessary to spray, except for areas in which Procerum root disease is an issue and weevils are sprayed annually. Proper timing and application rates are critical. Otherwise, time and money will be wasted, and trees may become damaged.

Tree foliage naturally turns yellow in the fall and winter when photosynthesis is reduced. Cold, dry weather also plays a role. In Fraser firs, deep green needles can be maintained by providing good soil fertility. In other species, particularly pines, some growers use colorants to improve tree appearance and marketability in the year of harvest. Colorants are water-soluble pigments that become permanent after drying for 15 to 30 minutes. The foliage usually remains green for at least one growing season. Trees are typically colored in the fall before yellowing occurs; if growers wait until after foliage changes color, more colorant must be used. Trees must be sprayed thoroughly, despite the absence of yellowing needles, in order to assure uniform coverage and good color at marketing time.

It is very important to pay attention to marketing in the one to three years before trees reach market size. Once trees reach the desired height, growers have three ways to market them to consumers: wholesale, choose-and-cut, or retail lots. Of the three, wholesale is easiest but brings in the least amount of money per tree. Choose-and-cut farms charge more for their trees than wholesale, but they also spend more on production and marketing practices. Retail lots have the potential for the greatest revenues, but the risk of ending the season with a lot full of unwanted trees is high. Cut trees that must be hauled away for disposal diminish profits considerably.

The tree species most often grown for sale during the holidays are white pine and Scotch pine. Both of these are highly adaptable to a range of growing conditions and are in demand by consumers. However, almost any conifer can make a good Christmas tree, although not necessarily on a massive scale. Planted tree species vary by region. In the Coastal Plain area, most growers tend to plant white pine, Scotch pine, Virginia pine, and Norway spruce. In the Piedmont, the three most popular trees are white pine, Scotch pine, and Virginia pine. In the mountainous areas of Virginia, white pine, Scotch pine, Virginia pine, Norway spruce, and Fraser fir are all grown for the Christmas tree market. Other tree species grown on a small scale in Virginia include blue spruce, balsam fir, and Douglas fir.

Growers select conifer species based on their region's soil and climate conditions, unique site conditions, marketability, tree management needs, and seedling cost and availability. It is important to consider the specific characteristics and growing requirements of each tree species. Particular characteristics make each species desirable or not: color, needle length/retention, growth rate, form, and susceptibility to various forest pests (see Table 1 below). Different varieties are grown from seed collected from different regions of the country and world. For example, there are at least 15 different Scotch pine seed sources used for Christmas tree production, all with varying characteristics. Economics and marketing must be considered as well. Although some trees are cheaper and easier to produce (e.g., white pine), they may not be as desirable and as valuable as other species (e.g., Fraser fir).

## **PINES**

In general, pines are known for their good needle retention, rapid growth rate, and ability to adapt to various soil types. Needles are clustered into groups of two to five, depending on the species. Tree plots are typically established using one- to three-year-old seedlings.

### **Eastern White Pine, *Pinus strobus***

Eastern white pine is the most widely planted Christmas tree species in Virginia. It is native to the mountains of Virginia but also is found at lower elevations east of the mountains. White pine needles are silver-green, soft, and demonstrate good retention after the tree is cut. This pine species prefers moist, well-drained, sandy loam soils located on northeast-, east-, or southeast-facing slopes but can grow virtually anywhere in the commonwealth. Eastern white pine grows quickly on average/good sites but needs heavy pruning to yield a compact,

symmetrical tree. Typically, it takes six to eight years to produce a 6-foot tree. Seedlings may be obtained from commercial nurseries or the Virginia Department of Forestry. VDOF gets its seedlings from Floyd and Carroll Counties and also sells a special Christmas tree-grade variety.

### **Scotch Pine, *Pinus sylvestris***

The Scotch pine, as its name suggests, is native to Europe, but it remains the most widely planted Christmas tree species in the United States. It is a robust, adaptable tree. Although it prefers moist, well-drained earth, it also does well in sandy soil. The needles of the Scotch pine are blue-green, slightly twisted, and 1.5 to 3 inches long. There are many varieties of Scotch pine, and all differ in the characteristics of the foliage. Most seedlings come from Spain or southern France. As with eastern white pine, trees reach a marketable height in approximately six to eight years. Scotch pines are high maintenance due their rapid growth and susceptibility to various diseases and pests (e.g., needle cast, gall cankers, tip moths, and sawflies). This tree species requires heavy pruning and may develop crooked stems.

### **Virginia Pine, *Pinus virginiana***

Although planted widely in southern areas for Christmas tree production, Virginia pine is rather new to the Christmas tree industry in Virginia. This pine species demonstrates average color, fair needle retention, and the ability to grow well on both poor and good sites. Virginia pine is drought tolerant and grows best on dry, south- and west-facing slopes. It requires heavy shearing (twice a year) and tends to grow irregularly with a crooked stem. Varieties differ widely in their characteristics and are vulnerable to several pests, including pine tip moth and voles. Seed stocks grown in the southernmost states do not grow as well in Virginia. On a positive note, Virginia pines reach market size one to three years sooner than other pine species.

### **Austrian Pine, *Pinus nigra***

Austrian pine, also native to Europe, is more commonly planted in northern states but has some very limited production and marketing in Virginia. *Pinus nigra* requires more maintenance than other pines and is notoriously difficult to shape into a high-quality tree due to its strong branching tendencies. The foliage is dark to yellow-green, quite rigid, and strongly attached. Austrian pine grows best in heavy/loamy soils but is more tolerant of alkaline soils than other pines. This pine species reaches market height in six to nine years although the growth rate is rather slow at first.

## **FIRS**

All firs are known for their pleasant aromas and soft, flat needles attached singly on twigs and branches. Needles are a medium to dark green and are 0.75 to 2 inches long. Firs prefer loamy soils and will not grow in heavy clay. This group of trees grows slower than pines, particularly in

their first few years of development. Firs require fertilization if grown for Christmas tree production. In order to reduce field time, three- to five-year-old transplants are used.

#### **Fraser Fir, *Abies fraseri***

Fraser fir is native to the high elevations (4,000 to 6,000 feet) of the Appalachian Mountains in Southwest Virginia, western North Carolina, and eastern Tennessee. It greatly resembles balsam fir, which is found farther north. The needles of Fraser fir are flat, 0.5 to 1 inch long, green on top, and silver below. Fraser firs need moderately acidic (pH of 5.3 to 5.8) soil with some organic matter and average moisture. These trees are known for their exquisite color, excellent needle retention, pleasant fragrance, and strong, slightly upturned branches that create a compact appearance. Ideally, planting sites should be located at higher elevations in mountainous regions on northern or northeastern slopes that receive high rainfall. Although the recommended minimum elevation for Fraser fir farming is 2,000 feet, some healthy plantings have been maintained in areas as low as 1,500 to 1,700 feet. If trees must be planted at lower altitudes, it is better if the area receives frequent summer rainfall, is on a northern exposure, and has moist soil. Unlike certain other trees, seed origin does not affect the growth habit of Fraser firs. Fraser firs reach 6 feet after seven to 10 years on good sites. It should be noted that Phytophthora root rot can be particularly devastating to Fraser firs. However, it is not as much of a concern if trees are planted on well-drained sites with good soil. Fraser firs may also be susceptible to late spring frosts.

#### **White Fir, *Abies concolor***

White fir, also known as concolor fir, is native to the western United States and has long (1.5 to 2.5 inches), silvery blue needles that curve upward along the twig. White fir reaches market height (7 feet) in nine to 12 years. Although seed stock is available from various sources, some growers prefer Arizona stock because of several positive characteristics. These include a faster growth rate, bluer color, and reduced susceptibility to cold damage. White fir requires sites with good air drainage.

### **SPRUCES**

Spruces are very popular among consumers. They resemble firs but have short, sharp-pointed, somewhat stiff foliage. Spruces also have a pleasant fragrance, but their needle retention is not as good as pines and firs. All spruces will drop their needles if they become dry, so they should be grown close to where they will be marketed. With the exception of Norway spruce, other spruce species are grown in Virginia only on a limited scale.

#### **Norway Spruce, *Picea abies***

The Norway spruce is native to Europe but is widely planted as an ornamental in the United States. Although an attractive tree, its appearance is not as appealing as that of white or blue spruce. The needles are dark green and measure 0.75 to 1 inch long, but retention is poor

unless trees are cut fresh and kept properly watered. Norway spruces can thrive in many different soil types, although this species flourishes on cool, moist sites. For the first few years, growth is slow, and it takes eight to 11 years for trees to reach market height. Much pruning is required to yield an attractive, compact tree.

#### **White Spruce, *Picea glauca***

White spruce is native to the northern United States and is a common Christmas tree species in that region. It has excellent foliage color; short, stiff needles; and a good natural shape. Its needle retention exceeds that of Norway spruce. White spruce grows best in loamy soils.

#### **Blue Spruce, *Picea pungens***

Blue spruce is native to the Rocky Mountains. Although it is a common ornamental tree in the eastern states, it is not grown or marketed widely in Virginia as a Christmas tree. This species has a symmetrical shape and beautiful blue foliage. Blue spruce needles are stiff, 1 to 1.5 inches long, and have sharp points that make decorating painful. Of all the spruces, blue spruce has the best needle retention. Only one-third of seedlings will develop good or excellent blue color; the rest will be an off-shade of blue or green. Blue spruce trees prefer well-drained sandy soil but can grow on heavier clay. This species has a slow growth habit and requires nine to 12 years to reach 6 feet. The sharp needles, stiff foliage, and rigid branches make it difficult to transport blue spruces over long distances.

### **OTHER**

#### **Douglas Fir, *Pseudotsuga menziesii***

Despite its moniker, Douglas fir is not a true fir, and the needles are actually sprucelike. It is native to the Pacific Northwest and Rocky Mountains where it is considered a premium Christmas tree. However, it is not widely grown in Virginia. Douglas fir has short, flat, dark green needles (0.75 to 1.25 inches long) borne singly on slender twigs, and reddish brown terminal buds. These trees grow best on upland sites located on north- or east-facing slopes with well-drained loam or sandy loam soils. Seed stocks vary in their characteristics. For example, Arizona/New Mexico seedlings grow fast and have dark green foliage, while northern Idaho/British Columbia stocks also grow rapidly but are less susceptible to frost damage. Douglas firs have a seven- to nine-year stock rotation.

Table 1. Selected characteristics and major pests of species used for Christmas tree production<sup>1</sup> (Rating Scale: E = Excellent, VG = Very Good, G = Good, F = Fair, P = Poor, VP = Very Poor)

Species	Fragrance	Color	Twig Stiffness	Shipping Qualities	Pest Resistance	Needle Retention	Major Pests <sup>2</sup>
Eastern white pine	VG	VG	G	E	F	E	WPW, PW, EPW, WPA, PBA, sawflies, bagworms, PNS, pine webworm, mites
Scotch pine	G	P-E	E	G	VP	E	NPTM, sawflies, PW, EPW, aphids, PSB, PNS, PTS, PBA
Virginia pine	G	P-VG	E	G	P	VP-F	VPS, NPTM, PW, pine webworm
Austrian pine	G	VG	E	VP	F	E	PNS, PTS, mites
Fraser fir	E	E	F	E	VG	VG	BWA, aphids, SSM, eriophyid mites, BTA
White fir	VG	VG	G	E	VG	VG	aphids
Douglas fir	VG	E	F	E	VG	VG	SSM, WPW, CSGA
Norway spruce	G	G	G	VG	F	P	WPW, ESGA, aphids, PNS, sawflies, mites, SSM
Blue spruce	G	E	E	F	F	G	SSM, WPW, sawflies, aphids, CSGA
White spruce	P	VG	VG	VG	G	F	SSM, WPW, sawflies, aphids

<sup>1</sup>Partially adapted from “Recommended Species for Christmas Tree Planting,” Ext. Bull. E-1155, Michigan State Cooperative Extension Service, by way of VCE Pub. 420-082, and “Christmas Tree Insects,” VCE Pest Management Guide: Horticultural & Forest Crops 2010.

<sup>2</sup>See the “Abbreviations” section at the end of this document for an explanation of acronyms used in this table

## SPECIAL USE LABELS

Section 18 Emergency Use Exemption and Special Local Need (SLN) 24(c) labels are used to supplement the chemical tools available to producers for pest control. Once the problem or gap in pest control has been identified, specialists submit the proper documentation for the Emergency Use/SLN label. Thus far, Extension specialists have been successful in obtaining these labels. Special Local Need labels in Virginia are granted by the Virginia Department of Agriculture and Consumer Services (VDACS) and are usually only valid for limited time intervals. Also, an annual fee must be paid by the registrant to maintain the product registration in Virginia. Section 18 Emergency Use labels are evaluated and granted by the Environmental Protection Agency (EPA) annually.

## WORKER ACTIVITIES

Worker activities differ depending on the tree species being grown, although there are some general practices that must be performed regardless of what type of tree is planted. If growers desire, foliar coloring may be performed in the fall. Table 2 correlates the timing of integrated pest management (IPM) activities with pests to be controlled.

Table 2. Timing of IPM activities for Christmas trees grown in Virginia<sup>1</sup>

Pest <sup>2</sup>	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Bagworm	Scout	Scout/ Pick	Pick			Spray	Spray				Pick	Pick
SSM				Scout	Scout/ Spray	Scout	Scout	Scout	Scout/ Spray	Scout		
BTA				Scout	Scout							
WG						Scout						
BWA							Scout/ Treat					
ESGA		Scout/ Treat	Scout/ Treat									
WPW			Scout/ Spray		Prune	Prune						
PTS		Scout/ Oil	Oil			Spray						
NPTM			Scout	Spray		Spray	Shear	Spray				
PNS				Scout	Spray							
Sawflies					Scout/ Spray	Scout/ Spray	Scout/ Spray					
PSB					Scout	Scout	Spray					

<sup>1</sup> Modified in part from “Fraser Fir Scouting Schedule for Insects and Mites” by Eric R. Day, VT Entomology, and “Fraser Fir IPM” by Dr. Jill Sidebottom, NC Cooperative Extension.

<sup>2</sup> See the “Abbreviations” section at the end of this document for an explanation of acronyms used in this table.

## ARTHROPODS – MAJOR PESTS

Chemical control recommendations were taken from ***Pest Management Guide: Horticultural and Forest Crops, 2010***. Please see:

[http://pubs.ext.vt.edu/456/456-017/Section-7 Low-Management Crops and Areas-6.pdf](http://pubs.ext.vt.edu/456/456-017/Section-7%20Low-Management%20Crops%20and%20Areas-6.pdf)  
for the most current control recommendations.

### **Balsam Woolly Adelgid, *Adelges piceae***

The balsam woolly adelgid (BWA) is native to central Europe and was introduced to North America in the early 1900s. The adelgid was first observed in the natural stands of Fraser fir in the 1950s. All natural stands of Fraser fir have since been impacted and have been devastated by BWA. In 2000, nearly half of growers reported treating for BWA. Balsam woolly adelgid feeds on the bark of the tree and can be found on the trunk, branches, and buds of Fraser fir.

Complete spray coverage is required to control this pest. Systemic pesticides do not control BWA because feeding occurs in the bark but not within the vascular tissue.

**MONITORING:** All Christmas tree fields should be scouted annually for BWA to determine when it first arrives in a field. Scout regularly for the adelgid or for trees losing apical dominance, and remove infested trees, if possible. The best time to monitor for BWA is in July when the adelgids are covered with white, woolly sacs and are more easily observed. If trees are flattening out on top or have a crooked leader, this is a sign of early BWA damage. Growers should walk through the field in a “Z” or “W” pattern and treat if an entire block is infested.

**CHEMICAL CONTROL:** The Virginia Pest Management Guide (PMG) recommends using carbaryl, chlorpyrifos, dormant oil, esfenvalerate, imidacloprid, or permethrin to control BWA. Bark and foliage should be sprayed in June, or when pests are found from May through October. If only a few, scattered trees are infested, they should be removed and burned. Healthy trees growing in a 20-foot-diameter circle around rogued trees should be sprayed. When removing infested trees, trees should be wrapped in a tarp so no adelgids fall off. Spot sprays must be applied to surrounding trees. In the past, most growers used Lindane until the chemical lost its registration. Before the loss of Lindane, problems with hemlock rust mites (secondary pests) were nonexistent. Since growers switched to synthetic pyrethroids, rust mites have become an annual pest requiring frequent treatment. When using Lindane, most growers treated only once in a rotation. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** In the 1950s and 1960s, considerable research was done to try to introduce predators of BWA into the natural stands, which proved unsuccessful. With the current interest in biological control for a similar pest, the hemlock woolly adelgid (HWA), research continues to determine if those predators will also control BWA. Growers and scouts need more education to be able to recognize and preserve natural enemies of BWA.

**CULTURAL CONTROL:** In addition to pesticide applications, growers can reduce problems with BWA by removing Fraser fir trees that cannot be treated (such as those in yards) and by culling heavily damaged trees. Large trees that cannot be adequately treated should be cut down. This includes Fraser fir trees grown in yards but not managed as Christmas trees as well as abandoned Christmas trees. Trees that have not had a straight top for two or more years in the field should be culled. Culled trees should not be removed from the field when crawlers are present because dragging the tree out of the field may help spread the insect. Culled trees may be burned. Growers should not plant young trees among older trees in partially harvested fields to ensure that pests are not spread as quickly to younger trees. Fertilizing trees with nitrogen fertilizer has been demonstrated to increase the fecundity of BWA, so this should be avoided or limited as much as possible.

#### SPRINGTIME PESTS

Balsam Twig Aphid, *Mindarus abietinus*  
Spruce Spider Mite, *Oligonychus ununguis*  
Hemlock Rust Mite, *Nalepella tsugifoliae*

Most growers apply a pesticide in the spring on trees nearing market size to control the balsam twig aphid (BTA). The spruce spider mite (SSM) is often controlled at the same time. If the hemlock rust mite (HRM) is also present, it, too, will need to be controlled. Fortunately, if treating for BTA in the spring, a miticide can be added to the mix in order to control all four pests (BTA, HRM, SSM, and BWA) at once.

The BTA is a serious springtime pest of fir species that causes needle curl and is associated with sooty mold. In 2000, nearly three-quarters of growers reported treating for BTA. Damage is caused when the aphids feed on the newly broken buds. Populations increase during warm, dry spring weather, which favors the rapid maturation of the stem mothers and survival of their offspring. However, tree needles will often straighten as they mature when there is adequate rainfall and fertility. Pesticide timing is important for the control of BTA. The treatment window is very narrow because pesticides are ineffective against the twig aphid egg. Once the trees have broken bud and the aphids colonize the new growth, however, firs are again protected from pesticide sprays. Balsam twig aphid hatch is complete by April 15, or earlier during warm springs. Bud break occurs anywhere between the last week in April and May 15. During this two- to three-week window, the weather is often unsuitable for pesticide application. Growers are encouraged to treat for BTA the year of and year before sale.

The SSM attacks a wide range of coniferous hosts. In 2000, half of growers reported treating for SSM. Although SSM is considered a cool-season mite, summer temperatures in the southern Appalachians are not high enough to slow its activity. The SSM can damage trees from March through October, although injury typically occurs in July and August. Spider mites cause yellow spotting on needles, which discolors the foliage and often results in premature needle shed. Spider mites are not a problem every year. Certain factors favor spider mite activity, the most important being rainfall. Spider mites are a dry-season problem. However, certain production practices can encourage SSM activity, including planting trees at lower elevations or on windy, exposed ridges; growing trees on rows adjacent to gravel roads that create dust; and using broad-spectrum insecticides. These factors promote spider mites because they harm the mite's natural predators.

Widespread rust mite problems were first observed in 1995 in western North Carolina. Since then, rust mites have been a frequent problem. In 2000, nearly one-quarter of growers reported treating for HRM. The HRM causes bronzing of the foliage and premature needle drop on Fraser firs. It is primarily a springtime pest, although damage can also occur in the fall.

**MONITORING:** Scouting for SSM and HRM is very important. Growers should especially assess their rust mite numbers before BTA control in the spring so they can switch to another control, if necessary. Workers should look for SSM beginning in mid-April and continue scouting on a monthly basis until the first heavy frost. Fields should be walked in a "Z" or "W" pattern, and a tree picked at random once every 50 feet. The shoots should be examined for mites or mite damage using a 10X hand lens. A minimum of 15 shoots should be assessed per acre. Workers must record the number of shoots sampled and total number of shoots infested with mites or mite eggs. Economic threshold is based on tree size. If less than waist height, trees should be

treated when the percentage of infested shoots is greater than 40%. Taller trees (including those in the year before sale) may be treated if the percentage of shoots with mites is greater than 20%. If no mites are found, trees should be rechecked in six to eight weeks. If 10% or fewer shoots are infested, then trees should be reexamined in four to five weeks. If greater than 10% of shoots have mites or eggs, then growers should return in two weeks. If the weather is hot and dry for more than 10 consecutive days, then trees should be checked sooner. Workers should scout for BTA and SSM in early April to assess any damage. Treatment should be applied if more than 10% of trees have at least one damaged twig, but only if trees are within two years of harvest. It should be noted that some degree of BTA damage is considered beneficial because it gives the tree an attractive, silvery appearance.

**CHEMICAL CONTROL:** Dormant oil (also sold as horticultural oil and superior oil) may be used to control SSM in late winter to kill overwintering eggs. If applied before bud break, it will not discolor new growth. Dormant oil can potentially damage new growth because the active ingredient (petroleum oil) can be caustic. Insecticidal soap may be used in May when plant growth has started and mites resume activity. When high populations are predicted, a miticide should be applied in the spring (early May) and/or early fall. For BTA control, the most effective chemicals are Asana, Dursban, and Lorsban. There is no need to treat for BTA until the final two or three years of the harvest cycle. Chemicals should be applied after egg hatch but before bud break (mid-April to early May). Once bud break has occurred, treatment is ineffective and should be postponed until the following year. Avoid applying pesticides that are known to increase HRM populations. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** Many different kinds of predatory mites have been observed when scouting for Christmas tree pests. Most have not been properly identified, nor their role in biological control studied. Syrphid fly larvae and ladybird beetle larvae often effectively eliminate twig aphids from a field. Unfortunately, this usually occurs after trees have suffered irreparable damage. As beneficial predators are identified, growers need to be taught to recognize, identify, and preserve them.

**CULTURAL CONTROL:** Christmas tree growers produce not one but two crops. Equally important to tree production are the groundcovers that surround the trees. If these groundcovers are allowed to flower, they will attract many natural predators that depend on nectar and pollen to reproduce. Natural enemies include syrphid flies, lacewings, ladybird beetles, and predatory mites. Managing groundcovers to promote native, flowering vegetation may help reduce problems with twig aphids and spider mites. The SSM is more active in sites that are warm and dry. To reduce problems with spider mites, especially for organically grown Christmas trees, sites should be chosen carefully. If trees are healthy, they should be able to survive a BTA infestation without sustaining too much damage, which can be sheared off or hidden by new growth.

### **White Grubs, Scarabidae spp.**

White grubs are the larvae of scarab beetles. It is primarily the May and June beetle grubs that feed on tree roots. Only 3% of growers reported grub damage in 2000, but individual losses can be serious. In 2001, one grower lost 70,000 3-1 transplants (valued at \$17,500) to Asiatic beetle

grubs. Research was conducted in the 1980s that identified several species of May and June beetles, including *Phyllophaga anxia*, *Phyllophaga fusca*, and *Polyphylla comes*, as being important. However, growers have also been experiencing problems with other grubs such as the Asiatic garden beetle grub (*Maladera castanea*) and the masked chafer grub (*Cyclocephala* spp. In addition, black vine weevil (*Otiorhynchus sulcatus*) larvae have damaged seedlings in seedbeds. Also, the oriental beetle grub (*Exomala orientalis*) has become a problem in certain counties in western North Carolina on hemlocks, although it is unknown if it damages Christmas trees. Grubs are most often a problem when trees are planted into old pastures where many grubs are already present and have been feeding off the short grass. Grub feeding kills seedlings, requiring the grower to reset fields. Once seedlings have sustained grub damage, they may survive but will seldom grow well. White grubs are rarely a problem on tree farms where a grass strip is maintained between trees.

**MONITORING:** Growers should scout before setting trees to determine if grubs are present. In June, workers should lift up 1-square-foot sections of sod at five sites per 2 acres. Treatment should be applied if there is an average of more than one grub per hole and damage is also present. Controlling grubs early before they cause damage is far better for the grower than trying to treat after damage has occurred. There are many species of scarab beetles, but not all of them feed on tree roots. Growers must learn how to identify grubs by examining the raster pattern on the tip of the abdomen. Scouting should take place in areas where new trees are planted, where yellowing or slow growth occurs on established trees, in areas where grass grows poorly, or where there is evidence of predator digging.

**CHEMICAL CONTROL:** White grubs are treated with diazinon or oftanol applied in the same manner as one would treat a lawn. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended, although white grubs have many natural enemies, including nematodes and wasps.

**CULTURAL CONTROL:** Research has demonstrated that using suppressive rates of herbicides to “chemically mow” groundcovers will reduce grub numbers over time because beetles prefer laying eggs in short grass rather than taller, uneven groundcovers. The May and June beetle grubs spend two to three years in the soil before molting and emerging as adults. Therefore, it will often take a couple of years before this strategy will reduce grub numbers. By then, damage has already occurred. Often grubs are worse in old pastures as they are already present feeding in the grass. It is important to maintain a wide strip of grass between trees because white grubs prefer to feed on grass roots and will move to tree roots only when nothing else is available.

### **Rosette Bud Mite, *Trisetacus fraseri***

The rosette bud mite (RBM) is an eriophyid mite that causes galls to form inside the vegetative buds of Fraser fir. The damaged buds do not “break” in the spring. This loss of bud tissue results in uneven density and holes in the tree canopy, weak bottoms, and light density. All of these conditions reduce the grade and the value of an affected Christmas tree. Good-quality trees may be produced in fields infested with RBM, but it may take a year or two longer to

produce them. This increases production costs and delays revenues. The earlier in the rotation that RBM infests a tree, the greater the impact on tree quality. Rosette bud mites are primarily a problem in Avery County, North Carolina, and Grayson County, Virginia, as well as certain plantations found at elevations above 4,000 feet. However, the range of RBM continues to increase. In 2000, 11.9% of growers reported treating for RBM.

**MONITORING:** Growers must be aware of how to identify this pest and be alert when it arrives in an area, especially on seedling material.

**CHEMICAL CONTROL:** Dimethoate is the only material that controls RBM in a single application. Samite and sulfur are also recommended. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** Rosette bud mite is found in natural stands but seldom affects many buds on a tree. Natural enemies may be a factor in this resistance.

**CULTURAL CONTROL:** One method of reducing the likelihood of RBM attacking smaller trees is to avoid interplanting young trees with old trees. It usually takes two to three years to cut all the trees in a block. Some growers will plant small trees next to the larger trees that are left. However, the young trees may then become infested with RBM. Therefore, it is better to clear cut a block of trees before replanting. Maintaining good fertility is another important tool to control RBM. With adequate fertility, good bud set will offset the effects of RBM as more buds are produced to replace those that do not break. Furthermore, shearing early and lightly will help improve tree quality because it encourages good bud set. Selectively harvesting heavily infested trees early also reduces problems with RBM the following year. Each infested bud can contain as many as 3,000 mites. By harvesting the worst-infested trees, some growers have been able to avoid pesticide applications altogether.

### Pine Needle Scale, *Chionaspis pinifoliae*

Pine needle scale (PNS) is primarily a pest of Scotch, Mugo, and Austrian pine species. It seldom damages white pine, Norway spruce, and other conifers. The scale's feeding causes stunted trees, slow growth, short needles and shoots, and sometimes yellow spots on needles. However, damage does not appear until the pests have been present for a few years. The soft-bodied scale insects are covered by a small (1/8 inch long), white, oyster shell-shaped covering. Females lay purple eggs that can be seen by carefully prying off the scale. Wingless reddish brown crawlers hatch from the eggs and are transported by wind or birds. Two generations occur per year.

**MONITORING:** White scales appear in fall and winter. Growers should note which rows or blocks may need treatment. Pine needle scale should be treated only if stunted growth, yellowing, or unsightly scale populations are present. In early May and early July, electrical tape (sticky side up) may be wrapped around twigs with high populations of scale. Treatments are applied one week after the first reddish purple crawler is found (usually mid-May and mid-to late July).

**CHEMICAL CONTROL:** Dormant oil is applied in late March after average temperatures surpass 45°F. This oil may temporarily remove the waxy bloom on needles, making the foliage appear

dull. However, the effect will be masked by summer growth. For this reason, dormant oils should not be used during the year of harvest. Malathion or diazinon may be applied one week after the first crawler is found using the tape method described above. Carbaryl or dimethoate may be used just after egg hatch and when crawlers first appear. Targeting the summer generation (those that hatch in July) is most effective. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended, but in areas of high populations, ladybird beetles are effective predators of pine needle scale.

**CULTURAL CONTROL:** Trees should be maintained to be vigorous and healthy because scales tend to be more damaging on stressed, unhealthy trees.

### **Nantucket Pine Tip Moth, *Rhyacionia frustrana***

Nantucket pine tip moth (NPTM) attacks two- and three-needled pine species, especially shortleaf, loblolly, and Virginia. Scotch and pitch pine are also vulnerable. In Virginia, this pest is mostly a problem in the eastern part of state. The adults are small, reddish brown moths that produce two to three generations per year in Virginia. The first generation emerges between late March and mid-April after spending the winter as pupae within damaged tips. Mating occurs soon after, followed by oviposition. The eggs hatch within 14 days. Larvae damage the shoot tips of young pines, causing severe stunting and stem deformation, and occasionally tree death. The third generation emerges in late July and early August. Tip moth larvae are most damaging to seedlings and saplings less than five years old, so Christmas tree farms and seed orchards are highly vulnerable.

**MONITORING:** Small, copper-colored moths may be observed flying from trees when branches are shaken. Damage from the previous year should also be assessed.

**CHEMICAL CONTROL:** In late April, a residual insecticide such as dimethoate may be applied, taking care to cover all lateral branches and the leader. Also, sprays may be reapplied in late June and late August if damage is heavy. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** For light infestations, damaged tips containing insects may be sheared off in July. The tips will then be consumed by natural enemies on the ground.

## **INSECTS – MINOR PESTS**

### **Bagworms, *Thyridopteryx ephemeraeformis***

Bagworms have a wide host range but are usually associated with arborvitae or junipers. They have only occasionally been a problem on Fraser fir Christmas trees. Bagworm caterpillars feed on foliage and retreat to the protective enclosure they construct and anchor to the tree's branches. Since bagworms have only one life cycle a year, timing of pesticide applications is key to control. Although seldom a problem on Fraser fir, bagworm populations can grow

quickly once they develop a taste for a new conifer species. For this reason, it is important to be vigilant in controlling bagworm infestations.

**MONITORING:** Growers should look for bags containing overwintering caterpillars in January.

**CHEMICAL CONTROL:** Sprays should be applied in mid-June when larvae are small and susceptible to insecticides. Later in the season, larger caterpillars are harder to control. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** *Bacillus thuringiensis* (e.g., B.t., Dipel, and Thuricide) can be used in early to mid-June to achieve adequate control.

**CULTURAL CONTROL:** Bagworms should be removed by hand in fall and winter and destroyed by either dropping them into a can of kerosene or burying them at least 6 inches deep.

### **Cinara Aphids, *Cinara* spp.**

Cinara aphids are large brown-black aphids that feed on conifers. They are relatively rare on firs and cause no serious damage. However, if a tree infested with aphids is harvested and set up indoors, they will become active and move about the home. Cinara aphids do not feed on houseplants, cannot bite people or pets, and do not carry diseases. Yet, some people will fumigate their homes if these aphids are found on their Christmas trees. They have been mistaken for ticks, and these reports have made their way into the media. Christmas tree growers have had to pay for the removal of these pests from customers' homes.

**MONITORING:** Scout in May and June for aphids and mark trees for spot spraying, or spray entire blocks if more than 5% of trees are infested. Trees should be checked for sooty mold and yellowing in October to identify infested trees in the field. These trees tend to be located in clumps and near field borders. Workers should also look for aphids clustered on the terminal, trunk, and upper whorl of tree branches. Fall scouting is important to be sure aphids are gone before trees are moved indoors by consumers.

**CHEMICAL CONTROL:** Currently, growers of Virginia pine and white pine treat for Cinara aphids during the fall of the year the trees will be harvested. In general, Fraser fir growers do not do this. Control is only necessary if there are extremely high numbers on many trees in a field block. Any chemical labeled for aphid control will control these pests. Growers may apply insecticidal soap or registered insecticides in May or whenever aphids are found. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** Ladybird beetles are predators of Cinara aphids.

**CULTURAL CONTROL:** Excess amounts of nitrogen should not be applied because this nutrient encourages sucking insects to proliferate. Consumers can remove aphids from Christmas trees by spraying with a water hose outside, treating the tree with household insecticides, or vacuuming aphids.

### **Cooley Spruce Gall Adelgid**

Cooley spruce gall adelgid (CSGA) attacks Colorado blue spruce and Douglas fir, primarily, but also may be found on Engelmann spruce, Sitka spruce, and Oriental spruce. Like eastern spruce

gall adelgid, CSGA are aphid-like black insects that create white, woolly ovisacs on the needles of Douglas fir, but cause spruces to form a pineapple-shaped gall. The CSGA life cycle is complicated and requires two hosts (Douglas fir and spruce) to produce all five morphs over a two-year span. These adelgids can survive on Douglas fir alone, but only two forms are produced. Cooley spruce gall adelgid cannot produce indefinitely on only spruces. Females lay eggs in spring on lateral twigs that hatch in 10 to 14 days; the crawlers colonize and feed on new growth. The galls protecting the adelgids dry out by mid-summer and after emerging, adults either migrate to Douglas fir or stay on the spruce host. Galls formed on spruce twigs can destroy the shape of a tree. Galls do not form on Douglas fir; the branches simply look snow covered. However, needles can become discolored, distorted, or may drop prematurely.

**MONITORING:** Growers should look for adelgids at the base of terminal buds in mid-spring.

**CHEMICAL CONTROL:** Registered pesticides should be applied to spruces between mid-September and early October to control overwintering females, or products can be applied in spring (prior to budbreak) before females lay eggs. Douglas fir may be sprayed in April just before budbreak, or in mid-September to early October.

**BIOLOGICAL CONTROL:** No commercially available biological controls are recommended.

**CULTURAL CONTROL:** Galls should be removed when they are still green in June or July, before mature adelgids emerge.

#### **Eastern Spruce Gall Adelgid, *Adelges abietis***

The eastern spruce gall adelgid (ESGA) is a pest of white and Norway spruce, which are occasionally sold as Christmas trees in the southern Appalachians. Nymphs feed at the base of new growth shoots, causing galls to form. In the summer, galls turn brown, thus reducing tree appearance and value.

**MONITORING:** Beginning in April, workers should scout for small woolly sacs at the base of buds. Trees should be reexamined in August and September to determine when galls have opened. Treatments are typically made when 5% of trees have 10 or more galls. Spot spraying may work with smaller infestations.

**CHEMICAL CONTROL:** This pest is relatively easy to control with proper timing. Dormant oil is applied in February or March. In severe cases, insecticides are applied in August or September when galls change color from green to brown. Adelgids exit via tiny openings in the galls, which resemble small pinecones. Treatments can also be applied in April, but timing is very tricky. The pests need to be targeted while still feeding at the base of the needle, just before the gall is formed. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Galls can be removed by hand if present in small numbers.

#### **Pine Bark Adelgid, *Pineus strobi***

The pine bark adelgid (PBA) is a native pest of eastern white pine, but it is also found on Scotch and Austrian pine. It feeds on bark, much like the balsam woolly adelgid, but white pines are

seldom affected by it in the forest setting. However, in the nursery setting the pine bark adelgid can reduce growth in young white pines. It is not a difficult pest to control, and no permanent damage is done if trees are otherwise healthy. The immature adelgids resume activity during warm spring weather, reproducing in April and May. Females lay eggs that hatch into crawlers, which move about the tree or are blown to other trees. Up to five generations occur per year.

**MONITORING:** Growers should scout for the pine bark adelgid in the spring when the new growth is lengthening.

**CHEMICAL CONTROL:** Chemical controls should be initiated only if the pest is present in very high numbers and damage appears (e.g., yellowing, “witches’ broom,” or sooty mold). Treat with dormant oil in late winter before bud break. Insecticidal soap and Sevin are also recommended control options. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Avoid using fertilizer because excess nitrogen causes population buildup.

### Pine Tortoise Scale

Mature pine tortoise scales (PTS) produce reddish brown coverings that resemble turtle shells. These pests mainly attack Scotch, jack, and Virginia pines, but other pines may also be colonized. One generation occurs per year and crawlers are present from mid-June to early July. Heavily infested trees may become covered with sooty mold, which grows on the honeydew secreted by the scales, and needles may turn yellow.

**MONITORING:** Female scales settle at the base of needles and crawlers become active in late June to early July. Growers should look for ants, wasps, and flies that are attracted to the honeydew produced by the scales.

**CHEMICAL CONTROL:** Chemicals should be applied between June 20 – 25, when necessary. Growers may treat with horticultural oil or insecticidal soap when soft scales are overwintering.

**BIOLOGICAL CONTROL:** None recommended, but natural enemies include minute pirate bugs, lacewings, lady beetles, and predatory midges.

**CULTURAL CONTROL:** Prune and destroy heavily infested branches.

### Weevils, *Hylobius* and *Pissodes* spp.

Several weevils occasionally damage Christmas trees. These include the pine root collar weevil (*Hylobius radialis*) (PRCW), the white pine weevil (*Pissodes strobi*) (WPW), and the pales weevil (*Hylobius pales*) (PW). These damage several species of pine and spruce trees and occasionally Fraser fir. Damage differs among weevil species. Pine root collar weevil larvae girdle the root collar of young pine trees, but are not considered pests in Virginia. The WPW destroys or deforms the tree’s leader. The adult PW feeds on stems, and is most often found when pines have been recently felled. They are also vectors of Procerum root disease. Adult female weevils are attracted to freshly cut stumps in early spring. Between the months of March and

June, they lay their eggs on the roots of felled trees. Larvae feed in long tunnels that run with the grain of the wood and later emerge as adults in late summer or early fall. The adults feed on shoots and twigs, and then overwinter in the leaf litter below the tree. The following spring, they reemerge and the cycle continues.

**MONITORING:** Symptoms of PW damage include dead seedlings or dead shoot tips called “flags” on older trees and pitch or resin bleeding on twigs, shoots, and at the base of flagged shoots. Growers should scout for adult weevils by spreading a sheet under the tree after dark and shaking the tree until the beetles fall out. Larvae can be located by carving bark away from stumps or the base of dead trees. For WPW, resinous bleeding in late March or early April is an indicator of where adult females are feeding and laying eggs. Also, trees should be checked in June to determine which tops are currently infested with WPW. Finally, fall scouting is done to assess the percentage of trees infested. If fall surveys show more than 5% of trees infested with WPW in the previous season, then the entire plantation or block should be treated.

**CHEMICAL CONTROL:** Although many pesticides reportedly give good control of weevils, timing is key. Usually the damage is already done before it is noticed, and the weevils are no longer present. For PW, any stumps remaining in the ground should be drenched along with the surrounding soil with a registered insecticide between early April and mid-May. Only stumps cut in the previous year need to be treated. Damage to new plantings may be prevented by dipping seedlings in an insecticide root dip. If flagging is observed in late summer, treatments should target adult weevils feeding in the trees. For control of WPW, the terminal leader (but not lateral shoots) should be treated with a registered insecticide before bud break (no later than late March or early April). Chemical applications may need to be done annually if trees are particularly valuable. Growers should keep in mind that repeated attacks by WPW create interesting, crooked branching that some people find quite appealing. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Implementing good sanitation practices (e.g., removing dead pine stumps and trees) is often an effective way to control weevils. Another control method is to delay replanting for two years after harvest, although this may cause problems if there are nearby plantings with fresh stumps. Also, trimming the bottom branches from trees creates conditions that are unsuitable for the PRCW, but this tactic is time consuming and rarely done. For control of WPW, growers should prune out and destroy infested tops in late June (before weevils make exit holes), making sure stems are cut below weevil feeding spots. All old stands of white pine and Norway spruce that may serve as refuges for WPW should be removed.

### **Pine Spittlebug, *Aphrophora parallela***

The pine spittlebug (PSB) is common throughout the eastern United States. It prefers to feed on Scotch pine but attacks other pine species, including Virginia pine. The brown adults somewhat resemble leafhoppers. During the spring, the immature nymphs are usually found in frothy masses on pine foliage or the trunk of the tree. Spittlebugs feed on plant sap, and heavy infestations can cause yellowing and stunted growth. Nymphs mature into adults in late

summer. Typically, pine spittlebugs produce only one generation per year. These pests may vector diseases such as Diplodia tip blight.

**MONITORING:** Workers should scout for spittle masses on shoots and trunks, and for dead, yellow twigs from May to early July. Adults lacking the spittle mass will be visible beginning in mid-June. All trees should be checked in May and June. If there are many spittle masses visible, fields should be rechecked for dead shoots in the fall. If dead shoots are present, trees should be treated in the following season. A pest sample should be submitted to the VT Insect Identification Laboratory if the Saratoga spittlebug is suspected.

**CHEMICAL CONTROL:** Sprays are applied in mid-July. For best timing of chemical application, spittle masses should be checked weekly beginning in late June. When 95% of the masses are unoccupied (around mid-July), the entire tree farm should be treated with a registered insecticide. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** It is important to maintain tree vigor and avoid planting tree species on sites to which they cannot adapt easily. Growers should plant trees that are resistant to Diplodia tip blight. Two- and three-needle pines tend to be more susceptible to Diplodia.

#### Root Aphids, *Prociphilus americanus*

Root aphids are large, white, woolly aphids that feed on conifer roots during the winter months and move to ash trees to feed on the leaves during the spring. Their life cycle is not well understood, but some of the aphids appear to remain on conifers year round. It is not known what effect root aphids have on their conifer hosts. It appears that when numbers are high (greater than 200 aphids per plant), tree growth is reduced. Root aphids may also exacerbate the effects of other problems such as poor fertility, dry sites, and prior grub damage.

**MONITORING:** No specific monitoring protocol is recommended because root aphids are subterranean and are not readily observed.

**CHEMICAL CONTROL:** Chemical controls are not recommended. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** None recommended.

#### Needle Sheath Mite, Eriophyidae spp.

The needle sheath mite, also known as the pine bud mite, is tiny (0.2 mm) and cannot be seen with the naked eye. Feeding damage by this pest is similar to that caused by abiotic sources (e.g., air pollution and drought), causing needles to become blotchy or turn yellow with brown tips. This mite infests white, Scotch, Austrian, and red pine.

**MONITORING:** Growers should use a 10X hand lens to check trees in March by examining 10 needle bundles on 10 random trees per block. Needles must be pulled open to look for the small, pale mites. Another sign of infestation is yellowing and stippling, especially on the south

side of the tree. Samples (10 needle bundles) can be submitted to the VT Insect Identification Laboratory through a local VCE agent. If mites and damage are present, treatment should be initiated.

**CHEMICAL CONTROL:** Carbaryl or dormant oil is applied to the entire stand in March/April. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Growers should consider planting species other than white pine. Trees should be well maintained because stressed trees are more likely to suffer damage.

### Pine Sawflies, *Neodiprion* and *Diprion* spp.

There are several species of pine sawflies that can affect white pines in the southern Appalachians, including the redheaded pine sawfly (*Neodiprion lecontei*), the blackheaded pine sawfly (*Neodiprion excitans*), and the introduced pine sawfly (*Diprion similis*). Larval feeding damage results in loss of needles.

**MONITORING:** Growers should check the upper parts of pine trees for sawfly colonies that typically infest the tips of lateral branches or the leader. Spot treatments are applied where pests are found, or the entire block may be treated if more than 5% of trees are infested.

**CHEMICAL CONTROL:** Growers seldom have to treat for sawflies, but feeding colonies may be treated using spot sprays. If the whole block is being treated, a mist blower or backpack sprayer may be used. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** Natural controls, primarily parasites, keep sawfly populations controlled.

**CULTURAL CONTROL:** Growers should cut off and destroy infested branches. Sawflies should be dipped in kerosene or buried 6 inches deep. Growers should avoid planting susceptible hosts and replant fields with spruce or white pine in areas frequently infested by sawflies.

### Gypsy Moth, *Lymantria dispar*

The gypsy moth is currently only found sporadically in the southern Appalachians. It is monitored and treated as needed by the Virginia Department of Agriculture and the Virginia Department of Forestry. Gypsy moth feeds on many tree species but not on Christmas trees. However, the egg masses could potentially be transported on Christmas trees.

**MONITORING:** In states such as Michigan where gypsy moth is found, Christmas trees must be inspected and treated before being shipped to pest-free areas.

**CHEMICAL CONTROL:** Currently, gypsy moth is not treated on Christmas trees in the southern Appalachians. See the *Summary – Arthropod Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended for use in Christmas tree plantations.

**CULTURAL CONTROL:** None recommended for use in Christmas tree plantations.

## Summary – Arthropod Chemical Controls

Chemical control recommendations were taken from **Pest Management Guide: Horticultural and Forest Crops, 2010**. Please see: [http://pubs.ext.vt.edu/456/456-017/Section-7 Low-Management Crops and Areas-6.pdf](http://pubs.ext.vt.edu/456/456-017/Section-7%20Low-Management%20Crops%20and%20Areas-6.pdf) for the most current control recommendations.

### **Organophosphates**

- **acephate** (*Orthene*) – Provides excellent control of sawflies, Cinara aphids (although seldom used on Christmas trees in mountains); fair control of PBA; good control of bagworms.
- **chlorpyrifos** (*Lorsban*) – Provides excellent control of bagworms, Cinara aphids, sawflies, PW, PBA, ESGA; good control of other weevils. *Lorsban* is occasionally used to control BWA. Control is enhanced when applied during the winter months when eggs are not present. *Lorsban* use has caused phytotoxicity, causing needles to drop in a small percentage of trees. Damage is often worse when the trees are under drought stress or when there is past spider mite damage. *Lorsban* was used on only 8.4% of the acreage in 2000. Effective against the BTA, its control of the SSM is enhanced with the addition of an ovicide. Control of HRM is not good. Damage is often worse when the trees are under drought stress or when there is past spider mite damage. *Lorsban* is effective in controlling grubs if it can be incorporated into the soil. This can be done before planting in the field or in seedbeds but cannot be done once the trees are planted in the field. In fields of established Christmas trees, control is often poor.
- **diazinon** (*Diazinon*) – Provides good control of weevils, PBA; excellent control of bagworms; fair control of Cinara aphids. *Diazinon* has also been used to control grubs, but control is often poor.
- **dimethoate** (*Dimethoate*) – Provides good control of bagworms, Cinara aphids, weevils, PBA; excellent control of ESGA; one of the best materials for elongate hemlock scale control but may take multiple applications with a high-pressure sprayer to achieve control. Control of BTA is excellent with *Dimethoate* while control of SSM is good, as *Dimethoate* does not have any activity against mite eggs. In 2000, growers applied *Dimethoate* on 21.2% of their acreage. When the HRM is a problem in the spring, most growers switch from *Di-Syston* to *Dimethoate*. By adding an ovicide such as *Savey*, growers will often achieve full-season control of both HRM and SSM. This is the only material that controls all three pests applied only once a year. In most instances, *Dimethoate* applications in the spring are made with an airblast mist blower. In 2000, 18.1% of growers used *Dimethoate* in a mist blower to achieve control of springtime pests. *Dimethoate* applied with a high-pressure sprayer is the only product that will control BTA after the trees have broken bud. In trees to be marketed that year where the first BTA treatment failed, applying *Dimethoate* in this manner will save the crop. *Dimethoate* is the only product that controls RBM with a single application made in early to mid-June. To control bud mites, *Dimethoate* is applied in June, during the time when the BTA are mating and laying eggs. Often, the grower can skip a BTA treatment the following year when trees are treated for RBM with *Dimethoate*. The mites are then killed in the buds. Coverage is crucial to control, and *Dimethoate* must be applied with a hydraulic sprayer.

- **disulfoton** (*Di-Syston 15 G*) – Provides good control of Cinara aphids. Control of BTA and SSM is excellent with this product although control of HRM is only fair. *Di-Syston 15 G*, being a granular, is quickly applied in the narrow treatment window for BTA control. *Di-Syston* is used on 49.6% of Christmas tree acreage and accounts for approximately 58.5% of all the insecticides used on the basis of pounds active ingredient per acre. Research has demonstrated that 30 pounds formulation per acre provides good control of BTA and SSM. It is not effective against HRM. If rust mites are present at treatment thresholds in April, an alternative pesticide such as *Dimethoate* should be chosen.
- **malathion** (*Malathion*) – Provides excellent control of bagworms, sawflies, PBA, ESGA; good control of weevils, aphids.
- **oxydemeton-methyl** (*Metasystox-R*) – Provides good control of weevils, Cinara aphids, bagworms; excellent control of PBA.

### Carbamates

- **carbaryl** (*Sevin SL*) – Provides excellent control of bagworms, Cinara aphids, sawflies, and ESGA, although it kills off natural enemies and creates subsequent problems with spider mites; good control of weevils, PBA. *Sevin* will control BTA but is used on less than 0.1% of the Christmas tree acreage. *Sevin* has been used to control grubs, but control is often poor. *Sevin* will control the RBM, but it must be applied twice (at bud break and two weeks afterward) to achieve control. Growers cannot afford to make two applications with a high-pressure sprayer.

### Chlorinated hydrocarbons

- **endosulfan** (*Thionex*) – Provides good control of bagworms, weevils, PBA; excellent control of ESGA, Cinara aphids. Control of BWA with endosulfan is excellent. Endosulfan cannot be used within 300 feet of surface water because of concerns with fish kills and the effects on other aquatic life. Hemlock rust mites have been found after the use of endosulfan. Endosulfan has activity against BTA and SSM. Adding an ovicide may achieve season-long control of SSM as well.

### Pyrethroids

- **bifenthrin** (*Talstar*) – Provides excellent control of aphids, bagworms, sawflies, PBA, ESGA. Provides good control of weevils. The control of BWA has not been as complete as with *Astro* or *Asana*. However, *Talstar* provides some SSM control, which will also aid growers. *Talstar* is the only product that will control BWA, BTA, and SSM. Adding a miticide is necessary to achieve season-long control of SSM.
- **cyfluthrin** (*Decathlon*) – Provides excellent control of bagworms, sawflies.
- **esfenvalerate** (*Asana*) – Provides excellent control of PW, PBA, ESGA; good control of weevils, bagworms; also used to control Cinara aphids. *Asana* has been used by growers for many years as an alternative to *Lindane*. The HRM often causes damage as much as 18 months after *Asana* application. Control has not been as long lasting as with *Lindane*, although in test plots, control will be as good as with *Lindane*. *Asana* is extremely effective against BTA. Some growers use this product at lower than labeled rates with a mist blower to achieve BTA control. Growers will use *Asana* from late February through

April to achieve BWA and BTA control. Adding a miticide is necessary to achieve SSM and HRM control.

- **permethrin** (*Astro*) – Provides good control of bagworms, weevils; excellent control of PBA, ESGA, Cinara aphids. However, rust mites, although not as bad as with *Asana*, have still been found following the use of *Astro*. *Astro* controls BTA as well as BWA. Adding a miticide is necessary to achieve SSM and HRM control.

### Neonicotinoids

- **imidacloprid** (*Provado*) – Provides good control of weevils, PBA, ESGA; excellent control of Cinara aphids. The imidacloprid products are systemic and therefore would not control BWA, which feeds on the bark and not the vascular system. However, *Provado* can be applied topically to the tree. Control of BWA with *Provado* has not been as good as with *Lindane* or *Asana* in field trials. *Provado* will control BTA but not SSM or HRM. Control of BTA is not as good as with *Asana* or *Di-Syston 15 G*. *Provado* use will often make spider mites worse.

### Spinosyn

- **spinosad** (*Conserve SC*) – Provides excellent control of bagworms.

### Other Chemicals

- **difluorobenzamide** (*Dimilin*) – Provides good to excellent control of weevils; fair control of bagworms when used on young caterpillars rather than when bags are large.
- **elemental sulfur**: Growers have achieved control of HRM with sulfur. Only slight control of BTA and SSM has been observed with sulfur use.
- **etoxazole** (*TetraSan/Zeal*): *TetraSan* is a new miticide that is used for the control of SSM and other mites. *Zeal* is registered for control of mites and spittlebugs.
- **fenpyroximate** (*Akari*): *Akari* has provided excellent control of HRM in hemlocks. Control was longer lasting than with *Dimethoate*. Spider mite control has been reported to also be excellent in the greenhouse.
- **hexythiazox** (*Savey*): Provides control of mite eggs. *Savey* does not kill the adult mites and must either be applied early in the season or be mixed with an adult miticide. Many growers are combining *Savey* with *Dimethoate*. Growers in some mountain counties have achieved season-long control of SSM with this mixture. However, in areas prone to spider mites because of lower rainfall, mites may come back by the end of the growing season. *Savey* does not control either BTA or HRM.
- **horticultural oil** – Provides good control of Cinara aphids, weevils, PBA, PTS, ESGA; works well against bagworms when applied early in season. Horticultural oil will control BWA when applied in the winter months. At that time, the eggs of the insect are not present. Eggs will survive oil treatment to hatch later on. Also, when trees are dormant, foliage burn is less likely. Few growers use horticultural oil because BWA control is not as long lasting as with other pesticides, and foliage burn is always a concern. Growers producing Fraser fir Christmas trees organically have used horticultural oil. Growers have used vegetable-based oil as well as petroleum-based oils. Horticultural oil will give some control of BTA and SSM. Usually, at least two applications must be made to

achieve adequate control. Control of HRM is excellent with horticultural oil. Most hemlock growers in the region use this product for rust mite control, but almost no Christmas tree growers do because they must also control BTA and SSM.

- **neem oil extract** (*Triact 70*): *Triact* has proven effective against the BTA. Control is slow, but BTA damage is minimized.
- **potassium salts of fatty acids (insecticidal soap)** – Provides good control of weevils, PBA, PTA, Cinara aphids; works well against bagworms when applied early in season. Insecticidal soap is similar to horticultural oil, providing control only when eggs are not present. Foliage yellowing has been observed with the use of soaps. Insecticidal soap should give some control of BTA, SSM, and HRM, although this has not been tested. Two applications would be necessary to achieve SSM control, as it has no reported activity against spider mite eggs.
- **pymetrozine** (*Endeavor*) – Provides excellent control of Cinara aphids. *Endeavor* is labeled for aphid control. *Endeavor* has no activity against mites.
- **tebufenozide** (*Confirm*) – Provides excellent control of bagworms.
- **thiamethoxam** (*Flagship*): *Flagship* is reported to work well against aphids. It will not control mites. *Flagship* has proven effective in white grub control in other states. *Flagship* is reported to translocate down effectively to the roots. This material may also control root aphids.

### Unregistered Chemicals

- **dicofol** (*Dicofol*): SSM control is reported as excellent, although it does not control SSM eggs. A second application must be made in 10 to 14 days, or another miticide such as *Savey* must be added to achieve full-season control.
- **isazophos** (*Triumph*): *Triumph* resulted in the best field control of white grubs in Christmas trees. However, it is no longer available in the United States.
- **oxythioquinox** (*Morestan*): *Morestan* is no longer being manufactured; however, growers did achieve full-season control of SSM with it. It has ovicidal properties.
- **pyridaben** (*Sanmite*): *Sanmite* has proven effective in controlling hemlock rust mites. It is not known if it would control rosette bud mites.
- **triazamate** (*Aphistar*): *Aphistar* is a carbamate and is an excellent systemic. Applied to the foliage, it will control root aphids in the root system. Excellent BTA control has also been observed. It will not control mites. *Aphistar* applied to the foliage will translocate down to the roots and kill root aphids effectively. Control is greatly enhanced with the addition of an adjuvant such as LI-700. *Aphistar* has a Section 18 emergency label in the Pacific Northwest for the control of root aphids on Christmas trees. It is not labeled in the southern Appalachians.

## DISEASES

### Phytophthora Root Rot, *Phytophthora* spp.

Phytophthora root rot is the biggest disease problem for Fraser fir Christmas tree production. Once sites are infested, fields can no longer be used to produce Fraser and Canaan fir.

However, growers can plant white pine in these sites if the farm is located in the pine's appropriate range. Symptoms of Phytophthora include yellow-green needles, wilting, reduced growth rate, dead branches, and tree death. Needles tend to stay on the tree but turn a rusty brown. Roots also turn rusty brown or black, and white growing tips are absent. The surface of the root can be pulled away from the inner core. Feeder roots are also absent. It may take years for trees to exhibit symptoms, which are similar to those caused by white grubs, transplant shock, drought, overwatering, or fertilizer burn. This disease tends to be most problematic in tree farms planted on old apple orchards or old pastureland.

**MONITORING:** If Phytophthora symptoms appear, growers should contact a local Extension agent to verify the disease.

**CHEMICAL CONTROL:** Metalaxyl and potassium phosphite are used to treat Phytophthora. See the *Summary – Disease Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** The best control method is prevention by using clean, healthy seedlings and transplants; selecting proper sites; and practicing proper sanitation. Growers should buy only from reputable dealers and refrain from taking seedlings from beds with dead or dying plants. Trees, especially firs, should be planted only on sites without a history of Phytophthora root rot. Soil should be well drained and not tight or clayey. Great care should be taken when moving soil around, and it may be best to leave stumps where they are. A cover crop may be sown in the fields to repair soil structure after clearing but before trees are set. Groundcovers also help to keep minimize soil movement and water runoff. Healthy roots are less vulnerable to Phytophthora infection. Fraser fir transplants should not be set deeper than 1 inch above the root collar. Excessive root pruning must be avoided at planting time. It is very important that the planting hole be large enough to comfortably hold the root system. Fertilizer should be spread evenly to avoid damaging roots. The chemical simazine damages roots, so its use should be minimized. Allow groundcovers to grow between trees to help cool soil. If Phytophthora is identified, containment should become the grower's major focus in order to reduce economic losses. Areas where trees are dying from the disease should be visited last to avoid spreading spores to uninfected soil. Growers should wear clean footwear and sterilize equipment. Mud and soil must not be carried from infected areas to clean areas. Trees may harvested early to reduce the spread of infection – selling smaller trees for less money is better than not selling them at all. Growers may replant with Norway spruce, Colorado blue spruce, and white pine, although the pines are also hosts to Phytophthora.

### **Needle Casts, Various spp.**

Needle cast is a sporadic disease that causes older foliage to turn yellow, brown, or gray-brown. Needles are often mottled or banded, and dark fruiting bodies are sometimes apparent. Many different species of fungi cause these symptoms, which are different from needle blight in that only foliage is affected. Needle cast disease symptoms resemble those caused by low pH, poor nutrition, fertilizer or chemical burn, and root rots. Fungi infect needles in spring, damage is seen the following spring, and infective spores are produced later in the season. Typically, infected needles are shed in the second year, although new growth may be lost as well.

Needle cast is particularly damaging to Douglas fir in Virginia. Once recognized, it is fairly easy to control if growers identify it early.

**MONITORING:** Growers do not usually scout for this disease unless there has been a problem in the past. Needles and fungal spores must be examined under a microscope to positively identify the disease.

**CHEMICAL CONTROL:** Growers may administer a preventive spray at bud break before the fungus begins producing spores. Trees should be treated within two years of market size. See the *Summary – Disease Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Growers should cut and burn trees with the worst disease symptoms, modify the site (harvest trees; keep weeds under control) to encourage good air movement in order to eliminate free water on foliage, and maintain good fertility. Site selection is very important, but needle cast is not as big a problem with seedlings.

### **Botrytis Blight, *Botrytis cinerea***

Symptoms of botrytis blight include gray, cottony fungal growth on infected needles and shoots. Later, the infection moves from the foliage into the stems. Shoots then become water soaked and develop lesions. Eventually, the main stem may become girdled, and the shoot will die. The disease is sometimes confused with tip moth damage in Douglas fir and other species.

**MONITORING:** No specific monitoring protocol is recommended.

**CHEMICAL CONTROL:** Thiophanate methyl provides good to excellent control if the disease is identified and treated early. Chlorothalonil is also used. See the *Summary – Disease Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Growers should maintain good cultural and sanitation practices to keep trees healthy because weak and/or frost-damaged tissues are more vulnerable to infection. Trees should be spaced properly to allow good air movement. Also, trees should be watered early in the day to ensure foliage is dry by evening.

### **Fern Fir Rusts, *Uredinopsis* spp.; *Milesina* spp.**

Fern fir rust occurs on fir trees. Cylindrical fruiting bodies form on the needles, which turn yellow and drop, thus causing cosmetic damage to the tree. Site conditions play an important role in the development of this disease.

**MONITORING:** No specific monitoring protocol is recommended.

**CHEMICAL CONTROL:** See the *Summary – Disease Chemical Controls* section for information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Growers should remove ferns close to fir trees by mowing or applying herbicides. Site selection is very important because the presence of particular species of ferns dictate whether this disease will be a problem. Shading and site preparation are also factors in the development of fern fir rust.

### **Needle Rusts, *Coleosporium* spp.**

Needle rust is a minor problem of two- and three-needle pines in Virginia. Orange blisters form on the needles, which kill the foliage and cause a slower growth rate and cosmetic damage. This disease requires pine and goldenrod/aster hosts to complete its life cycle.

**MONITORING:** No specific monitoring protocol is recommended.

**CHEMICAL CONTROL:** See the *Summary – Disease Chemical Controls* section for information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Trees should be planted on sloped sites with good airflow and must be properly spaced. Growers must control hosts by mowing in August each year or spraying with herbicides. Trees should not be planted near goldenrod or asters. Needle rust-resistant species include white spruce, Norway spruce, blue spruce, black spruce, white pine, and balsam fir.

### **Diplodia, *Diplodia pinea***

*Diplodia* causes shoot blight and stem cankers on conifers. It is spread by shearing and is a severe problem on Scotch pine but also impacts Douglas fir. Collar rot may occur in nursery seedlings, but shoot blight is common on trees of all ages. Symptoms include small, resinous branch or stem cankers and resin-soaked or dark-stained wood that leads to dieback or deformity.

**MONITORING:** No specific monitoring protocol is recommended.

**CHEMICAL CONTROL:** Azoxystrobin (*Quadris*), myclobutanil (*Myclostect*), chlorothalonil (*Bravo*), and thiophanate methyl (*Topsin*) are options for managing the disease. Bordeaux mixture was once recommended in Virginia but currently is not used as much. See the *Summary – Disease Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Grasses must be controlled in order to ensure good airflow. It is better to choose slopes that face south or west because eastern and northern slopes are more likely to have disease problems. Growers should seek to improve factors that affect tree health (e.g., site characteristics, irrigation, mechanical wounds, and insect activity).

### **Phomopsis, *Phomopsis juniperovora***

*Phomopsis* can be a serious problem on junipers and eastern red cedar. However, eastern red cedar is a species not commonly grown on Christmas tree farms. Symptoms include dead branch tips with gray fruiting bodies at the base. *Phomopsis* kills seedlings, invades the stem, and causes the formation of cankers. It is common in nurseries and in yard trees. Fungal spores enter wounds in the tree and are spread by rain, mechanical disruption, and insects.

**MONITORING:** No specific monitoring protocol is recommended.

**CHEMICAL CONTROL:** Registered chemicals include thiophanate methyl (*Topsin*), copper hydroxide (*Kocide*), and chlorothalonil (*Daconil*). See the *Summary – Disease Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Growers should not use overhead irrigation because it helps spread spores. Maintain good sanitation, rogue infected trees, and prune infected twigs before spraying.

#### **Cedar Apple Rust, *Gymnosporangium juniperi-virginianae***

Cedar apple rust mostly affects junipers (e.g., cedars) and trees belonging to the Rosaceae family (e.g., apple, crabapple, hawthorn, quince, and serviceberry). Although only a minor pest of cedar trees, it is a very serious disease of apple trees. Orange, gelatinous fruiting structures appear in the spring that later dry to woody galls. Occasionally, this fungus will kill the end of a twig beyond the gall.

**MONITORING:** No specific monitoring protocol is recommended.

**CHEMICAL CONTROL:** Mancozeb (*Penncozeb*), triadimefon (*Bayleton*), and chlorothalonil (*Echo*) are labeled for use against cedar apple rust. See the *Summary – Disease Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Growers should avoid planting alternate hosts near cedars and remove galls from trees before sporulation.

#### **Pine-Oak Gall Rust, *Cronartium quercuum***

Pine-oak gall rust, also known as eastern gall rust, is a serious disease of Scotch pine, although it is not a primary concern in Virginia. It can also affect Austrian pine, which is not an economically important species. This disease requires two alternating host species (pine and oak) to complete its life cycle. Pine-oak gall rust causes branches to swell in parts, resulting in galls up to 4 inches wide. Tree growth rate is also reduced. Mature galls exhibit white or yellow fruiting bodies that produce yellow spores in spring and are spread by wind. Severe infections cause witches' broom (multiple shoots arising from gall), branch death, and tree death.

**MONITORING:** No specific monitoring protocol is recommended.

**CHEMICAL CONTROL:** Mancozeb (*Penncozeb*) is labeled for use. See the *Summary – Disease Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Growers should remove alternate hosts, inspect pine seedlings and avoid planting those with galls, and prune infected branches to improve appearance and reduce inoculum.

#### **Air Pollution**

Symptoms of air pollution typically include yellow, red, or brown tips on new needles that are commonly preceded by yellow flecks, stipples, or bands. The precise causes of air pollution are thought to be ozone and sulfur dioxide. Of all the Christmas tree species, white pine is the most susceptible to damage due to air pollution.

**MONITORING:** No specific monitoring protocol is recommended.

**CHEMICAL CONTROL:** See the *Summary – Disease Chemical Controls* section for information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Growers should fertilize trees after symptoms appear and plant species that are resistant to the effects of air pollution.

### **White Pine Root Decline, *Leptographium procerum***

This disease is a problem in Virginia on white pine. Symptoms include chlorotic needles, wilting, resinous spots on the bole, basal cankers, and blue-black basal sapwood stains. The tree may also be killed. This disease is not a problem in natural stands.

**MONITORING:** No specific monitoring protocol is recommended.

**CHEMICAL CONTROL:** See the *Summary – Disease Chemical Controls* section for more information.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Control weevils that vector disease. Growers should remove infected trees and roots, if able, and refrain from planting white pine in poorly draining soils. Growers should not replant white pine where root decline has been a problem in the past.

### **Summary – Disease Chemical Controls**

*Chemical control recommendations were taken from **Pest Management Guide: Horticultural and Forest Crops, 2010**. Please see: [http://pubs.ext.vt.edu/456/456-017/Section-7\\_Low-Management\\_Crops\\_and\\_Areas-1.pdf](http://pubs.ext.vt.edu/456/456-017/Section-7_Low-Management_Crops_and_Areas-1.pdf) for the most current recommendations.*

*Recommendations are for Fraser fir seedbeds and liner beds.*

#### **Chemical class**

- **aluminum tris** (*Aliette WDG*) – Organophosphate. For control of Phytophthora root rot.
- **azoxystrobin** (*Quadris*) – Methoxyacrylate. For control of Diplodia and needle casts.
- **chlorothalonil** (*Daconil Zn, Echo 720*) – Organochlorine. For control of botrytis blight, needle casts, Diplodia, cedar apple rust, and Phomopsis.
- **chlorothalonil + thiophanate methyl** (*Spectro 90WDG*) – Organochlorine + Organic. For control of botrytis blight and needle casts.
- **copper hydroxide** (*Kocide*) – Inorganic copper. For control of Phomopsis.
- **copper sulfate + hydrated lime** (*Bordeaux mixture*) – Inorganic copper. For control of needle casts.
- **mancozeb** (*Penncozeb*) – Carbamate. For control of rusts.
- **metalaxyl** (*Subdue GR, Subdue WSP, Subdue MAXX, Fenox*) – Benzenoid. For control of Phytophthora root rot. *Subdue* products are only effective when used in conjunction with good cultural practices; they will not overcome poor management practices (e.g., planting on sites with poor drainage). They will not revitalize trees with moderate to severe root rot. *Subdue* is used in nurseries more than in the field.
- **myclobutanil** (*Mycotect*). For control of rusts and Diplodia.
- **potassium phosphite** (*Alude, Agri-fos, Fosphite*) – Inorganic. For control of Phytophthora root rot.
- **thiophanate methyl** (*Topsin*) – Organic. For control of Phomopsis.

- **triadimefon** (*Bayleton*) – Triazole. For control of cedar apple rust.

## VERTEBRATES – MAJOR PESTS

### White-Tailed Deer, *Odocoileus virginianus*

Deer cause damage by browsing on new growth (major problem) and by bucks rubbing their antlers on trees (minor problem). Deer prefer to feed on certain tree species. Effective control options are limited.

## VERTEBRATES – MINOR/LOCALIZED PESTS

Birds damage trees by roosting on and breaking treetops. Moles, rabbits, and groundhogs dig burrows that disrupt soil structure and can create liability issues in “cut-your-own” operations when customers fall into their holes. They are more problematic where there is thick vegetation, such as groundcovers. Voles have been known to girdle trees. They are prevalent in older plantations and nurseries (seed- and transplant beds) and are more troublesome where straw or vegetation provides cover to allow girdling to take place unnoticed. Bears can damage trees but are a local problem.

**MONITORING:** No specific monitoring protocol is recommended, but growers should be aware of the signs indicating vertebrate pests are present.

**CHEMICAL CONTROL:** Most growers need a special permit to control vertebrate pests. Control is restricted to nonprotected species (including five rodents and eight bird species). Poison baits are sometimes used.

**BIOLOGICAL CONTROL:** None recommended.

**CULTURAL CONTROL:** Practice proper vegetative control.

## WEEDS

Generally, weeds compete with Christmas trees for water, nutrients, light, and space. Weeds can inflict serious quality defects on Christmas trees to the point of making trees unmarketable. Thick weeds underneath trees can ruin their shape and kill lower branches. Vines can distort the tops of Christmas trees. Large weeds like pokeweed or hardwood sprouts can overtop and shade young Christmas trees. Competition from weeds can add years to the production cycle if not properly managed. Other weeds such as poison ivy or brambles can injure workers. Also, dry weeds can provide fuel to flash fires in Christmas tree fields. Furthermore, certain weed management practices can attract pests such as grubs and voles. However, weeds also provide food and habitat for desirable wildlife such as beneficial insects and songbirds. For these reasons, proper weed management is critical to effective IPM in Christmas trees.

Hundreds of weed species representing many diverse groups of plants may be present in Christmas tree fields. Weeds are grouped as summer- or winter-germinating annuals or perennials and as grasses, grasslike sedges, or broadleaf weeds. For practical management,

weeds are categorized by the biological characteristics that determine the herbicide mode of action to be used for control. For preemergence herbicides, the season a weed germinates and the primary weed class to which it belongs are key distinctions. For selective postemergence herbicides, controls are divided along the lines of the major weed classes and families. Some herbicides control grasses while others control only broadleaf weeds. The herbicide and application rate may vary with the life cycle of the weed and whether it is an annual, a biennial, or a perennial. While these distinctions are oversimplified, they adequately match most weeds to the appropriate herbicide tool and serve as a way to organize weed pests.

Not all weeds are solely problems to be controlled. Many low-growing annual and perennial weeds can serve as beneficial groundcovers (Table 3). These plants minimize soil erosion and keep the root zone cool while providing minimal competition for water and nutrients. Some also serve as a habitat for beneficial predators. It is important to keep in mind that some groundcovers can be competitive or grow too tall unless they are suppressed by a low rate of postemergence herbicide. Followers of good IPM strategies lightly suppress the desirable groundcovers while killing or heavily suppressing the undesirable weeds. Over time, with repeated suppression and spot treatment of problem weeds, plant populations shift to favor desirable groundcovers.

Once the management of a natural groundcover becomes an IPM goal, the perception of problematic weeds changes as well. If a weed is not a desirable groundcover, it is then considered either a manageable or a problem species. Pest weeds are those that escape the herbicide suppression program and impair tree growth or quality. These undesirable weeds may require additional treatments, higher herbicide rates, or possibly the sacrifice of desirable groundcovers to achieve control. However, most weeds can be eliminated with spot treatments of postemergence herbicides applied at lethal rates during the fall. If an undesirable weed can be managed within the context of the groundcover suppression program, it is not really a problem weed. As more growers rely almost exclusively on low-suppression rates of glyphosate herbicide, susceptibility or tolerance of a weed to that one material has become the primary weed management decision.

Table 3. Desirability of weeds in Fraser fir Christmas trees based upon weed height, competitiveness, and postemergence herbicide suppression<sup>1</sup>

Desirable	Manageable	Undesirable
Chickweed	Asters	Bindweeds*
Creeping buttercup	Cool-season grasses	Briars*
Dandelion	Horsenettle	Burdock & thistle*
Dwarf buttercup	Horseweed	Catchweed bedstraw
False dandelion	Lambsquarters	Dayflower*
Ground mint	Most annual grasses	Established pokeweed*
Nimblewill	Mustard	Evening primrose*
Plantain	Pigweed	Goldenrod
Red sorrel	Ragweed	Greenbriar*
Trailing cinquifol	Seedling pokeweed	Hardwood sprouts*
Violet	Wild carrot	Poison ivy*
White clover	Yarrow	Trumpet creeper*
Wild strawberry		Vines
Yarrow		Virginia creeper*
		Wild buckwheat

<sup>1</sup> From Toth, S., et al., 2004.

\* These weeds will likely need spot treatment with a postemergence herbicide applied at a lethal rate.

Weed management in Christmas trees has evolved into an IPM system based on periodic monitoring of weed size, vigor, and species. Control tactics have shifted from primary dependence on preemergence herbicides to postemergence herbicides. Pesticide decision-making now involves the consideration of soil conservation and the establishment of beneficial groundcovers along with weed control. With the use of suppressive rates of postemergence herbicides, native weed populations have become a soil management tool that many growers manipulate for a desired balance of surface cover, cooler soil temperatures in summer, nitrogen fixation, water percolation, and surface durability.

For many growers, the area of greatest concern is the management of weeds in their seedling and transplant nurseries. Only a few herbicides are labeled for Christmas tree nurseries, and young Fraser fir seedlings and transplants have less tolerance of those herbicides than do established trees. Few growers still fumigate their beds for weed and disease control. Therefore, the product *Goal* is particularly important, both as a pre- and postemergence herbicide for broadleaf and grass weeds. *Vantage* is the primary tool to control grasses that escape *Goal*. Some growers use dormant-season applications of *Roundup* to address perennial weeds such as briars. Many resort to hand removal of weeds that escape these limited strategies. Currently, no strategy provides optimal control of yellow nutsedge.

## WEED GROUPS

### Cool-Season Perennial Grasses

Cool-season perennial grasses such as tall fescue, fine fescues, Kentucky bluegrass,

quackgrass, and orchardgrass are highly competitive with Christmas trees for water and nutrients. Allowed to grow unchecked, these grasses can shade bottom branches and ruin the shape of Christmas trees. All cool-season grasses can be eliminated by labeled rates of either preemergence or postemergence herbicides. Most can be eliminated over several seasons of suppression using repeated applications of low rates of postemergence herbicides. In areas where particularly aggressive patches of grasses (e.g., quackgrass) are established, fall spot treatment with lethal rates of postemergence herbicide may be justified. Cool-season grasses provide ideal habitat for white grubs. On tree sites that were formerly pastureland, grasses should not be completely eliminated from between the trees in order to provide an alternative food source for white grubs. Grubs are particularly attracted to mown grass. By allowing a rough weed height profile to rise from the growth of broadleaf weeds, additional egg laying by beetles may be discouraged.

### **Summer Annual Broadleaf Weeds**

Weeds such as ragweed, pigweed, horseweed, and lambsquarters begin to germinate as soon as the soil warms up in late spring. Germination can occur any time during the summer when the soil surface is exposed to sunlight. Improperly managed, dense stands of summer annuals can grow tall very rapidly. Management problems arise more from shading the trees and physically impeding tree farm workers than from competition for water and nutrients. Thick stands get in the way of any summertime activities, especially shearing Christmas trees. By the middle of winter, a field predominantly covered with dead and decayed summer annuals will often lack adequate groundcover to avoid soil erosion. On the positive side, coarse annual root systems of broadleaf weeds are less competitive than perennials or grasses for water and nutrients. The roots of annual broadleaf weeds also create extensive pore spaces in the soil after they rot. In newly planted fields, a light stand of summer annuals provides shade to trees and can ease transplant shock. Most summer annual weeds can be kept in check with suppressive rates of postemergence herbicides. Although the weeds may not die, their height, density, and seed production will be reduced. Postemergence herbicide effectiveness can vary from season to season if growers do not pay attention to the timing of initial summer annual weed germination. By delaying weed suppression treatments until weeds such as ragweed and pigweed have germinated, uniform suppression is much more likely. Applying lethal rates of either preemergence or postemergence herbicides can open the site to new waves of seed germination later in the summer and encourage establishment of undesirable perennial weeds. Fall treatment of summer annual broadleaf weeds with *Roundup* accomplishes little if seed has already matured because the weeds will die during the first killing frost.

### **Summer Annual Grasses**

Weeds such as foxtail, panicum, crabgrass, and barnyardgrass follow a pattern of development and timing of treatment very similar to summer annual broadleaf weeds. Germination is governed by soil temperature and the availability of open soil. Germination will continue until days shorten and soils cool in the fall. Some grasses can become extremely thick in just a few weeks. When a thick stand of annual grasses is killed or dies from frost in the fall, it can be a fire

concern and may leave the soil bare and subject to erosion in the winter. Weed growth must be monitored and treatment timing adjusted accordingly. Annual grasses are easily killed or suppressed by several postemergence herbicides, including products selective for grasses. While several preemergence herbicides will interrupt the germination of summer annual grasses, the grasses are often the first weeds to come back in the bare ground of a preemergence band as it begins to fail in midsummer.

### **Winter Annuals**

Weeds such as mustard, henbit, chickweed, pepper weed, and catchweed bedstraw germinate in late summer or fall and overwinter as small seedlings. Winter annuals undergo rapid growth in early spring and usually die by early summer. Most are easily suppressed or killed by postemergence herbicides. If preemergence herbicides are used without the addition of a postemergence herbicide, they should be applied in the fall before winter annual germination occurs. Some growers have managed winter groundcovers of chickweed and henbit to protect soils through the winter. Catchweed bedstraw is a winter annual vine that can be particularly difficult to control because it can germinate in midwinter and grow under the partial protection of a Christmas tree's lower limbs. Spring applications of postemergence herbicide often fail to kill all the seedlings. Fall treatments of a preemergence herbicide will inhibit germination. Establishment of a solid perennial groundcover will also minimize germination of this winter annual.

### **Biennial Broadleaf Weeds**

Biennial weeds require two growing seasons to complete their life cycles. Wild carrot, common mullein, and certain thistles germinate and form a low-growing rosette of leaves in the summer or fall of the first year and grow a tall flower stalk in the second year. After producing seed the second year, they die. Biennials that appear to be innocuous in their first year can become a major impediment to traffic and shearing operations in their second year. Biennials can be controlled by a number of different preemergence and postemergence herbicides. Most growers apply postemergence herbicides in spring or early summer to kill or suppress the weeds before they produce flower stalks. Glyphosate will control most members of this weed group. Clopyralid, a selective postemergence herbicide, is particularly effective on thistles but not on Queen Anne's lace or mullein.

### **Perennial Broadleaf Weeds**

Perennial weeds live two or more years. Many different broadleaf weeds fall into this category and have diverse means to reproduce and survive winter. Many herbaceous weeds die back to their roots, stolons, or storage roots. For example, wood violets produce corms, wild garlic sprouts from bulbs, and pokeweed has a large woody crown and thick root. Japanese knotweed and peppermint are examples of weeds with rhizomes (underground stems). Yellow nutsedge spreads by rhizomes and overwinters as tubers. Woody plants generally survive winter with both dormant stems and roots intact. Because they can store energy from year to year and

have an array of different characteristics, many perennials are difficult to control. Management of perennial weeds has largely been addressed in the previous discussion of the IPM approach. Preemergence herbicides have a place in controlling the germination of perennial seedlings in bare ground conditions. Where perennials are already established, postemergence herbicides are necessary. Many perennials are kept in check through regular suppression herbicide applications. Several weeds generally need additional treatments at higher rates to be completely eliminated. These include woody vines, hardwood stump sprouts, established pokeweed, and brambles. Where growers opt for less intensive site preparation, woody sprouts and vines can be a greater problem. Nonselective herbicides can be very effective during site preparation and in spot treatments in the fall after Christmas tree foliage has hardened off. Virtually all perennial weeds can be controlled through a complement of nonselective herbicides although several seasons of treatment may be needed for some weeds.

### **CULTURAL/ALTERNATIVE WEED CONTROL METHODS**

- Mowing
  - Used in conjunction with preemergent bands under trees
  - Practiced primarily in southern mountains with gentler terrain
  - Aggravates white grub problems
  - Favors grasses that are competitive for water and nutrients
  - More expensive than weed suppression (chemical mowing)
  - Less acreage being mowed than in past
  - Will always be used on main roads
- Fabric mulches
  - Used in organic production
  - Labor intensive to install
  - Problems with string trimming or mowing
  - Problems with rodents
  - Will last two or three years without covering with mulch
- Organic mulches
  - Poor weed barrier
  - Labor intensive and expensive
- Sown groundcovers
  - Can work after recent tillage
  - Better germination if rolled for good soil contact
  - Some species will inhibit weed germination (rye, oats, fine fescue, and plantain)
  - Increasing interest among growers
- Chemical mowing
  - Very low rates of glyphosate, or clopyralid + sethoxydim + oxyfluorfen
  - Glyphosate suppression is becoming dominant weed management practice
  - Encourages low-growing perennial groundcover, especially white clover

### **CURRENTLY REGISTERED/RECOMMENDED HERBICIDES**

Other herbicides may be registered, but the following chemicals are recommended in the 2010 PMG. Be sure to read labels and make sure products are labeled for use on the right tree species. See the PMG for most current recommendations and efficacy data.

[http://pubs.ext.vt.edu/456/456-017/Section-7\\_Low-Management\\_Crops\\_and\\_Areas-7.pdf](http://pubs.ext.vt.edu/456/456-017/Section-7_Low-Management_Crops_and_Areas-7.pdf)

### **PREEMERGENCE HERBICIDES**

- **dimethenamid** (*Tower 6EC*) – Chloroacetamide
  - Preemergence control of annual grasses, yellow nutsedge, and certain broadleaf weeds; similar uses as S-metolachlor; applied as directed spray either before bud break or after new growth has hardened; not for use on Norway spruce, Scotch pine, or white pine.
- **flumioxazin** (*Sureguard*) – N-phenylphthalimide
  - Preemergence control/early postemergence control of most annual grasses and broadleaf weeds; can be applied over top of dormant trees; long residual; controls triazine-resistant weeds; could apply only two applications of herbicide annually with this product; controls hoary alyssum (a weed not controlled by other preemergence herbicides).
- **napropamide** (*Devrinol 50DF*) – Propionamide
  - For control of most annual grasses and certain annual broadleaf weeds, apply before weed germination in fall or early spring.
- **oryzalin** (*Surflan*) – Dinitroaniline
  - Good to excellent preemergence control of most annual grasses and certain annual broadleaf weeds; will control triazine-resistant weeds. Needs 2 inches of rain within 21 days after application; expensive; not used on newly planted trees (such applications can girdle the stem at the soil line).
- **oxyfluorfen** (*Goal*) – Diphenylether
  - Good preemergence and early postemergence control on most annual grasses and broadleaf weeds; most important herbicide in nurseries; expensive.
- **pendimethalin** (*Pendulum Aqua Cap*) – Dinitroaniline
  - Excellent preemergence control of most annual grasses and certain annual broadleaf weeds; same family as *Surflan* but less phytotoxic; needs rainfall to activate (2 inches to 1 inch); less expensive than *Surflan*; stains equipment.
- **pronamide** (*Kerb*) – Benzamide
  - RESTRICTED USE; not used much anymore; good for cool-season grasses, especially quackgrass, fescue, bluegrass, and orchardgrass; good for high organic sites; must be applied when soil temperature is less than 55°F; expensive (reason for limited use); more water soluble than other soil-applied herbicides and can move down slope.
- **s-metolachlor** (*Pennant Magnum*) – Chloroacetamide
  - Provides good preemergence control of annual grasses and yellow nutsedge; problems with weed control at nondamaging rates; needs water to activate the herbicide; reasonable cost.
- **simazine** (*Princep*) – Triazine

- Preemergence control of most annual grasses and broadleaf weeds; poor weed control on higher organic sites; triazine-resistant weeds (ex. ragweed, lambsquarter, and pigweed); tank mixed with a killing rate of *Roundup* to maintain bands; public concerns about groundwater contamination; most widely used preemergence herbicide in Christmas trees due to low cost; grower concern about potential loss; not a season-long product; late-season weeds are not controlled.

### **POSTEMERGENCE HERBICIDES**

- **clethodim** (*Envoy Plus*) – Cyclohexanedione/Cyclohexenone/Oxime
  - Good control of annual and perennial grasses; not used as widely as *Vantage* among grass-selective herbicides; expensive; safe applied over the top of trees; may need repeat application for perennial grass control.
- **clopyralid** (*Stinger*) – Pyridinecarboxylic acid
  - Very selective broadleaf herbicide; low rates (3 to 5 ounces per acre); great on legumes and most composite weeds (e.g., clover, vetch, thistles, spotted knapweed, and ragweed); very expensive compared to *Roundup*; relatively cost-effective due to very low rates; need to control weeds when small and actively growing; can be applied over the top of trees; not labeled for use on Norway spruce.
- **fluazifop-P-butyl** (*Fusilade II*) – Aryloxyphenoxy propionate
  - Excellent postemergence control of annual grasses and perennial grasses, especially quackgrass; grass needs to be actively growing and not under stress; can be used in combination with other herbicides; timing critical; more effective on smaller grasses; no residual; *Vantage* used more commonly in North Carolina; can be applied over the top of selected trees, but use as directed spray after bud break until new growth hardens; repeat application may be necessary on some perennial grasses.
- **glyphosate** (*Roundup* and others) – Glycine/Phosphoric acid
  - Excellent control of a wide variety of emerged weeds; nonselective; use low rates during season (4 to 8 ounces) for vegetation suppression; most widely used herbicide; very inexpensive; cost-effective; no residual; conifers most tolerant to glyphosate in fall; do not allow to contact Christmas tree foliage.
- **oxyfluorfen** (*Goal*) – Diphenylether
  - Good preemergence and early postemergence control of most annual grasses and broadleaf weeds; most important herbicide in nurseries but not used as much in field; expensive; contact burn of weed foliage.
- **paraquat** (*Gramoxone Inteon*) – Quaternary ammonium
  - Applied as directed spray for contact kill of emerged annual weeds; perennial weeds require repeated applications; do not allow to contact Christmas tree foliage or any other desired vegetation.
- **sethoxydim** (*Segment/Vantage*) – Oxime

- Good to excellent control of annual and perennial grasses; no residual; can be applied over the top of Christmas trees without injury; more effective on younger, actively growing grasses (not under moisture stress); can be used in combination with other herbicides, usually *Goal* for vegetation suppression; used extensively in nurseries; growers are using suppression rates of *Roundup* instead.

## ABBREVIATIONS

BTA – balsam twig aphid  
 BWA – balsam woolly adelgid  
 CSGA – Cooley spruce gall adelgid  
 ESGA – eastern spruce gall adelgid  
 EPW – eastern pine weevil  
 HRM – hemlock rust mite  
 HWA – hemlock woolly adelgid  
 NPTM – Nantucket pine tip moth  
 PBA – pine bark adelgid  
 PNS – pine needle scale  
 PRCW – pine root collar weevil  
 PSB – pine spittlebug  
 PTS – pine tortoise scale  
 PW – pales weevil  
 RBM – rosette bud mite  
 SSM – spruce spider mite  
 VPS – Virginia pine sawfly  
 WG – white grubs  
 WPA – white pine aphid  
 WPW – white pine weevil

## CONTACTS

### **Developed and Written by:**

#### **Holly A. Gatton**

IPM Project Manager  
 Virginia Polytechnic Institute and State University  
 Department of Entomology  
 Virginia Tech Pesticide Programs  
 302 Agnew Hall – 0409  
 Blacksburg, VA 24061  
 Ph: 540-231-6543  
 Fax: 540-231-3057  
 E-mail: [hgatton@vt.edu](mailto:hgatton@vt.edu)

**Collaborating Authors:**

**Pesticides:**

**Michael J. Weaver**

Professor and Extension Pesticide Coordinator  
Virginia Polytechnic Institute and State University  
Department of Entomology  
Virginia Tech Pesticide Programs  
302 Agnew Hall – 0409  
Blacksburg, VA 24061  
Ph: 540-231-6543  
Fax: 540-231-3057  
E-mail: [mweaver@vt.edu](mailto:mweaver@vt.edu)

**Edited by:**

**Susan E. Terwilliger**

Editor  
Virginia Polytechnic Institute and State University  
Department of Entomology  
Virginia Tech Pesticide Programs  
302 Agnew Hall – 0409  
Blacksburg, VA 24061  
Ph: 540-231-6543  
Fax: 540-231-3057  
E-mail: [snessler@vt.edu](mailto:snessler@vt.edu)

**Other Contacts:**

**Christmas Trees:**

**Kyle Peer**

AREC Superintendent/Extension Specialist for Christmas Trees  
Virginia Polytechnic Institute and State University  
Department of Forestry  
Reynolds Homestead Forest Resources Research Center  
P O Box 70  
Critz, VA 24082  
Ph: 276-694-4135  
Fax: 276-694-2971  
E-mail: [krpeer@vt.edu](mailto:krpeer@vt.edu)

**Insects:**

**Eric R. Day**

Extension Entomologist

Virginia Polytechnic Institute and State University  
Department of Entomology  
205A Price Hall – 0319  
Blacksburg, VA 24061  
Ph: 540-231-4899  
E-mail: [idl@vt.edu](mailto:idl@vt.edu)

## ONLINE RESOURCES

Mount Rogers Christmas Tree Growers Association, <http://www.mtrogersfraserfir.org/>  
Virginia Christmas Tree Growers Association, <http://www.virginiachristmastrees.org/>  
Virginia Cooperative Extension, <http://www.ext.vt.edu/>  
Virginia Department of Forestry, <http://www.dof.virginia.gov/index.shtml>

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