



IPM Elements for Christmas Trees in Virginia and North Carolina

The purpose of this document is to consolidate current integrated approaches to Christmas tree pest management in North Carolina and Virginia. The goals are: 1) to form a general working definition of Integrated Pest Management (IPM) for Christmas tree production, and 2) to develop a system of assessing how well growers adopt IPM guidelines, and if their operations have implemented enough core practices to qualify them as "IPM Practitioners" under these guidelines.

Growers should use this document and its sub-headings as a checklist of possible IPM practices. Growers should count only the activities they perform in their Christmas tree pest management practices and aim to be compliant with 80% of the activities listed below.

This document is intended to help Christmas tree growers identify areas in their operations that possess strong IPM qualities and also point out areas for improvement. Growers should attempt to incorporate the majority of these specific techniques into their usual production and maintenance practices, especially in areas where they fall short of the 80% goal.

Pests & Diseases of Christmas Trees

DISEASES	ARTHROPODS	WEEDS/VERTEBRATES
<p style="text-align: center;"><u>Major Diseases:</u></p> <p style="text-align: center;">Phytophthora Root Rot Eastern Gall Rust Botrytis Pine Oak Gall Rust Fern Fir Rust White Pine Root Decline Diplodia</p> <p style="text-align: center;"><u>Minor Diseases:</u></p> <p style="text-align: center;">Needle Cast Needle Rust Ammosum Root Rot Phomopsis Cedar Apple Rust</p>	<p style="text-align: center;"><u>Major Pests:</u></p> <p style="text-align: center;">Balsam Woolly Adelgids Balsam Twig Aphids Spruce Spider Mites Hemlock Rust Mites White Grubs Rosette Bud Mites Cinara Aphids Elongate Hemlock Scales</p> <p style="text-align: center;"><u>Minor Pests:</u></p> <p style="text-align: center;">Bagworms E. Spruce Gall Adelgids Pine Bark Adelgids Weevils Pine Sawflies Gypsy Moths</p>	<p style="text-align: center;"><u>Major Weed Pests:</u></p> <p style="text-align: center;">Vines Briars Burdock & Thistle Evening Primrose Hardwood Sprouts Dayflower Established Pokeweed</p> <p style="text-align: center;"><u>Vertebrate Pests:</u></p> <p style="text-align: center;">Deer Birds Moles Rabbits Ground Hogs Mice & Voles Bears</p>

	Check if done
I. SITE SELECTION/MAINTENANCE & PLANTING SYSTEMS:	
1. Choose a well-prepared site (treated for white grubs if necessary) that is not too warm and dry [to prevent spruce spider mites (SSM)] nor too moist (to prevent Phytophthora root rot).	
2. Do not plant young trees among older trees in partially harvested fields to avoid the quick spread of Balsam Woolly Adelgid (BWA) and Rosette Bud Mite (RBM) to younger trees. It is better to clear-cut a block of trees prior to replanting.	
3. For Fraser fir, choose sites that have rich, loamy, well-drained soils.	
4. Avoid sites that have poor fertility, are dry, and have prior grub damage.	
5. Avoid planting trees on farms at lower elevations or on windy, exposed ridges. Also avoid southern or southwestern exposures and sites adjacent to dusty, gravel roads. Arid, dusty conditions favor SSM while repelling natural enemies. Organic growers in particular should pay heed to site characteristics.	

6. Scout for white grubs (WG) in the fall prior to planting, and treat if necessary.	
7. Ground cover management – allow ground covers between trees to flower and attract beneficial insects (e.g., syrphid flies, lacewings, lady beetles, predatory mites) that naturally control tree pests. Native, flowering vegetation is very important to reducing Balsam Twig Aphid (BTA) and SSM.	
II. SOIL MANAGEMENT, FERTILIZATION, & IRRIGATION:	
1. Maintain good fertility to avoid problems with RBM. However, nitrogen fertilization has been shown to increase BWA population numbers, so avoid overfertilizing.	
2. Collect soil samples for analysis prior to fertilization at depths of 0 – 4 inches, 4 – 8 inches, and 8 – 12 inches. Mountain soils are typically low in phosphorous and calcium.	
III. TREE TRAINING & CROP MANAGEMENT:	
1. Pruning – Early removal of double leaders and lateral tips on young trees will encourage increased trunk caliper as well as additional buds on interior branches.	
2. Shearing early and lightly will encourage good bud set, thus helping to offset effects of RBM on tree quality.	
3. Trim bottom branches of trees to make conditions unsuitable for pine root collar weevil.	
IV. PEST MONITORING, FORECASTING, & MANAGEMENT:	
1. Scout fields annually for BWA.	
2. Identify the presence of other pests and diseases. Implement disease-management strategies, if necessary.	
3. Scout for SSM and Hemlock Rust Mites (HRM) prior to implementing BTA control in spring so a broader pesticide than Di-Syston (no longer available after 2009) may be used, if necessary. Scout for BTA to see if treatment was successful.	
4. Scout for WG during initial site selection and preparation, especially in seedling beds and new fields that were once pasture land.	
5. Scout for Pine Bark Adelgid (PBA) in spring when new growth is lengthening. Chemical control is only necessary if PBA are present in very high numbers. Otherwise, less toxic control methods are preferred. See the Arthropod Pest section for more information.	
6. Scouting is most important for BWA, Elongate Hemlock Scale (EHS), SSM, HRM, and PBA. Second most important: RBM, bagworms, WG, Eastern Spruce Gall Adelgid (ESGA), Cinara aphids (CA), and weevils. Scouting is only minimally helpful in controlling BTA.	

7. Time pesticide application to least impact beneficials and to help prevent secondary pest problems.	
8. Combine pest treatments, if possible, to maximize efficiency.	
V. GROUNDCOVER & WEED MANAGEMENT:	
1. Chemical mowing uses low rates of glyphosate or other chemicals to help suppress weeds. Glyphosate suppression is becoming the dominant weed management practice, and it is beneficial because it permits low-growing perennial ground cover (e.g., white clover) to flourish. Be aware that some weed species are developing glyphosate resistance; therefore, monitor fields to determine if alternative spot sprays of certain weeds are necessary.	
2. Utilize chemical mowing to stunt weeds if control cannot be maintained using mechanical methods. Chemical mowing has also been shown to reduce the WG population, if present, while conventional mowing attracts these pests.	
3. Employ groundcover management techniques that will reduce soil erosion, nutrient runoff, and herbicide use.	
4. Conserve <u>beneficial weeds</u> (e.g., chickweed, trailing cinquefoil, dandelion, false dandelion, creeping & dwarf buttercup, white clover, nimblewill, wild strawberry, red sorrel, plantain, ground mint, violet) and some manageable weeds (e.g., yarrow) because they minimize soil erosion and keep the root zone cool. These weeds also provide surface cover, improve soil nitrogen levels, allow water percolation, and improve surface durability. With the benefits in mind, lightly suppress desirable ground covers while killing or heavily suppressing undesirable weeds with spot treatments. Periodically monitor weed size, vigor, and species composition. Consider soil conservation and establishment of beneficial ground covers as well as how to control weeds. However, options are limited in nursery settings, so hand weed when possible.	
5. <u>Cool season perennial grasses</u> can be eliminated over several seasons through suppression tactics or with fall and spring glyphosate applications. Keep in mind that grasses are attractive to WG so do not completely eliminate them, particularly in between tree rows because it gives the grubs other targets besides tree roots. Also, the beetles that produce WG are attracted to mowed grass so let weeds reach a height unattractive to egg-laying females.	
6. <u>Summer annual broadleaf weeds</u> impede summertime activities such as shearing trees. They also increase soil erosion because they are dead by winter. However, they are beneficial to newly planted fields, and light stands of summer annuals provide shade, ease transplant shock, and leave pore spaces in the soil after they rot. Control summer annuals with suppressive rates of post-emergence herbicides, but wait until ragweed and pigweed have germinated. Herbicides need not be applied in the fall because these weeds have already gone to seed and will die soon enough.	
7. <u>Summer annual grasses</u> should be monitored and treatments must be timed properly. Spray with suppressive or lethal doses of post-emergence herbicides selective for grasses.	
8. <u>Winter annual weeds</u> can be suppressed or killed with post-emergence herbicides. Winter covers of chickweed and henbit can be managed to protect	

soils in winter. Catchweed bedstraw is difficult to control, but fall treatments of pre-emergence herbicides can be administered to inhibit germination. Establish a solid perennial ground cover to further minimize germination of weeds.	
9. <u>Biennial broadleaf weeds</u> can be controlled using post-emergence herbicides to suppress or kill weeds prior to flower stalk formation in spring or early summer.	
10. <u>Perennial broadleaf weeds</u> can be controlled using pre-emergence or post-emergence herbicides but are usually controlled by regular suppressive herbicide applications. Woody vines, hardwood stump sprouts, established pokeweed, and brambles need extra treatments at high rates to eliminate. Site preparation is important because less intensive preparation methods may allow woody sprouts and vines to be more problematic. Use nonselectives in site preparation and spot treatments in fall after foliage has hardened off.	
11. Mechanical mowing can be harmful because WG become more numerous, competitive grasses tend to flourish, and it is more expensive than chemical mowing. For these reasons, where possible, conventional mowing should be restricted to main roads.	
12. Fabric mulches are used mainly in organic production. This weed control technique is labor intensive but lasts 2 to 3 years. However, rodents may become an issue and it can be difficult to use a mower or weed-eater around the fabric.	
13. Organic mulches provide a poor weed barrier, and they are labor intensive and expensive to apply.	
14. Sown groundcovers effectively control weeds after recent tillage. Better germination occurs if rolled for good soil contact, and some species actually inhibit weed germination (e.g., rye, oats, wheat, barley, plantain). Frost-seeding legumes such as white clover in late winter proves to be a reduce input method of groundcover establishment.	
15. Clear tall and noxious weeds to allow workers access to trees for annual shearing.	
16. Conserve beneficial natural enemies if possible. For example, weevils may offer some control of thistles and knapweed.	
17. Avoid bare ground production practices that promote annual weed growth, increased soil temperatures, increased SSM problems and loss of topsoil due to erosion.	
VI. DISEASE MANAGEMENT: Be sure to correctly identify and regularly monitor diseases BEFORE attempting chemical controls.	
1. Learn to recognize and identify Christmas tree diseases.	
2. <u>Phytophthora root rot</u> is a major problem for Fraser fir Christmas tree production. Once sites become infested with this disease, Fraser and Canaan fir trees can no longer be grown there, but fields can potentially be replanted with white pine, Colorado blue spruce, or Norway spruce. However, white pines may die if disease pressure is high enough. Ensure seedlings and transplants are healthy by not using previously infected sites for seedling or transplant beds. Beds should drain well, should not be at risk of flooding, and the soil must not be too tight or clayey. Contact a local Extension Agent to identify the definitive	

<p>cause of symptoms resembling Phytophthora; many other pests cause similar symptoms. For transplanting, choose sites with good drainage; heavy clay soils do not drain well and are not suitable. If clearing fields, avoid soil compaction and loss of topsoil. Phytophthora tends to be a problem in old apple orchards, but not pasture land. Sow a cover crop to repair soil before trees are set. Keep roots healthy by not setting Fraser transplants deeper than 1 inch above root collar. Avoid excessive root pruning when planting. Spread fertilizer evenly. Allow ground covers to grow between trees, thus keeping the soil cool. If disease is identified, quarantine infested areas of field. Avoid spreading infected soil to healthy areas by cleaning soil off boots and equipment with water and bleach. Use a ground cover on infected areas to reduce spread of fungal spores. Divert water if it flows from infected to healthy part of field. Harvest early; it is better to sell smaller trees than lose larger ones to disease. The best control method is to avoid sites becoming infected in the first place. Be sure to use disease-free transplants. If phytophthora is suspected, plant diagnostic samples must include both plant and soil from immediate location of the diseased plant(s).</p>	
<p>3. <u>Botrytis</u> may be confused with tip moth damage in Douglas fir, so be sure the problem has been properly identified before applying chemicals. Control is good or excellent when thiophanate methyl is applied early.</p>	
<p>4. <u>Needle cast</u> can be prevented by spraying at bud break. Site selection is important for preventing and controlling this disease. Remove severely damaged trees and treat if within two years of marketing. Scouting should be done if needle cast has been a problem in the past.</p>	
<p>5. <u>Fern fir rust</u> causes cosmetic damage to trees and is a problem on Fraser fir in North Carolina. Site selection is important because ferns vector the disease. Be sure to <u>prepare the site properly before planting</u>.</p>	
<p>6. <u>Diplodia</u> can be a serious problem on Scotch pine and Douglas fir. Suppress ground vegetation to ensure good airflow. Plant on southern or western slopes (eastern and northern slopes are more prone to problems). Use chemical options, if necessary.</p>	
<p>7. <u>Eastern gall rust</u> can be controlled by removing infected trees and the alternate hosts of the disease (e.g., yellow pine, oak).</p>	
<p>8. <u>Air pollution</u> damage is not caused by a biotic factor, but it is an important disease, nonetheless. Fertilize trees after symptoms appear and use resistant species (e.g., white pine).</p>	
<p>9. <u>White pine root decline</u>, or <u>Procerum root disease</u>, can be controlled by eliminating the weevils that vector this disease.</p>	
<p>VII. PEST MANAGEMENT: Be sure to correctly identify and regularly monitor pest populations BEFORE attempting chemical controls.</p>	
<p>a. Arthropod Management:</p>	
<p>1. Prune or remove pests by hand (bagworms, ESGA); remove and destroy immature cones (BTA).</p>	

<p>2. Balsam woolly adelgid is managed by cutting down large trees if treatment is unfeasible. Field trees are culled and burned when they have been without a straight top for 2 years or more, but not when crawlers are present, and trees should NEVER be dragged when crawlers are active to avoid the spread of pests. Horticultural oils or insecticidal soaps help control all BWA life stages except eggs. However, oils and soaps may cause foliage burn or yellowing, so use with caution. Use chemical controls only as a last resort and keep in mind that secondary pests such as HRM and scales tend to proliferate and cause damage after the application of some pyrethroids and chlorinated hydrocarbons. Do not interplant young trees with older trees. Lady beetles and syrphid fly larvae provide fair to good control.</p>	
<p>3. Spring pests, such as BTA, SSM, HRM, and BWA should be treated at the same time in spring on trees nearing market size, preferably during the year of sale and the year prior to sale. For BTA, spray in late winter/early spring before bud break when aphids enter new growth and become protected from pesticide spray. Avoid use of broad spectrum pesticides because SSM will proliferate. Synthetic pyrethroids encourage development of HRM, as well. Usually miticides must be added to spray to get complete control of primary pests and secondary pests. Neem oil can be used to control BTA, but it works slowly. One application of horticultural oil will give fair to good control of BTA and SSM but it is excellent for controlling HRM. Sulfur is effective against HRM but offers only fair control of BTA and SSM. Lady beetles, syrphid fly larvae, and predatory mites provide good to excellent control of SSM and BTA.</p>	
<p>4. White grubs are most damaging in May and June when they feed on roots. Seedlings are most vulnerable and may never grow well once attacked. Avoid planting trees in old pastures already infested with grubs. Apply chemical controls during site preparation if grubs are present. Chemical mowing has been shown to reduce the white grub population over time, although once control is achieved, the damage may have already been done. Teach workers to identify beneficial predators and parasites that naturally control white grubs and strive to protect them and their habitats.</p>	
<p>5. Cinara aphids are not damaging on firs but may upset homeowners if they crawl off a tree after being brought home. Both horticultural oil and insecticidal soaps give good control in controlling this pest. Pine (Virginia and White) growers may treat these pests in the fall of the year to be harvested. Lady beetles and syrphid fly larvae provide good control.</p>	
<p>6. Elongate hemlock scales (EHS) are kept in check by natural enemies such as twice-stabbed lady beetles in the northeastern United States. Growers should learn to recognize this pest if unfamiliar with it since it is fairly new to the south and has spread rapidly through most of North Carolina and is present in Elk Creek and other parts of Virginia. Cull and destroy heavily infested trees.</p>	
<p>7. Bagworms can be removed by hand or treated with less toxic chemicals (e.g., horticultural oil, insecticidal soap) early in the season to avoid having to use more potent pesticides later in the year (e.g., OPs and carbamates). Avoid carbaryl since it can cause secondary pests such as spider mites to proliferate.</p>	
<p>8. Eastern spruce gall adelgids are easy to control with proper timing. Galls can be removed by hand. Horticultural oil is also effective. Avoid carbaryl because of secondary pests.</p>	

9. Pine bark adelgids should not be sprayed with chemicals unless populations are very dense. Horticultural oil and insecticidal soap are good, effective control options. Scout for PBA in spring when new growth is lengthening.	
10. Weevils can be controlled effectively with proper timing; if damage is done before grower notices then weevils are likely gone and there is no point in treating with chemicals. When treated early, horticultural oil and insecticidal soaps give good control. Practice good sanitation techniques and remove dead pines quickly. Trim bottom branches from trees to deter pine root collar weevil. Growers should be aware of white pine harvest conditions that lead to weevil problems.	
11. Pine sawflies rarely require chemical treatment because biological control agents normally keep the sawfly population in check. If chemicals are used, avoid carbaryl because of the tendency for secondary pests (e.g., spider mites) to flourish.	
12. Fall treatment with Talstar will control spring BTA and reduce HRM problems.	
b. Vertebrate Management:	
1. Follow all wildlife management laws, get appropriate permits, and attempt to control only non-protected species.	
2. Use repellents, baits, physical barriers, exclusion fencing, traps, and other deterrents to repel and/or control vertebrate pests. Combining practices increases success.	
3. Moles, rabbits, and ground hogs are more problematic where vegetation is thick, so practice good ground cover management.	
4. Mice and voles are more troublesome in older plantations where thatch is thick, but also in nurseries (seed and transplant beds) where straw or other vegetation provides cover for rodents to girdle young trees. Mice and voles are easily controlled using chemical baits.	
5. Use traps for bears, groundhogs, mice, moles, rabbits, and voles.	
6. Install fencing to keep out bears and rabbits.	
7. Use putrescent chemicals for birds, deer, and rabbits. Carnivore scent repellents help scare off deer, groundhogs, mice, moles, and rabbits. Be sure to rotate materials to avoid habituation to deterrents and repellents.	
8. Hunt (where legal) bears, deer, groundhogs, and rabbits.	
VIII. PESTICIDE SAFETY & EFFICACY:	
1. Correctly identify and regularly monitor pest populations BEFORE attempting chemical controls	
2. When pesticides are to be utilized, choose one based on efficacy, reasonable cost, and safety to applicators, native pollinators, natural enemies, and the environment.	
3. Purchase chemicals from a reputable dealer and utilize only those that are registered for treating Christmas trees infested with the target pest or disease.	

4. Follow all pesticide labeling explicitly, including use of appropriate personal protective equipment (PPE). Farm owners and workers should all be aware of proper use of PPE.	
5. Apply pesticides in accordance with resistance management guidelines when resistance development is an issue.	
6. Maintain accurate and complete pesticide application records.	
7. Make sure equipment is properly calibrated and maintained. Be sure all workers know how to use various types of sprayer equipment (e.g., high pressure sprayers, airblast mistblowers).	
8. Follow proper storage and disposal guidelines. Store pesticides where they will be protected from elements, but preferably not in your home. Contact a local Extension Agent if you have waste pesticides and are unsure how to safely dispose of them.	
9. Discuss with a local Extension Agent your legal obligations as they pertain to pesticide usage.	
10. Attend specialized training prior to using any fumigants (e.g., programs given by Degesch America, Inc. or local Extension offices).	
11. Monitor weather conditions to allow proper drying time and to avoid drift due to windy conditions.	
IX. GROWER EDUCATION:	
1. Attend local and regional grower meetings each year.	
2. Join local grower association(s) and cultivate relationships with Cooperative Extension Agents.	
3. Obtain current fact sheets and guides for Christmas tree pest management from your local grower association or Extension Agents. Farm workers should be strongly encouraged to read these.	
4. Participate in local extension workshops, demonstration plots, and/or short courses on Christmas tree production, pest ID, and pest management options. Encourage farm workers to attend so that they can learn to distinguish harmful pests from harmless arthropods. For example, not all white grubs feed on tree roots. Learn to identify rosette bud mites and elongate hemlock scale, especially if they have not yet reached your area.	
5. Earn a pesticide applicator license and regularly attend Pesticide Applicator Recertification Conferences.	
6. Read online newsletters produced by your local grower associations.	
7. Implement IPM practices not currently used in your Christmas tree pest management program on a limited number of trees and gauge their success.	
8. Learn to recognize beneficial insects and/or predators/parasitoids that naturally control pests and be sure workers strive to protect these natural enemies of tree pests. Also, learn to recognize and protect important flowering plants in ground covers and field borders. Good weeds include yarrow, Queen Anne's lace or wild carrot, mustard, false dandelion, and other simple white or yellow flowers. Syrphid fly larvae are predators of BTA, also eat BWA and SSM. Adult syrphid flies feed on pollen and nectar of flowing weeds that should be conserved in groundcover. Aphid midges eat SSM and rust mites.	

Predatory mites prey on spider mites, but prefer moist conditions. Lady beetles feed on aphids, adelgids, and mites. Predatory soil nematodes feed on white grubs. Tiphia wasps also feed on white grubs. To conserve natural enemies, apply pesticide only when found to be necessary via scouting. Choose a pesticide that is specific for the pest problem, not a broad spectrum chemical that kills everything. Apply BWA pesticides in fall or winter when they will have the least impact on beneficial predators. Time pesticide applications to avoid impacting honeybees and native pollinators, i.e., in the early morning, evening, or at night.	
9. Understand and explain to buyers that Cinara aphids are not ticks and are of no harm to pets, people, houseplants and so they should not become alarmed if a few travel home on the tree.	
10. Become aware of white pine harvest conditions that lead to weevil problems.	
11. Growers should learn to recognize Gypsy moths and other serious tree pests to avoid their spread even though they may not be serious problems on Christmas trees.	
12. Learn grafting techniques to introduce Phytophthora-resistant rootstock.	
X. HARVESTING PRACTICES:	
1. Selectively harvest heavily infested trees early to reduce problems with RBM the following year. This may completely eliminate the need for chemical applications to treat this pest.	
2. Become aware of white pine harvest conditions that lead to weevil problems.	
3. Scout market trees for cinara aphids and look for bee activity to locate aphids.	

ACRONYMS:

- BTA = balsam twig aphids
- BWA = balsam woolly adelgids
- CA = cinara aphids
- EHS = elongate hemlock scales
- ESGA = Eastern spruce gall adelgids
- HRA = hemlock rust mites
- PBA = pine bark adelgids
- RBM = rosette bud mites
- SSM = spruce spider mites
- WG = white grubs

FOR FURTHER INFORMATION:

- Crop Profile for Christmas Trees in North Carolina (Mountains), <http://www.ipmcenters.org/cropprofiles/docs/NCchristmastrees.pdf>
- North Carolina Christmas Tree Growers Association, <http://ncchristmastrees.com>

- North Carolina Extension Christmas Tree Production, <http://www.ces.ncsu.edu/fletcher/programs/xmas>
- Pest Management Strategic Plan for Christmas Tree Production in NC, TN, and VA, <http://www.ipmcenters.org/pmsp/pdf/NCTNVChristmasTree.pdf>
- Virginia Christmas Tree Growers Association, <http://www.virginiachristmastrees.org>
- Virginia Christmas Tree Pests Fact Sheets, <http://www.idlab.ento.vt.edu/IDLab/Fact/Fact1.html>

WRITTEN AND DEVELOPED BY:

Holly Gatton	hgatton@vt.edu	Project Manager Virginia Tech Pesticide Programs Dept. of Entomology 302 Agnew Hall, MC 0409 Blacksburg, VA 24061
Bryan Davis	bryan_davis@ncsu.edu	IPM Technician Ashe Cooperative Extension Jefferson, NC 336-846-5850
Wythe Morris	morrisw@vt.edu	Associate Extension Agent VCE – Carroll County 205 Oak Street, Suite 102 Hillsville, VA 24343
Jill Sidebottom	jill_sidebottom@ncsu.edu	Area Extension Forestry Specialist Mountain Conifer IPM Mountain Hort. Crops Research Center 455 Research Drive Mills River, NC 28759
Kevin Spurlin	spurlink@vt.edu	Unit Coordinator/Extension Agent VCE – Grayson County 129 Davis Street Courthouse Basement, Room 103 Independence, VA 24348
Mike Weaver	mweaver@vt.edu	Director Virginia Tech Pesticide Programs Dept. of Entomology 302 Agnew Hall, MC 0409 Blacksburg, VA 24061