Control & Management of Christmas Tree Insect Pests in Michigan 1995
Michigan State University Extension Service

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Issued April 1995
52 pages

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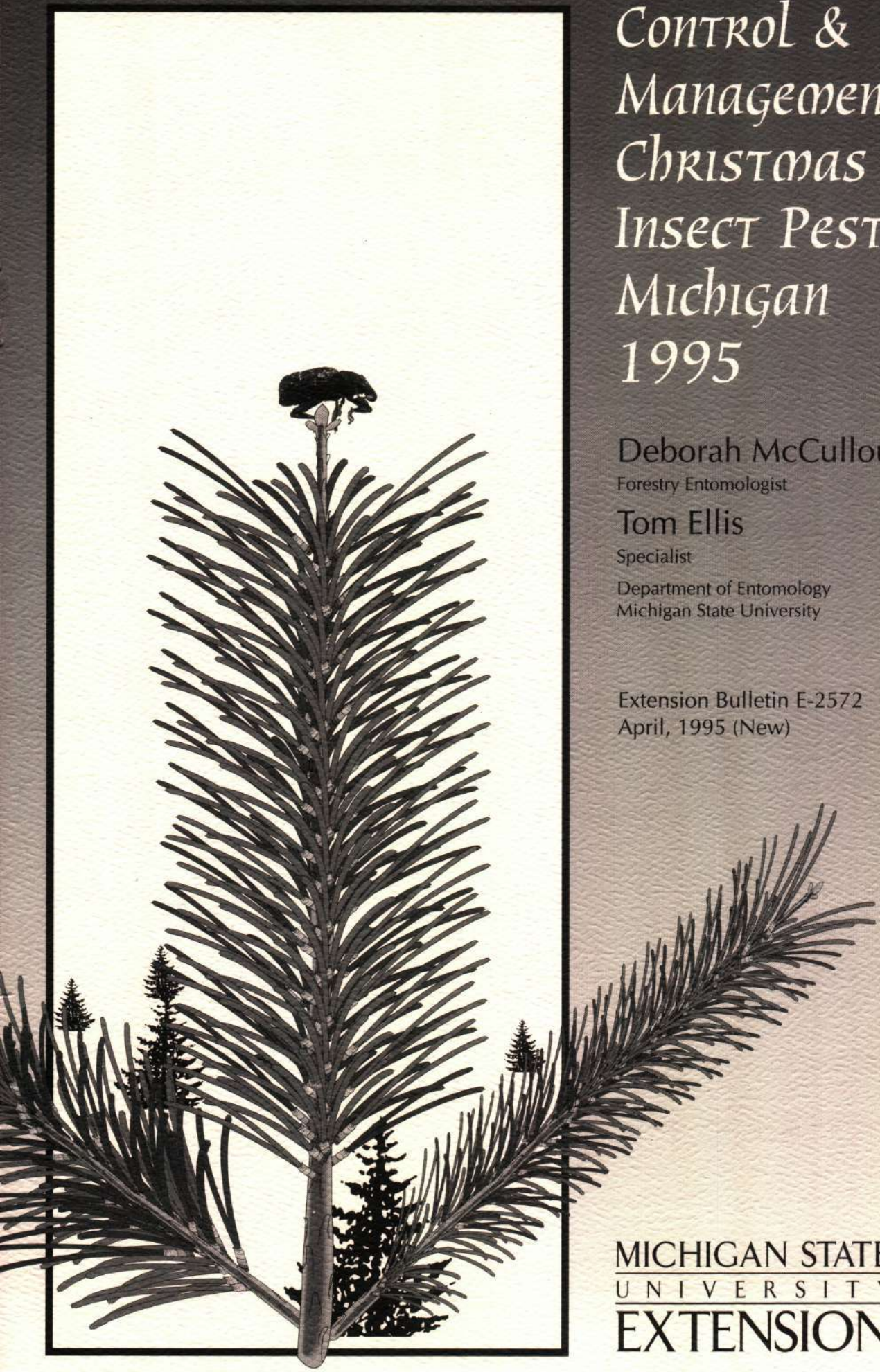
Extension Bulletin E-2572
April, 1995 (New)



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Purpose of This Bulletin

The purpose of this bulletin is to provide you with the latest available management information and tactics needed to control insect pests in commercial Christmas tree plantations in Michigan.

How to Use This Bulletin

This bulletin provides Integrated Pest Management (IPM) information and management strategies for insects and other arthropod pests that commonly attack species grown for Christmas tree production in Michigan. Climatological tables and insect phenological (seasonal development) information are provided to help you properly time pest management activities. Recommendations for scouting and monitoring, and information on cultural or mechanical tactics for insect pest management are also provided.

The Pests

Insect and other arthropod pests are referred to by common names in this bulletin. Appendix III lists all of the common and scientific names of insects mentioned in this publication. Management guidelines and recommendations are provided to help you select the most effective control tactics for specific pests. Occasionally, collective names are used when referring to similar species. For example, "aphid pests"of Christmas trees may include the giant pine aphid, powdery pine needle aphid, spotted pine aphid, white pine aphid, and others. All can be managed using similar tactics. If there are two or more pests threatening the tree, compare the recommendations for each pest and read the labels of the registered insecticides you are considering for use. In some cases, a single insecticide application can be used to control both pests.

Changes in Recommendations

Recommendations may change as products are removed from the market, new products are introduced, new uses are found for old products, or new restrictions are placed on products. Your county MSU Extension agent is informed of these changes as they occur. Check with your MSU Extension agent for updates that have occurred since the publication of this bulletin. Not all insecticides registered for insect pests of Christmas trees are listed in this bulletin. We have included many products commonly used by growers, but this is not meant to promote or encourage use of particular products. Always read the label of the insecticide to be sure that it is registered and appropriate for the target pest.

Management Guidelines

The minimum number of pests or amount of damage considered to pose a threat is given in many cases. These guidelines represent "rules of thumb" which have emerged over many years of observation, experience and research. The management guidelines and treatments are only useful if fields are scouted routinely on a frequent schedule during the growing season.

IPM For Christmas Tree Growers

Christmas tree growers must deal with a great number of insects pests. The entire tree, including roots, stems, foliage, shoots and terminal leaders, is vulnerable to attack. Damage can range from complete mortality, to growth loss, to cosmetic damage that reduces the value of trees at market time.

Integrated Pest Management (or IPM), is the best approach to manage insect pests of Christmas trees. IPM is defined as using all available tools or tactics to prevent economically important damage from pests, without causing damage to the environment.

What are these tools and how are they used in an IPM program?

I. **Scouting** is one of the most important tools that a Christmas tree grower can use. Scouting or monitoring fields will help growers detect insects or insect damage early, while there is still time to take action.

Scouting and monitoring must be done **regularly** and **frequently**, particularly from late April to mid-July, when the destructive forms of many insect pests are active. Walk through each field and examine trees of different ages, trees growing on field edges and trees in the center of the field. Always look at 10-20 trees, but look at more trees in larger fields. When scouting, inspect the parts of trees that are likely to be damaged by different pests. For example, look at the terminal leader and upper lateral shoots for signs of shoot borers. Look at new shoots and at the needles in the upper, mid- and lower canopy to detect aphids, scales, galls, and defoliators. Look at the stem and root collar area to check for signs of pine root collar weevil or Zimmerman pine moth activity.

II. **Identification** of insect pests and the **diagnosis** of insect damage is the second essential tool that Christmas tree growers must possess.

If you find signs of insect presence or damage, try to determine:

a) **what kind** of insect pests are present;
b) what **stage** of the insects are present;
c) what the **size** of the pest population is;
d) how much damage has occurred;
e) how much damage is likely to occur if no control measures are taken;

f) whether the pest or damage requires immediate attention or if control measures can be postponed until the trees are near harvest.

Growers may wish to carry a **hand lens** when scouting Christmas tree fields. This little piece of equipment can help growers locate or identify small insects like scale crawlers and aphids. Growers should also consider purchasing an insect **field guide** with pictures and biological information that will help in identification of unusual insects. A variety of field guides are available in most bookstores.

It is also important to know where to find help in diagnosing insect problems. Christmas tree growers can request help from the following sources:

County MSU Extension office
(Extension personnel are often familiar with local pests and will have current information on pests in your area)

MSU Insect Diagnostic Clinic

Department of Entomology
243 Natural Science Building
Michigan State University
East Lansing, MI 48824
(517) 353-9386
(517) 355-4665

MSU Landscape Crops Advisory Team Newsletter (Landscape CAT-Alert)
(Weekly 8-12 page newsletter with current information from specialists; subjects include insect pests, diseases, weather, fertilization, weed control and other areas; published weekly during the growing season).

Landscape CAT-Alert Newsletter
Extension Agriculture and Natural Resources
11 Agriculture Hall
Michigan State University
East Lansing, MI 48820
(517) 355-0117

USDA Forest Service Christmas Tree Pest Manual
(includes information on life cycle and biology; symptoms of damage; treatment options; color photographs)
1983 - Call or write for information on price and availability to:

Superintendent of Documents
P.O. Box 371954
Pittsburg, PA 15250-7954
(202) 783-3238

III. Degree days are a third tool that Christmas tree growers can use to improve insect pest management. As many experienced growers know, the date when specific insect pests become active varies from year to year. During a cool spring and summer, insect development is typically quite slow. However, if spring and summer weather is especially warm, insects will develop faster and damage will become apparent early in the growing season. There may be four or more weeks difference from one year to the next in timing of insect activity.

The accumulation of degree days help growers monitor insect development and activity in their particular area of the state. Degree days are determined by spring and summer growing conditions. Therefore, degree days can be used to time insecticide application or to implement other control measures where timing is critical. Using degree days to time treatments is more effective than simply relying on calendar dates. See the section in this bulletin entitled: *The Importance of Temperature in Christmas Tree Pest Management* for a thorough discussion and examples.

Current and projected degree day accumulations for various areas around the state are published weekly in the **Landscape CAT-Alert Newsletter** (see Col. 1). Growers may also wish to contact their local MSU Extension office for more information on how to use degree days.

IV. Implement the appropriate IPM tactic. Once an insect pest has been detected and identified, a grower must determine if some type of control is needed. This decision will be based on the size of the pest population, the kind of damage the insect is causing, and the control measures that are available. It is also very important to consider the cost effectiveness of potential controls. Growers must carefully weigh the costs of control, the value of the tree, and the impact of the damage on the value of the tree. Control options may be quite different for high-value Christmas tree species and low-value species. A bulletin on **Costs and Returns in Michigan Christmas Tree Production, 1986** (MSU Agricultural Exp. Sta., Research Report 492, 1988) may be useful.

Cultural and mechanical controls can often be very effective in preventing insect pest damage. Cultural controls include activities such as roguing out and destroying trees with heavy infestations of Zimmerman pine moth or pine tortoise scale. Growers can clip off and destroy galls made by Cooleys' spruce gall adelgid, shoots infested with Eastern pine shoot borer, or terminal leaders infested with white pine weevil. Basal pruning or butt-pruning of the lower whorl of branches is a cultural practice that can reduce damage by pine root collar weevil, European pine shoot moth and even lophodermium needlecast disease. Cultural controls are often most practical when used to prevent insect pest populations from building and when pest populations are at low levels.

Biological controls include the beneficial predators, parasites and diseases that kill pest insects. Every insect pest that occurs in Christmas trees has one or more natural enemies.

Ladybugs, lacewings and certain mites are common predators; tiny wasps and some fly species are parasites. Parasites and predators are often very effective at keeping insect pests at low levels. For example, aphids, scales and mites rarely build to damaging levels in pine or spruce forests. Their populations are controlled or "regulated" by predators and parasites. Insects also are affected by a variety of bacterial, fungal and viral diseases.

Many biological control organisms, however, are sensitive to the insecticides used to control insect pests. For example, insecticides applied to control a defoliator may also kill beneficial predatory mites and beetles, resulting in an outbreak of spider mites, scales or aphids. These "secondary pests" may ultimately be very difficult to control and may damage trees for several years. Christmas tree growers can help preserve natural enemies by using insecticides carefully and only when needed.

Insecticides are a very important tool in the IPM toolbox, particularly when large pest populations threaten the growth rate, appearance, or survival of Christmas trees. When using insecticides, growers should be conscious of factors such as timing, coverage and selection of the appropriate insecticide. Integrating insecticide use with scouting and degree days will help growers apply insecticides at the appropriate time. A good knowledge of the pest insects' life cycle, and selection of an appropriate insecticide and application equipment will improve coverage and the effectiveness of the control. The ability to recognize beneficial biocontrol insects, combined with cultural, sanitation or mechanical controls, may allow growers to delay insecticide treatment of a minor pest problem until trees are near harvest.

V. Evaluate the effectiveness of implemented management. It is important to determine how effective your management and control tactics are. This information will help you improve your management strategies for next year. Return to your fields after applying a treatment and compare post-treatment counts of insect pests with scouting counts. It is a great idea to keep an insect pest management log — include your observations on where pests first showed up, what kinds of natural enemies you observed, where and when specific treatments were applied, and what the results were. Growing Christmas trees for profit is a complex business, and growers must plan and integrate insect pest control with other aspects of Christmas tree management. Sound IPM practices will pay off in the long run, however, both economically and environmentally.

The Importance of Temperature in Christmas Tree Pest Management

Growth and development of many plants and cold-blooded animals, insects included, are dependent upon the amount of heat present when an organism is developing. The summer of 1992 was a good example of what happens when there is too little seasonal heat accumulation: plant growth and insect pest development were slow and phenological events (seasonal development) occurred later than usual. The opposite is true during growing seasons that are hotter than normal; development is accelerated and phenological events are ahead of schedule. Growers who take advantage of the available weather information, especially heat accumulation data, can make better management decisions that those who do not. Development of plants, pests, and diseases during the course of a growing season can be monitored through use of **Degree Days** (DDs), a simple, temperature-derived index.

Over the years, scientists have developed several ways to calculate DDs. However, all forms of DDs have a common principle; biological processes do not begin until a certain temperature threshold is reached or exceeded. This threshold is referred to as the **base temperature.**

Simply stated, once the base temperature is reached, plants begin to grow and cold-blooded animals, like insects, begin to develop. Many of these temperature thresholds lie between 40° F and 50° F. The DDs for a given day are calculated using daily temperature data relative to the base temperature. Insect and Christmas tree development progresses as DDs are accumulated throughout the growing season. In Michigan, this accumulation of DDs normally begins in March and ends in late fall.

Table 1 depicts the average degree days, at base 50° F (DD 50), accumulated over the last thirty years at representative stations from four geographical regions in Michigan. The table and graph shows the association of the DDs with the average calendar date for easy reference. Table 2 lists many of the insect pests of Christmas trees, the DD when the first appearance of these pests can be expected, and the average range of calendar dates for the occurrence of this DD accumulation.

The first bloom of common flowering plants can serve as a gentle reminder that the appearance of certain insects is forthcoming. Table 3 lists some common early bloomers and the average date (1985 - 1988) when first bloom occurred in Midland, MI.

The tables and graphs are guides to make your scouting and monitoring efforts more efficient. Specific weekly data for your area are available from the MSU Extension office in your county. This information is also available on a weekly basis throughout the growing season in the Landscape Crop Advisory Team Alert newsletter. This weekly bulletin provides DD tables on a weekly basis, up-to-date pest development rates and management information, and advice from specialists at Michigan State University as well as out-of-state.

DDs are a valuable predictive tool. By knowing development trends ahead of time, growers can anticipate when to look for specific pests and plan appropriate management action before the pest becomes a problem.

While the accumulated DD totals may not yield perfect estimates for all plant or insect stages, they are superior to using traditional growing season calendars or other time-averaged data. Degree day accumulations should be used only as a guide in your management system; ultimate decisions should be based heavily upon scouting and monitoring.

Table 1. Average Degree Day Accumulation, Degree Day (base 50), 1961 - 1990.

	Reporting Station			
Date	Coldwater	Alma	Lake City	Chatham
March 1	4	1	0	0
March 15	14	8	2	1
April 1	38	27	11	4
April 15	72	58	28	15
May 1	160	144	91	61
May 15	275	257	174	127
June 1	479	461	334	266
June 15	711	688	514	412
July 1	1012	982	750	622
Jul 15	1303	1279	995	847
Aug 1	1664	1649	1300	1130
Aug 15	1936	1925	1524	1351
Sep 1	2227	2214	1758	1574

Table 2. First Appearance of Common Christmas Tree Insect Pests in Michigan.

Common Name	DD 50	Average Dates (Lake City)
Balsam gall midge	200 - 300	May 18 - May 29
Cooley spruce gall adelgid	25 - 100	Apr 14 - May 3
Eastern gall aphid	25 - 100	Apr 14 - May 3
Eastern pine shoot borer	200 - 300	May 18 - May 29
European pine shoot moth	25 - 200	Apr 14 - May 18
Introduced pine sawfly	500 - 700	June 14 - June 28
Jack pine budworm	300 - 350	May 29 - June 3
Northern pine weevil (summer adults)	1200 - 1400	July 26 - August 8
Northern pine weevil (winter adults)	25 - 100	Apr 14 - May 3
Pales weevil	25 - 100	Apr 14 - May 3
Pine chafer	400 - 500	June 6 - June 14
Pine needle scale	200 - 300	May 18 - May 29
Pine root collar weevil (summer adults)	1200 - 1400	July 26 - August 8
Pine root collar weevil (summer adults)	1200 - 1400	July 26 - August 8
Pine root collar weevil (winter adults)	300 - 350	May 29 - June 3
Pine tortoise scale (1st generation)	400 - 600	June 6 - June 22
Pine tortoise scale (2nd generation)	700 - 900	June 28 - July 10
Redheaded pine sawfly	500 - 700	June 14 - June 28
Spruce bud scale	700 - 900	June 28 - July 10
Spruce budworm	200 - 300	May 18 - May 29
Spruce needleminer	150 - 180	May 11 - May 16
White pine weevil (summer adults)	1200 - 1400	July 26 - August 8
White pine weevil (winter adults)	25 - 200	Apr 14 - May 18
Zimmerman pine tip moth	25 - 200	Apr 14 - May 18

Table 3. Phenological First Bloom Sequence of Some Common Plants for Midland, Michigan (1985-1988).

Common Name	Scientific Name	Average Date
Mezereum	*Daphne mezereum*	1-Apr
Red Maple	*Acer rubrum*	6-Apr
Forsythia	*Forsythia x intermedia*	14-Apr
Magnolia	*Magnolia stellata*	16-Apr
Norway maple	*Acer platanoides*	22-Apr
Serviceberry	*Amelanchier sp.*	28-Apr
Flowering crab	*Malus sp.*	4-May
Common lilac	*Syringa vulgaris*	6-May
Viburnum	*Viburnum lantana*	9-May
Horse-chestnut	*Aesculus hippocastanum*	10-May

PESTICIDE RECOMMENDATIONS

Adana Tip Moth

Host: Austrian, red, and Scotch pine
Injury site: Buds and developing shoots
Symptoms: Stunted, dying or dead shoots with small hole at base.

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
Larvae begin feeding in late April-early May	acephate (Orthene)		
	75 SP	1 lb/100 gal	Caution
	azinphosmethyl (Guthion)		
	2 S	1-1/2 to 3 pt/acre	Danger
	2 L	1-1/2 to 3 pt/acre	Danger
	3 FL	1 to 2 pt/acre	Danger
	35	1 to 2-1/8 lb/acre	Danger
	50	3/4 to 1-1/2 lb/acre	Danger
	carbaryl (Sevin)		
	XLR Plus	1 qt/100 gal	Caution
	4F	1 qt/100 gal	Caution
	permethrin (Pounce)		
	3.2 EC	4 to 8 oz/acre	Caution
	25	6.4 to 12.8 oz/acre or 0.1 to 0.2 oz/acre	Warning

Allegheny Mound Ant

Host: All conifers
Injury site: Stem or root collar of seedlings or young trees
Symptoms: Dead or dying tree.

Spring to Fall	Diazinon various formulations	Various	Warning

Anomala Beetle
(Pine chafer)

Host: All pines
Injury site: Needles
Symptoms Scorched appearance, broken or brown needles, adults present.

400-500 DD: 1st adults active	fenvalerate (Asana) XL	0.03 to 0.05 lb/acre	Warning

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
Shear damaged shoots and correctively prune leaders before June	Spray in mid- to late April to control larvae as they hatch from eggs; repeat in late May if needed.	Young trees and seedlings most likely to be infested.
Physically destroy mounds; this is difficult and must be repeated until the colony moves	Treat mounds between April and October, when activity is observed. For best results, mix insecticide into upper 2-3 inches of mound and apply just before rain.	Ants often feed on syrupy "honeydew" excreted by aphids and scales. Reduce aphid and scale populations to help manage ants.
Shear to remove injured foliage	Late June to control feeding adults.	

APHIDS

Host: All conifers
Injury site: Needles, shoots, branches
Symptoms: Discolored foliage, honeydew, sooty or glittering foliage

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
Spring-summer	acephate (Orthene)		
	75 SP	1 lb/100 gal	Caution
	bifenthrin (Talstar)		
	10 WP	6.4 to 32 oz/100 gal	Caution
	chlorpyrifos (Dursban)		
	4E	1 pt/100 gal	Warning
	diazinon		
	50 WP	1 lb/100 gal	Warning
	4E	1 pt/100 gal	Warning
	lambda-cyahlothrin (Scimitar)		
	10 WP	2.4 to 4.8 oz/100 gal	Warning
	Malathion		
	57	1.5 pt/100 gal	Caution
	permethrin (Pounce)		
	3.2 EC	4 to 8 oz/acre	Caution

BAGWORM

Host: All firs and spruces, and Eastern white pine
Injury site: Needles
Symptoms: Defoliation; brown bags w/needle particles; flagging.

Larvae become active in late May	Bt (Dipel)		
	8 L	8 to 16 oz/100 gal	Caution
	Bt (Foray)		
	48 B	1.3 to 6 pt/acre	Caution
	carbaryl (Sevin)		
	XLR Plus	1 qt/100 gal	Caution
	4 F	1 qt/100 gal	Caution
	acephate (Orthene)		
	75 SP	1 lb/100 gal	Caution

BALSAM GALL MIDGE

Host: Balsam and Fraser fir
Injury site: Needles
Symptoms: Thin canopy, premature needle drop, small galls at base of needle.

200-300 DD: 1st adults active	carbaryl (Sevin)		
	XLR Plus	1 qt/100 gal.	Caution
	50 W	2 lb/100 gal	
	4F	1 qt/100 gal	
	diazinon		
	50 WP	1 lb/100 gal	Warning

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
Limit use of broad-spectrum insecticides to avoid killing insect predators. Dormant oils, superior oils and insecticidal soaps are often effective and will not harm beneficial insects.	Variable, depending on species, weather and natural enemies. Monitor populations for several days to determine if predators will control aphids.	Usually a minor problem. However, honeydew secreted by aphids may lead to buildup of black sooty mold on shoots. Ants may protect aphids from their natural enemies.
Remove and destroy bags; cull heavily infested trees.		Bt will not harm beneficial insects.
None. Parasitic wasps and competition from related midge species usually control this pest.	Spray when needles are roughly 1.5 inches long.	Spraying after galls are formed is not effective.

Balsam Twig Aphid

Host: All firs, spruces, juniper
Injury site: Needles
Symptoms: Twisted curled needles, honeydew and sooty mold.

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
1st Activity: 50-200 DD	acephate (Orthene)		
	75 SP	1 lb/100 gal	Caution
	Bifenthrin (Talstar)		
	10 WP	6.4 to 32 oz/100 gal	Caution
	F		
	fenvalerate (Asana)		
	XL	5.8-9.6 oz/acre	Warning
	Malathion		
	57	1 to 1-1/2 pt/100 gal.	Warning
	fluvalinate (Mavrik)		
	22.3F	4 to 10 oz/100 gal	Caution

Bark Beetles

Host: All conifers
Injury site: Cambium tissue (between wood and bark) of stems
Symptoms: Galleries and tunnels under bark; boring dust or pitch tubes often seen on stem. Tree color fades from top down.

Summer	chlorpyrifos (Dursban)		
	50 W	1 lb/100 gal	Warning
	4 E	1 pt/100 gal	Warning

Cooley Spruce Gall Adelgid

Host: White, blue, Engleman and Sitka spruce; Douglas fir
Injury site: Lateral shoots of spruce; needles of Douglas fir
Symptoms: Spruce: pineapple-shaped galls on tips of new shoots. Douglas fir: Yellow spots on bent needles and cottony balls on underside of needles.

25-100 BASE DD: 1st adults; 200-300 BASE DD: 1st galls; 1500-1600 BASE DD: 2nd adults	carbaryl (Sevin)		
	50 W	2 to 4 lb/100 gal	Warning
	4 SL	1 to 2 qt/gal	Caution
	XLR Plus	1 to 2 qt/100 gal	Caution
	4F	1 to 2 qt/100 gal	Caution
	80 S	1-1/4 lb/100 gal	Warning
	4 (Sevimol)	1 to 2 qt/100 gal	Warning
	chlorpyrifos (Dursban)		
	50 W	0.5 lb/100 gal	Warning
	4 E	8 oz/100 gal	Warning
	chlorpyrifos (Lorsban)		
	4 EC	1 qt/acre	Warning

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
Limit use of broad spectrum insecticides to avoid killing insect predators.		
Maintain healthy, vigorous trees. Avoid piling slash near living trees. Debark or destroy freshly cut or recently killed trees and logs.		Spraying to control larvae is not effective since larvae are protected by bark. Stressed, injured or diseased trees are most likely to be infested.
Remove and destroy (burn) galls before July; don't interplant spruce and Douglas fir.	Treat early-late April and again in early fall if needed.	Spraying after galls appear is not effective.

Eastern Pine Shoot Borer

Host: Douglas fir; all pines; white spruce
Injury site: Lateral shoots/terminal leader
Symptoms: Dead or discolored shoots; terminal leaders clearly broken at base, exit hole on damaged shoots.

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
100-250 DD: 1st adults active	azinphosmethyl (Guthion)		
	2 S	1-1/2 to 3 pt/acre	Danger
	2 L	1-1/2 to 3 pt/acre	Danger
	50	3/4 to 1-1/2 lb/acre	Danger
	3 FL	1 to 2 pt/acre	Danger
	35	1 to 2-1/8 lb/acre	Danger
	bifenthrin (Talstar)		
	10 WP	12 to 32 oz/100 gal	Caution

Eastern Spruce Gall Adelgid

Host: All spruces
Injury site: Base of expanding shoots
Symptoms: Small, pineapple-shaped gall at base of new shoots.

25-100 DD: 1st adults active; 500-1600 DD: 2nd adults active	carbaryl (Sevin)		
	4L	1 qt/acre	Caution
	XLR	1 to 2 qt/100 gal	Caution
	4 SL	1 qt/100 gal	Caution
	4 F	1 qt/100 gal	Caution
	50 W	2 lb/100 gal	Caution
	chlorpyrifos (Dursban)		
	50 W	1/2 lb/100 gal	Warning
	4 EC	8 oz/100 gal	Warning
	chlorpyrifos (Lorsban)		
	4 EC	1 qt/100 gal	Warning

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
Shear damaged shoots and correctively prune leaders.	Treat before young larvae bore into shoots, usually occurs in mid-May.	Usually a minor problem. Once injury is apparent, larvae will be protected inside shoots and spraying will be ineffective.
Clip and burn galls before they open in July. Remove and destroy heavily infested trees.	Treat in April when buds begin to swell; repeat in September after galls open, if necessary.	If galls are present, wait until September to treat.

Eriophyid Mite

Host: All fir and all pines
Injury site: Needles
Symptoms: Yellow stippled needles; tips of needles may turn brown, twist and hook; new growth may be stunted and deformed.

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
Early April; overlapping generations throughout growing season.	carbaryl (Sevin)		
	4 SL	1 qt/100 gal	Caution
	80 SP	1-1/4 lb/100 gal	Warning
	50 W	2 lb/100 gal	Warning
	XLR	1 qt/100 gal	Caution
	4 F	1 qt/100 gal	Caution
	4 (Sevimol)	1 qt/100 gal	Warning
	chlorpyrifos (Dursban)		
	50 W	1/2 lb/100 gal	Warning
	4 E	8 oz/100 gal	Warning
	chlorpyrifos (Lorsban)		
	4 EC	1 qt/acre	Warning
	diazinon		
	4 EC	1 pt/100 gal	Warning
	dicofol (Kelthane)		
	35	1 to 1-1/3 lb/100 gal	Warning
	50	1/2 to 1 lb/100 gal	Warning
	Morestan		
	4 E	4 to 8 oz/100 gal	Caution

European Pine Sawfly
(see also Pine Sawflies)

Host: All pines
Injury site: Needles
Symptoms: Defoliation of one year old or older foliage

100-200 DD: 1st larvae	acephate (Orthene)		
	75 S	1 lb/100 gal	Caution
	carbaryl (Sevin)		
	XLR	1 qt/100 gal	Caution
	4 F	1 qt/100 gal	Caution
	4 (Sevimol)	1 qt/100 gal	Warning
	chlorpyrifos (Lorsban)		
	4 EC	1 qt/acre	Warning
	Malathion		
	57	1 to 1-1/2 pt/100 gal	Caution

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
Use insecticides only when necessary to avoid killing predatory mites and other beneficial organisms.	Spray in early May and repeat in 10 days.	Good coverage of branches and needles is important.
Colonies of feeding larvae can be removed and destroyed.	Spot treat colonies of larvae when first observed; usually early May to early June.	Defoliation of old foliage is less significant to tree vigor than defoliation of new foliage.

European Pine Shoot Moth

Host: Pines, especially Scotch, Austrian and red pine
Injury site: Buds and developing shoots
Symptoms: Stunted shoots, usually dead before expansion; hard yellowish pitch mass over buds in mid- to late-summer; caterpillar overwinters in buds, under pitch.

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
25-100 DD: 1st larvae 700-1000 DD: Adults	diazinon		
	4 E	1 pt/100 gal	Warning
	50 WP	1 lb/100 gal	Warning
	AG	1 pt/100 gal	Warning
	50	1 lb/100 gal	Warning
	azinphosmethyl (Guthion)		
	2 S	1 to 1-2/3 pt/acre	Danger
	2 L	1-1/2 to 3 pt/acre	Danger
	35	1 to 2-1/8 lb/acre	Danger
	50	3/4 to 1-1/2 lb/acre	Danger
	carbaryl (Sevin)		
	50 W	2 lb/100 gal	Warning
	XLR	1 qt/100 gal	Caution
	4 F	1 qt/100 gal	Caution
	80 S	1.25 lb/100 gal	Warning
	4 SL	1 qt/100 gal	Caution
	4 (Sevimol)	1 qt/100 gal	Warning
	chlorpyrifos (Dursban)		
	50 W	1 lb/100 gal	Warning
	4 E	1 pt/100 gal	Warning
	chlorpyrifos (Lorsban)		
	4 EC	1 qt/acre	Warning
	Imidan		
	50 W	2 lb/100 gal	Warning
	Malathion (Cythion)		
	57%	1-1/2 pt/100 gal	Warning

Grasshopper

Host: All conifers
Injury site: Needles; seedlings
Symptoms: Ragged needles and scarred bark on twigs, branches or seedlings.

Mid-summer.	carbaryl (Sevin)		
	50 W	2 lb/100 gal	Warning

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
If shearing is delayed until mid-July, many eggs will be destroyed. Basal prune the lower whorl of trees. This will reduce survival of overwintering larvae.	Spray when newly hatched larvae are moving to new shoots; usually early to late April.	Sprayer should deliver at least 35-50 gallons of liquid per acre.
Control grassy vegetation before planting.	Spray in August or September.	Trees and seedlings near the edge of plantations are most likely to be affected.

Gypsy Moth

Host: All conifers
Injury site: Needles; stem
Symptoms: Presence of egg masses is critical; defoliation causes ragged foliage.

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
100-180 DD: 1st larvae	Bt (Dipel)		
	4 L	1 to 4 pt/100 gal/acre	Caution
	2 X	1/4 to 3/4 lb/100 gal	Caution
	Bt (Foray)		
	48 B	1.3 to 6 pt/acre	Caution
	acephate (Orthene)		
	75 S	1to 1-1/3 lb/100 gal	Caution
	carbaryl (Sevin)		
	XLR	3/4 to 1 qt/100 gal	Caution
	4 F	1 qt/100 gal	Caution
	50 W	2 lb/100 gal	Warning
	80 S	1-1/4 lb/100 gal	Warning
	4 (Sevimol)	1 qt/100 gal	Warning
	chlorpyrifos (Lorsban)		
	4 EC	1 qt/acre	Warning
	diflubenzuron (Dimilin)		
	25 W	1 to 4 oz/100 gal (hydraulic sprayer)	Caution
	Imidan		
	50 W	1 to 1-1/2 lb/100 gal	Warning
	bendiocarb (Turcam)		
	76 W	3 oz to 2.5 lbs/100 gal	Warning

Introduced Pine Sawfly

(see Pine Sawflies)

Jack Pine Budworm

Host: Jack and Scotch pine
Injury site: Needles; new shoots
Symptoms: Defoliation; dry clipped needles webbed to shoots.

300 - 350 DD: 1st larvae	chlorpyrifos (Dursban)		
	50 W	1/2 lb/100 gal	Warning
	4 EC	8 oz/100 gal	Warning

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
Remove and destroy egg masses before shipping.	Bt can be used when caterpillars are 1" or less. Treat older caterpillars with a registered insecticide before pupation.	Young caterpillars (<1" long) usually do not survive on conifers; older caterpillars will readily consume conifer foliage. Trees with egg masses are subject to state and federal shipping regulations.

Jack Pine Tip Beetle

Host: Pines, particularly Scotch and red pine
Injury site: Tips of lateral shoots
Symptoms: Yellow or red shoot tips; small glob of pitch at base of damage.

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
Pitch tubes begin to appear in spring and can be found throughout summer.	Insecticides not registered for this pest and are rarely needed.		

Nantucket Pine Tip Moth

Host: Pines, particularly Austrian, red and Scotch
Injury site: Lateral shoots
Symptoms: Deformed shoot tips; dead or dying needles at ends of shoots; mined needles,

Spring to early summer	acephate (Orthene)		
	75 S	1 lb/100 acre	Caution
	azinphosmethyl (Guthion)		
	2 S	1-1/2 to 3 pt/acre	Danger
	2 L	1-1/2 to 3 pt/acre	Danger
	35	1 to 2-1/8 lb/acre	Danger
	50	3/4 to 1-1/2 lb/acre	Danger
	carbaryl (Sevin)		
	XLR Plus	1 qt/acre	Caution
	4 F	1 qt/100 gal	Caution
	4 (Sevimol)	1 qt/100 gal	Warning
	chlorpyrifos (Dursban)		
	50 W	1 lb/100 gal	Warning
	4 EC	1 pt/100 gal	Warning
	diflubenzuron (Dimilin)		
	25 W	4 oz/100 to 400 gal	Caution
	Imidan		
	50 W	2 lb/100 gal	Warning
	permethrin (Pounce)		
	3.2 EC	4 to 8 oz/acre	Caution
	25	6.4 to 12.8 oz/acre	Warning
	trichlorfon (Dylox 80 turf)		
	80 W	20 oz/100 gal	Warning
	bendiocarb (Turcam)		
	76 W	2 lb/100 gal	Warning

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
Shear injured tips and correctively prune as needed.	This insect is not known to cause economic damage and should not require treatment.	Damage symptoms are similar to those of pine shoot beetle.
Shear to remove infested or injured shoots.	Treat in mid-May to mid-June to control young larvae. A second generation may require treatment in mid-July to late August.	This insect is rarely aproblem in Michigan.

Northern Pine Weevil

Host: All pines, sometimes spruces
Injury site: Shoots, seedlings
Symptoms: Flagging and browning of new shoots; small circular wounds at base of damage, often exuding pitch; dead seedlings.

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
25-150 DD: 1st adults active; 1200-1400 DD: 2nd adults active	chlorpyrifos (Dursban)		
	50 W	33-1/3 lb/100 gal	Warning
	4 E	4 gal/100 gal	Warning
	bendicarb (Turcam)		
	76 W	2 lb-10 oz/100 gal	Warning

Northern Pitch Twig Moth

Host: Pines, particularly Scotch
Injury site: Crotch of young twigs
Symptoms: Small, hollow pitch blister in crotch of shoots

Blisters can be seen throughout the year	Insecticides not registered for this pest and are rarely needed.

Pales Weevil

Host: Pines, particularly Scotch and eastern white, Douglas-fir, some spruces
Injury site: Shoots, seedlings
Symptoms: Flagging and browning of shoots; patches of exposed bark at base of dead shoots, often exuding pitch.

25-100 DD: 1st adults active; 1200-1400 DD: 2nd adults active	chlorpyrifos (Dursban)		
	4 E	33-1/3 lb/100 gal	Warning
	50 W	4 gal/100 gal	Warning
	chlorpyrifos (Lorsban)		
	4 EC	1 to 3 qt/acre	Warning
	Imidan		
	50 W	2 lb/100 gal	Warning
	70 W	48 lb/100 gal	Warning
	50 W	67 lb/100 gal	Warning
	bendiocarb (Turcam)		
	76 W	2 lb 10 oz/100 gal	Warning

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
Remove fresh stumps and recently dead or dying trees by late spring to eliminate breeding material. Application of fertilizer to stump surface will reduce survival of the next weevil generation.	Spray stumps with chlorpyrifos in April. Use foliar spray to kill feeding adults in late August-September.	This insect is most common where stress has reduced tree vigor.
Remove damaged when shearing. Break open blister and destroy larvae inside.		This insect is not known to cause economic damage.
Remove fresh stumps by late spring to eliminate breeding material.	Spray stumps with chlorpyrifos in April. Use foliar spray to kill feeding adults in late April and late August-September.	Stumps that are more than a year old are not suitable habitat for beetles and do not require treatment.

Pine Bark Adelgid

Host: Eastern white pine and occasionally Scotch and Austrian pine
Injury site: Stem and large branches
Symptoms: Discolored, stunted or dying tree; clumps of white, wooly, waxy material on stem and large branches.

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
Blue-green nymphs appear in early May	Malathion (Cythion) 0.57	1-1/2 pt/100 gal	Warning
	chlorpyrifos (Dursban) 50 W	1/2 lb/100 gal	Warning
	4 E	8 oz/100 gal	Warning

Pine Needle Midge

Host: Pines, particularly Scotch and red
Injury site: Needles
Symptoms: Bending or drooping of needles; brown bent needles in upper canopy; loss of injured needles causing thin crowns; bright orange larvae feeding at base of needle fasicles.

400-500 DD: 1st adults active.	chlorpyrifos (Lorsban) 4 EC	1 qt/acre	Warning

Pine Needle Scale

Host: All pines, all spruces and Douglas-fir
Injury site: Needles
Symptoms: White, elongated scales on needles; discolored needles with white "flecks".

200-300 DD: 1st crawlers active; 1300-1400 DD: 2nd crawlers active	acephate (Orthene) 75 S	2/3 lb/100 gal	Caution
	carbaryl (Sevin) XLR	2 lb/100 gal	Warning
	chlorpyrifos (Dursban) 50W	2 lb/100 gal	Warning
	4 E	1 qt/100 gal	Warning
	4 EC (Lorsban)	1 qt/acre	Warning
	diazinon 4 E	1 pt/100 gal	Warning
	50 W	1 lb/100 gal	Warning
	AG	1 pt/100 gal	Warning
	malathion (Cythion) 57%	4 pt/100 gal	Warning

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
Dormant oil or insecticidal soap usually effective. Use a hose to wash adelgids off of tree.	Spray in mid-April to mid-May when nymphs are active. Trees can also be sprayed in summer; 2-3 applications at 1 week intervals may be needed.	Minimize use of broad-spectrum insecticides that may kill beneficial insects. Small trees are seldom attacked.
Shear and prune damage to restore form and appearance.	Treat in mid-May to early June	Trees usually outgrow effects of light to moderate attack in 2-3 years.
Remove and destroy severely infested trees, when crawlers are not present. Limit use of insecticides to avoid killing beneficial insect predators.	Sprays only effective when when crawlers present. First generation crawlers usually coincide with lilac bloom.	Populations often begin on lower branches.

Pine Root Collar Weevil

Host: All pines, particularly Scotch and red
Injury site: Root collar
Symptoms: Foliage fades to yellow, then red; black pitch on root collar and surrounding soil; larval feeding galleries in root collar and large roots.

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
300-900 DD: Adults lay eggs; 1200-1400 DD: Adults feeding	acephate (Orthene) 75 S	1 lb/100 gal	Caution
	chlorpyrifos (Lorsban) 4EC	1 qt/acre	Warning

Pine Sawflies

Host: All pines, particularly Scotch
Injury site: Needles
Symptoms: Defoliation; dried tufts of skeletonized needles.

Spring to late summer	acephate (Orthene) 75 S	2/3 lb/100 gal	Caution
Redheaded pine sawfly: 400-600 DD: 1st larvae	azinphosmethyl (Guthion) 2 S	1-1/2 to 3 pt/acre	Danger
	2 L	1-1/2 to 3 pt/acre	Danger
Introduced pine sawfly: 500-700 DD: 1st larvae	35	1 to 2-1/8 pt/acre	Danger
	50	3/4 to 1-1/2 lb/acre	Danger
European pine sawfly: 100-200 DD: 1st larvae	carbaryl (Sevin) 50 W	2 lb/100 gal	Warning
	80 S	1-1/4 lb/100 gal	Warning
	4 SL	1 qt/100 gal	Caution
	4L	1 qt/acre	Caution
	chlorpyrifos (Dursban) 50 W	1/2 lb/100 gal	Warning
	4E	1/2 lb/100 gal	Warning
	Imidan 50W	2 lb/100 gal	Warning

Pine Shoot Beetle

Host: All pines
Injury site: Current year and older shoots
Symptoms: Shoots with 3/16 inch circular holes, often with round glob of pitch; shoots bent and often brown above boring hole; boring dust or feeding galleries may be observed on recently cut trees, stumps and other brood material.

Adults breed February-March. Adults shoot-feed beginning in early June (450 DD) and continue through October	Recent research suggests several products including cyfluthrin, fenpropathrin, bifenthrin, acephate and chlorpyrifos, control shoot-feeding adults. Chlorpyrifos (EC formulation) and carbaryl (XLR) may help control adults boring into breeding material. Contact your MSU Extension office for up-to-date information. Note that sanitation is the most important part of management.	Various	Various

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
Warm temperatures discourage weevils and reduce survival. Basal prune trees, removing at least the lowest whorl of branches. Duff and litter can be raked away from the stem. Remove fresh stumps if possible.	Soak root collar area in early summer to kill adults and developing larvae.	Problems most common in sandy soils. Weevils tend to be poor fliers and will attack "pockets" of trees.
If colonies are sparse, knock off and destroy larvae.	Varies depending on species and weather.	Spot-treat larval colonies.
Cultural controls are VERY important. Cut fresh stumps at ground level to reduce breeding material. Trees, stumps, and branches cut or killed within 8 months should be chipped, burned or buried by May 1. Use freshly cut pine logs in infested fields to "trap out" overwintering adults. Destroy trap logs by May 1 to prevent new generation beetles from emerging.	Destroy brood material by Feb. 1. Destroy trap logs by May 1. Spray trees in early and mid-June when new adults begin to shoot feed.	State and federal regulations restrict shipment of infested trees outside quarantine area. Contact Dept. of Agriculture officials for inspection and certification procedures.

Pine Tortoise Scale

(soft scale)

Host: All pines, particularly Scotch, red and Austrian
Injury site: Shoots and needles
Symptoms: Reddish-brown, helmet-shaped scales on woody tissue; discolored needles; black sooty mold on needles, shoots and branches.

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
400-500 DD: 1st crawlers active; 700-900 DD: 2nd crawlers active	acephate (Orthene) 75 S	2/3 lb/100 gal	Caution
	chlorpyrifos (Lorsban) 4 EC	1 qt/acre	Warning
	Malathion 57%	1-1/2 pt/acre	Warning

Redheaded Pine Sawfly

(see Pine Sawflies)

Spider Mites

Host: All conifers
Injury site: Needles
Symptoms: Stippled or yellow mottled needles; webbing and fine frass on needles; presence of dark colored mites.

Early and late summer are usually peak periods.	chlorpyrifos (Dursban) 50 W	1/2 lb/100 gal	Warning
	4 E	8 oz/100 gal	Warning
	chlorpyrifos (Lorsban) 4 EC	1 qt/acre	Warning
	diazinon 4 E	1 pt/100 gal	Warning
	dicofol (Kelthane) 35	1 to 1-1/3 lb/100 gal	Warning
	50	1/2 to 1 lb/100 gal	Warning
	morestan 4 E	4 to 8 oz/100 gal	Caution
	propargite (Omit) 30 W	3 to 7-1/2 lb/100gal/acre	Danger
	propargite (Ornamite) 30%	3 to 7-1/2 lb/100 gal/acre	Danger

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
1. Minimize use of insecticides that kill beneficial insect predators. 2. Destroy heavily infested trees when crawlers not active. 3. Dormant oil often effective.	Spray trees when crawlers are active.	Ladybird beetles or other insect predators often control populations within a few weeks. These predators will be less effective if many ants are present protecting the scales, or if broad spectrum insecticides are used.
Minimize use of insecticides to avoid killing predatory mites and insects.	Rap a branch over a white piece of paper to determine if mites are present. Two to three sprays at 7-10 day intervals may be needed if populations are high.	Problems most severe during drought conditions and when predatory mites are killed by broad-spectrum insecticides. Mites most common on older needles near the stem.

Spruce Bud Scale

Host: Spruce, particularly Norway
Injury site: Base of new twig growth
Symptoms: Red or dark globular "bumps" on twigs; honeydew and sooty mold on twigs and needles.

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
700-1200 DD: 1st crawlers.	acephate (Orthene)		
	75 S	2/3 lb/100 gal	Caution
	chlorpyrifos (Lorsban)		
	4 EC	1 qt/acre	Warning

Spruce Budworm

Host: Spruce and balsam fir
Injury site: Needles
Symptoms: Defoliated shoot tips, browning of clipped and webbed needles.

200-300 DD: 1st larvae.	Bt (Dipel)		
	2 X	1/4 to 3/4 lb/100 gal	Caution
	many other formulations		
	carbaryl (Sevin)		
	4F	1-2 qt/100 gal	Caution
	50W	2-4 lb/100 gal	Warning
	80S	1-1/4 lb/100 gal	Warning
	XLR	1 to 2 qt/100 gal	Caution
	carbaryl (Sevimol)		
	4	1 to 2 qt/100 gal	Warning
	chlorpyrifos (Dursban)		
	50W	1/2 lb/100 gal	Warning
	4E	1/2 lb/100 gal	Warning
	chlorpyrifos (Lorsban)		
	4EC	1 qt/acre	Warning
	malathion (Cythion)		
	ULV	13 oz/acre	Caution

Spruce Needle Miner

Host: All spruces
Injury site: Needles
Symptoms: Clusters of reddish-brown needles webbed together; needles hollow with tiny hole at the base.

150-200 DD: 1st larvae	acephate (Orthene)		
	75S	2/3 lb/100 gal	Caution
	carbaryl		
	4 SL	1 qt/100 gal	Caution
	4 F	1 qt/100 gal	Caution
	50 W	2 lb/100 gal	Warning

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
Destroy heavily infested trees when crawlers not active.	Treat in July when crawlers are active.	Minimize use of broad spectrum insecticides to conserve insect predators.
Shear off damaged foliage; avoid planting near balsam fir or white spruce.	Spray insecticides in May when larvae first appear. A second spray 7-10 days later may be needed if populations are high.	Bt will provide adequate control and will not harm beneficial insect predators. Bt should be applied when larvae have completed half of their development.
Do not plant near infested spruce windbreaks.	Spray in mid to late July when larvae are hatching. Consider a second spray in 10-14 days if needed.	Clusters of mined needles are most common near the stem.

FIRST ACTIVITY: DD BASE 50	INSECTICIDE/ FORMULATION	APPLICATION RATE	SIGNAL WORD
Spruce Needle Miner (continued)			
	80 S	1-1/4 lb/100 gal	Warning
	4 L	1 qt/acre	Caution
	XLR	1 qt/acre	Warning
	chlorpyrifos (Dursban		
	50 W	2 lb/100 gal	Warning
	4 E	1 qt/acre	Warning
	chlorpyrifos (Lorsban)		
	4EC	1 qt/acre	Warning

White Grubs

Host: All conifers, but particularly pines
Injury site: Roots
Symptoms: Dead or dying seedlings; fibrous roots absent on dead seedlings; damage scattered throughout field.

Late spring through summer	diazinon 25 EC	3 qt/100 gal	Caution

White Pine Weevil

Host: Spruces, pines and occasionally Douglas-fir
Injury site: Terminal leader
Symptoms: Round feeding wounds and fresh pitch on terminal leader in early spring; terminal leader wilts and dies in mid-summer, forming a characteristic shepards' crook; top 2-3 years of growth may be killed each year.

25-220 DD: 1st adults active	chlorpyrifos (Lorsban) 4 EC	1 qt/acre	Warning
	diflubenzuron (Dimilin) 25W	4-8 oz/acre	Warning

Zimmerman Pine Moth

Host: All pines, especially Scotch and Austrian; rarely spruce and Douglas-fir
Injury site: Stem and large branches; occasionally terminal leader
Symptoms: Pitch mass on stem, at branch whorl or on shoots near terminal leader; dead, broken tops. Large globular pitch mass often mixed with reddish frass on stem or large branches; patches of dead foliage in canopy; broken tops.

25-100 DD: 1st larvae	chlorpyrifos (Lorsban) 4 EC	1 qt/acre	Warning
	endosulfan (Thiodan) 3 EC	1 qt/100 gal	Danger
	50 W	1-1/2 lb/100 gal	Danger
	trichlorfon (Dylox 80 Turf) 80 W	20 oz/100 gal	Warning

CULTURAL CONTROL	WHEN TO TREAT	COMMENTS
Disk grassy fields and leave fallow for one year before new planting. Control grassy vegetation 6 months before planting.	Late spring to early summer when insects become active.	Fields previously occupied by grasses are most at risk. Eliminating vegetation several months before planting seedlings will reduce damage.
Prune infested leaders below feeding larvae before July. Destroy infested leader. Use corrective pruning to restore form.	Spray early in spring to kill adult weevils before oviposition.	Spray leaders only; weevils will not attack anywhere else.
Cut out feeding larvae inside pitch masses; prune damaged shoots, remove and destroy "brood" trees that are repeatedly attacked.	Spray stems and large branches in early to mid-April before larval activity begins.	Early application and good coverage of stems and branches are essential for effective control.

Appendix I
Safe Use of Pesticides

Pesticide Name

The trade name (first letter capitalized; Lorsban, for example) is used when a pesticide is sold under only one well-known brand name. The accepted common name of a pesticide is used when it is sold under several brand names; chlorpyrifos, for example, has dozens of trade names (Lorsban is probably the most common). Some well-known brand names may be given in parentheses following the common name; carbaryl (Sevin).

Application Rates

The amount or rate of each formulation (the commercial mixture of toxicant and inert ingredients) used are given. Examine the label or contact your county MSU Extension agent for more help in choosing appropriate rates for your situation. Use this information to help you select the safest insecticide for your application.

Abbreviations

We have tried to be consistent in the abbreviations used in the control recommendations. The abbreviations used are as follows:

Dry Measure

oz = ounces
lb = pound; 16 oz per lb

Liquid Measure

fl oz = fluid ounces
pt = pint; 16 fl oz per pt
qt = quart; 32 fl oz per qt, 2 pt per qt
gal = gallon; 128 fl oz per gal, 8 pt per gal, 4 qt per gal

Areas or Amounts Treated

sq ft = square foot, square feet
sq yd = square yard(s)
per acre (acre) = 43,560 square feet

Dry Formulations

The amount of active ingredient(s) in a dry formulation is given as a percentage in the formulation. For example, 50% WP indicates a wettable powder formulation containing 50 percent active ingredient.

B–bait; insecticide mixed with some attractant material that is applied without mixing with water.

D–dust; a finely ground insecticide intended for use without mixing with water.

G–granule; a coarse particle intended for use without mixing with water.

WP–wettable powder; a finely ground insecticide intended to be mixed with water for application.

SP–soluble powder; a finely ground insecticide to be dissolved in water for application.

Liquid Formulations

The amount of active ingredient in a liquid formulation is given as pounds active ingredient per gallon. This is usually cited with the ingredients statements on the label. For example, 3.2 lb/gal EC indicates an emulsifiable concentrate that contains 3.2 pounds active ingredient per gallon.

EC = emulsifiable (or soluble) concentrate: a solution of insecticide intended to be mixed with water for application.

F = flowable: a suspension of insecticide intended to be mixed with water for application.

ULV concentrate = ultra low-volume concentrate: a solution of insecticide intended to be applied by aircraft without mixing with water.

Safe Use of Insecticides in Pest Management (Guidelines)

Selecting Insecticides

Always thoroughly read the label and the supplemental labeling material for any insecticide that you may consider using. Understand the label instructions and limitations. Make certain that your operation will use the insecticide only for the purposes listed and in the manner directed on the label. Select only those insecticides that are labeled for the crop you wish to use it on and the pest(s) you wish to control. To do otherwise will cost you in terms of effective and economical product performance, and may lead to an unacceptable risks to humans, the crop, and the surrounding environment.

Protecting Groundwater

Many people who live in rural Michigan get their drinking water from wells. Since well water is groundwater, it is easy to see why you should be concerned about keeping insecticides out of groundwater. There are several processes that determine the fate of insecticides and whether they will end up in your drinking supply.

Adsorption is the binding of chemicals to soil particles. The amount and persistence of insecticide adsorption varies with insecticide properties, soil moisture content, soil pH, and

soil texture. Soils high in organic matter or clay are the most adsorptive; coarse, sandy soils are much less adsorptive. A soil-adsorbed insecticide is less likely to volatilize, leach or be degraded by microorganisms, but is also less available for intake by plants.

Volatilization occurs when a solid or liquid turns into a gas. Volatilization of insecticides increases with higher air temperature and air movement, higher temperature at the treated surface (soil, plant, etc.), low relative humidity, and when spray droplets are small. Insecticides also volatilize more readily from coarse-textured soils and from medium- to fine-textured soils with high moisture content. An insecticide in a gaseous state can be invisible and carried away from a treated area by air currents.

Runoff is the movement of insecticides in water across the soil surface. It occurs as water moves over a sloping surface, carrying insecticides either mixed in the water or bound to eroding soil. The amount of insecticide runoff depends on the grade or slope of an area, the erodibility and texture of the soil, the soil moisture content, the amount and timing of irrigation or rainfall, and properties of the insecticide.

Leaching also moves insecticides in water. In contrast to runoff, leaching occurs as water moves downward through the soil. Factors that influence leaching include whether the insecticide dissolves easily in water, soil structure and texture, and the amount and persistence of insecticide adsorption to soil particles.

Absorption is the process by which chemicals are taken up by plants. Once absorbed, most insecticides degrade within plants. However, some residues may persist inside the plant and may be released back into the environment as the plant tissues decay.

Crop removal can transfer insecticides. When treated crops are harvested, the insecticide residues are removed with them and transferred to a new location. After harvest, many agricultural commodities are washed or processed, which can remove or degrade much of the remaining residue. However, the wash water may now be contaminated and should be disposed of as a potential contaminant.

Microbial degradation occurs when microorganisms such as fungi and bacteria use an insecticide as a food source. Conditions that favor microbial growth include warm temperatures, favorable pH levels, adequate soil moisture, aeration (oxygen), and fertility. Adsorbed insecticides are more slowly degraded because they are less available to some microorganisms.

Chemical degradation is the breakdown of a insecticide by processes not involving a living organism. The adsorption of insecticides to the soil, soil pH levels, soil temperature and moisture all influence the rate and type of chemical reactions that occur. Many insecticides, especially the organophosphate insecticides, are susceptible to degradation by hydrolysis in high pH (alkaline) soils or spray mixes.

Photodegradation is the breakdown of insecticides by sunlight. To learn how to protect groundwater when applying insecticides, some basic information on groundwater is helpful. *Groundwater* is the water beneath the earth's surface occupying the saturated zone (the area where all the pores in the rock or soil are filled with water). It is stored in geological formations known as *aquifers*. Groundwater moves through aquifers and can be obtained at points of natural discharge such as springs or streams, or by drilling a well into the aquifer.

The upper level of the saturated zone in the ground is called the *water table*. The water table depth below the soil surface fluctuates throughout the year, depending on the amount of water removed from the ground and the amount of water added by recharge and connected surface waters. *Recharge* is water that seeps through the soil from rain, melting snow, or irrigation. Surface waters are visible bodies of water such as lakes, rivers, and oceans.

Both surface water and groundwater are subject to contamination by *nonpoint source pollution*. This type of pollution generally results from land runoff, precipitation, acid rain, or percolation rather than from a discharge at a specific, single location (such as a single pipe or well head). Contamination from these single sites is known as *point source pollution*.

Keeping Insecticides Out of Groundwater

An insecticide that is not volatilized, absorbed by plants, bound to soil, or broken down can potentially move through the soil to groundwater. The movement of groundwater is often slow and difficult to predict. Substances that enter groundwater in one location can turn up years later in other locations. A major difficulty in dealing with groundwater contaminants is that the sources of pollution are not easily recognized. The problem is occurring underground, out of sight.

It is very difficult to clean contaminated groundwater. The best solution is to prevent contamination in the first place. The following insecticide application practices can reduce the potential for surface and groundwater contamination.

Use integrated pest management programs—Keep insecticide use to a minimum by combining chemical control with other pest management practices.

Consider the geology of your area—Be aware of the water table depth and the permeability of the geological layers between the surface soil and groundwater. Sinkholes can be especially troublesome because they allow surface water to quickly reach groundwater.

Select insecticides carefully—Insecticides that are highly soluble, relatively stable, and not readily adsorbed to soil tend to be the most likely to leach. Read labels carefully and consult a specialist from MSU Extension, or your chemical dealer, if necessary. The tables at the back of this bulletin will also help you choose the best insecticide for your use.

Follow label directions—The label carries crucial information about the proper rate, timing, and placement of the insecticide

Calibrate accurately—Calibrate equipment carefully and often to avoid over or under application.

Measure accurately—Carefully measure concentrates before they are placed into the spray tank. Do not "add a little extra" to ensure the insecticide will do a better job.

Avoid back-siphoning—The end of the fill hose should remain above the water level in the spray tank at all times to prevent back-siphoning of chemicals into the water supply. Use an anti-backflow device when siphoning water directly from a well, pond, or stream.

Consider weather and irrigation—If you suspect heavy rain will occur, delay applying insecticides. Control the quantity of irrigation to minimize potential insecticide leaching and runoff.

Avoid spills—But when spills occur, contain and clean them up quickly with an absorbent material such as cat litter.

Mix on an impervious pad—Mix and load insecticides on an impervious pad if possible, where spills can be contained and cleaned up. If mixing is done in the field, change the location of the mixing area regularly.

Dispose of wastes properly—Obey laws regulating the disposal of insecticide wastes. Triple rinse containers. Pour the rinsewater into the spray tank for use in treating the site or the crop.

Store and mix insecticides away from water sources such as well, ponds, and springs.

Protect Nontarget Organisms

Bees and other pollinating insects are essential for successful production of tree fruits, small fruits, most seed crops and certain vegetables. Many insecticides are highly toxic to pollinating honeybees and wild bees. Be aware of how bee poisonings can occur from applying insecticides and how to prevent them. Take the following precautions to reduce the chance of bee poisoning:

- Do not apply insecticides that are toxic to bees if the site contains a crop or weeds which are in bloom. Mow cover crops and weeds to remove the blooms before spraying.

- Select insecticides that are least harmful to bees, and select the safest formulation. Dusts are more hazardous to bees than sprays. Wettable powders are more hazardous than emulsifiable concentrates or water soluble formulations. Granular insecticide formulations are generally the least hazardous to bees. Microencapsulated insecticides are extremely hazardous because the minute capsules can be carried back to the hive.

- Reduce drift during application. Use drift control materials whenever possible.

- Time insecticide applications carefully. Evening applications are less hazardous than early morning; both are safer than midday applications.

- Do not treat near hives. Bees may need to be moved or covered before using insecticides near colonies.

The best way to avoid injury of **beneficial insects and microorganisms** is to minimize insecticide use. Use selective insecticides whenever possible and apply only when necessary as part of a total pest management program.

Insecticides can be harmful to all kinds of vertebrates such as **fish and wildlife**. Most recognizable are the direct effects from acute poisoning. Fish kills can result from water pollution by an insecticide (usually insecticides). Insecticides can enter water via drift, surface runoff, soil erosion, and leaching.

Bird kills from insecticides can occur when birds ingest the toxicant in granules, baits, or treated seed; drink or use contaminated water; or feed on insecticide-contaminated prey.

Insecticide Emergency Preparedness

At the time that the insecticide is purchased, ask the chemical dealer for a complete **specimen** label of the product you bought. This label and labeling information packet is an exact duplicate of the label information that is affixed to and/or must accompany the insecticide container. Use the specimen label material as a reference during any insecticide emergency. Bring the specimen label material along with any person who has become poisoned and needs medical attention.

Closely follow all the warning statements outlined in the PRECAUTIONARY STATEMENTS section on the insecticide label. Be certain that you use all protective clothing and equipment as specified by the label. Make certain all persons involved in the operation of the farm know and can carry out the STATEMENT OF PRACTICAL TREATMENT that is given on the front panel of all insecticide labels.

Transporting Insecticides

Have agricultural chemicals delivered by your dealer directly to your insecticide storage facility if possible. Transporting insecticides, especially large quantities, can involve a high degree of assumed liability by the grower. Department of Transportation shipping rules must also be followed for transporting large quantities of insecticides, including proper placarding of the vehicle, liability insurance, special handling requirements, etc.

Storing Insecticides

Insecticides must be stored in a facility that will protect them from temperature extremes, high humidity, and direct sunlight. The storage facility should be heated, dry and well ventilated. It should be designed for easy containment and cleanup of insecticide spills and made of materials that will not absorb any insecticide material that leaks out of a container. Store only insecticides in such a facility and always store them in their original containers. Do not store any feed, seed, food, or fertilizer with insecticides. Do not store any protective clothing or equipment in the insecticide storage facility. Try to store herbicides separate from insecticides and fungicides because volatile materials will cross-contaminate other materials. Keep the facility locked at all times when not in use to prevent animals, children, and irresponsible adults from entering and becoming poisoned. Post the facility as a PESTICIDE STORAGE FACILITY to warn others that the area is off limits. Always read and follow the STORAGE AND DISPOSAL section of all insecticide labels. For further information on proper storage, and plans for constructing a facility, consult Midwest Plan Service 37 and MSU Bulletin E-2335.

Handling and Mixing Insecticides

Always wear protective clothing and equipment when handling, mixing, and applying insecticides and during the clean up of application equipment. Protective clothing should include full coverage clothing, chemical resistant gloves and boots, eye protection, hard hat, and a MSHA/NOISH approved respirator with a chemical absorbent material appropriate for the insecticide being used.

Mix insecticides downwind and below eye level. Avoid excessive splashing and sloshing. If insecticides are spilled on you, wash them off immediately with lots of water and change clothing. Resume spraying only after cleaning up any spills. Try to use closed handling/mixing systems when appropriate.

Mix only what is required for the area to be sprayed according to label directions. Avoid mixing excessive amounts. To do otherwise will create a hazardous waste which is difficult and expensive to dispose of. Keep unauthorized persons out of the areas when you handle insecticides.

Applying Pesticides

Prior to any application, the equipment used must be thoroughly checked for sound operation and accurately calibrated. Poor maintenance and calibration practices will lead to excessive residues on the crop and could harm humans, animals, crops and the environment. Inspect the application equipment during use to prevent the unintentional release of chemicals. If the equipment needs repair, stop the application operation and fix the problem before completing the spray job. Spray only the label directed rate to the target area.

Do not spray on days when the wind is greater than 10 miles per hour and/or weather conditions (e.g., inversions) are conducive to insecticide drift away from the target area. Make every effort to AVOID PESTICIDE DRIFT.

Warn all unauthorized persons to get out of the target area during the insecticide application. Warn occupants of properties abutting the target area when such precautions are specified by the label of the insecticide being used.

Handling and Disposing of Insecticide Containers

All insecticide containers are considered HAZARDOUS WASTE unless they are triple rinsed and the rinsate is used as additional dilution in the spray mixture. After triple rinsing all emptied insecticide containers, perforate both ends so that the container cannot be reused. All metal and plastic triple rinsed containers should be offered for recycling. If this option is not available, dispose of them in a state licensed sanitary landfill. Dispose of all paper containers in a sanitary landfill or municipal waste incinerator. Do not bury or burn any insecticide containers. Do not reuse any empty insecticide containers for any purpose.

Cleaning of Pesticide Application Equipment

Follow all specific label directions for cleaning application equipment. If such instructions are not given on the insecticide label, then triple rinse the entire inside of the application equipment, spraying the rinsate on a labeled site not exceeding labeled rates. Wash off the outside of the equipment in the target area. Only after rinsing the equipment out with fresh water should you clean the spray system with an appropriate cleaning solution. Do not spray any cleaning solution onto any crop; dispose of the cleaning solution as you would any municipal waste. Follow the equipment manufacturer's guidelines for routine and year-end cleaning and maintenance.

Unused and Unwanted Pesticides

Unused and unwanted insecticides are considered HAZARDOUS WASTE by both federal and state regulations. To be exempt from the stringent requirements for the disposal

of hazardous insecticide waste, make every effort to purchase the exact amount of insecticides that will be needed during the growing season. Take extreme care in the calibration and application of any insecticide so that leftovers are not generated at the end of the job. Use any insecticide containing rinsates and unused insecticides exactly according to label USE directions. If these procedures cannot be met, contact the Michigan Department of Natural Resources Hazardous Waste Division for instructions on the legal disposal of insecticide waste.

Worker Protection Standard

New federal rules for farm worker protection, issued during 1992, require farmers to provide additional training and notification to farm workers to prevent accidental or occupational exposure to pesticides. Farmers should contact Extension agents to learn the details of this standard and availabilty of training materials for education of workers and handlers.

Read and follow the label instructions on **Restricted Entry Intervals (REI)** for every pesticide used. Some pesticide labels require both oral warning and posted signs to notify workers of pesticide applications. If the label doesn't require *both* forms of notification, notify workers *either* orally or by posting warning signs at entrances to treated areas. When using posted signs, post 24 hours or less before the pesticide application and remove signs within three days after the end of the restricted entry interval. Keep workers out during the entire time the signs are posted (except for early-entry workers wearing the proper personal protective equipment).

Record Keeping

The 1990 Farm Bill requires that all applicators who apply restricted use insecticides (RUP) keep records and maintain them for two years. Records to be kept include:

1. brand or product name, formulation, and the EPA registration number of the RUP that was applied;

2. total amount and the rate of application of the RUP;

3. address or location, the size of area treated, the target pest, and the crop, commodity or stored product to which the RUP was applied;

4. month, day and year on which the RUP application occurred; and

5. name, address, and certification number (if applicable) of the certified applicator who applied or supervised the application of the RUP.

Beginning in October of 1992 a Drift Management Plan is required. The purpose of the plan is to show that reasonable care has been taken by the grower to prevent drift of insecticides during application

E-2340 to E-2345 includes direction and forms for a complete farm record keeping system, can be used for recording your sprays. Penalties are up to $500 for the first violation and up to $1000 for subsequent violations. Provisions for protecting the identity of individual producers are included in the law. At the time of this printing, no state agency was designated to enforce this new rule, however, accurate records should be kept for efficient farm management.

Endangered Species Act

To minimize the adverse impact of insecticides on endangered species, the EPA has initiated **The Endangered Species Act.** Every implicated insecticide will have an endangered species warning statement regarding use of the product within the geographic area when endangered species restrictions apply. Users must obtain a county-specific endangered species bulletin from their local CES office, which will identify the specific area where use restrictions apply. Application of listed insecticides in the identified geographic areas in that county will be restricted or prohibited.

SARA Title III Emergency Planning and Community Right to Know Act

The Community Right to Know law, under SARA Title III, requires farmers to notify their State Emergency Response Commission (SERC), Local Emergency Planning Committee (LEPC) and local fire department that they store extremely hazardous materials. Check with the state DNR or CES to receive a list of EPA established "extremely hazardous substances" and their planning threshold quantities. Extension bulletin E-2173 cited on page 2 provides all necessary information required to comply with this law.

The SERC, LEPC and local fire chief may request maps of your storage facility and detailed lists of materials you store.

This law also requires that, in the event of a spill, the SERC, LEPC and National Response Commission be notified. The reportable quantities for spills is much less than for storage and can be obtained from the above sources. See Extension Bulletin E-2173 for more details on SARA Title III. Extension Bulletin E-2334 will also assist you in preparing an emergency response plan for your farm.

Right to Farm

As a farmer in Michigan you are protected from nuisance law suits under the Right to Farm law if you follow acceptable management practices. These practices are completed for insecticides and nearly ready for fertilizers. Contact your local MSU Extension Service Office or Regional Department of Agriculture Office to obtain copies.

This section has been adopted, in part, and modified from *Chemical Control of Insects & Nematodes in Field & Forage Crops* (Extension Bulletin E-1582, October 1991) written by Douglas A. Landis, George W. Bird, Larry G. Olsen and Fred Warner, Department of Entomology and Pesticide Research Center, Michigan State University.

APPENDIX 2

GLOSSARY OF TERMS

Base Temperature	The temperature at which organisms begin metabolic activity related to growth and development. This temperature is used to calculate Degree Days. 42° F and 50° F are most commonly used.
Chemical Control	Using a pesticide to manage or control a pest population.
Common Name	A local name given to an organism. Sometimes confusion arises when one name is used to describe more than one organism or when there are several common names for one organism.
Cultural Control	A non-chemical means of managing or controlling a pest. For example, removing and destroying galls before the adult Cooley spruce gall adelgid emerges is a cultural control.
Degree Days	A means of calculating the development of some plants and insects using heat accumulation during the growing season. Sometimes referred to as Growing Degree Days.
Insecticide	A substance or mixture of substances intended to kill insect pests.
Insect Pest Management	Integrated Pest Management (IPM) applied to insect pests.
IPM	Integrated Pest Management: Using all of the available tools or tactics to prevent economically important damage from pests, without causing damage to the environment.
Pesticide	A substance or mixture of substances intended for preventing, destroying, repelling, or mitigating pests, or intended for use as a plant regulator, defoliant, or desiccant.
Phenology	The seasonal development of plants and animals.
Root Collar	The base of the main stem, just above and below the soil surface.
Scientific Name	The Latin name of an organism. Every organism has a unique genus and species name.
Scouting	A systematic and regular examination used to monitor pests in Christmas tree plantations.

APPENDIX 3

COMMON AND SCIENTIFIC NAMES OF INSECTS REFERENCED IN BULLETIN

COMMON NAME	SCIENTIFIC NAME
Adana tip moth	*Rhyacionia adana* Heinrich
Allegheny mound ant	*Formica exsectoides* Forei
Aphids	*Homoptera: Aphididae*
Bagworm	*Thyridopteryx ephemeraeformis* (Haworth)
Balsam gall midge	*Paradiplosis tumifex* Gagne'
Cooley spruce gall adelgid	*Adelgis cooleyi* (Gillette)
Eastern pine shoot borer	*Eucosma gloriola* Henrich
Eastern spruce gall adelgid	*Adelges abietis* (Linnaeus)
Eriophyid mites	*Setoptus spp.*
European pine sawfly	*Neodiprion sertifer* (Geoffroy)
European pine shoot moth	*Rhyacionia buoliana* (Denis & Schiffermuller)
Grasshoppers	*Orthoptera: Acrididae and Tettigoniidae*
Gypsy moth	*Lymantria dispar* (Linneaus)
Introduced pine sawfly	*Diprion similis* (Hartig)
Jack pine budworm	*Choristoneura pinus* Freeman
Jack pine tip beetle	*Conophthorus banksianae* McPherson
Nantucket pine tip moth	*Rhyacionia frustrana* (Comstock)
Northern pine weevil	*Pissodes approximatus* Hopkins
Northern pitch twig moth	*Petrova albicapitana* (Busck)
Pales weevil	*Hylobius pales* (Herbst)
Pine bark adelgid	*Pineus strobi* (Hartig)
Pine chafer	*Anomala oblivia* Horn
Pine needle midge	*Contarina baeri*
Pine needle scale	*Chionaspis pinifoliae* (Fitch)
Pine root collar weevil	*Hylobius radicis* Buchanan
Pine shoot beetle	*Tomicus piniperda*
Pine spittlebug	*Aphrophora parallela* (Say)
Pine thrips	*Gnophothrips sp.*
Pine tip moths	*Rhyacionia spp.*
Pine tortoise scale	*Toumeyella parvicornis* (Cockerell)
Pitch pine tip moth	*Rhyacionia rididana*
Redheaded pine sawfly	*Neodiprion lecontei* (Fitch)
Spruce bud scale	*Rhysokermes piceae* (Schrank)
Spruce budworm	*Choristoneura fumiferana* (Clemens)
Spruce needleminer	*Endothenia albolineana* (Kerfott)
White grub	Coleoptera: Scarabidae
White pine weevil	*Pissodes strobi* (Peck)
Zimmerman pine moth	*Dioryctria zimmermani* (Grote)

APPENDIX 4

MAJOR PESTS OF MICHIGAN CHRISTMAS TREES SPECIES

TREE SPECIES	PEST SPECIES
All conifers	Allegheny mound ant, aphids, bark beetles, grasshoppers, gypsy moth, mites.
All firs	Allegheny mound ant, aphids, bagworm, bark beetles, grasshoppers, gypsy moth, mites, pales weevil, spruce budworm.
Balsam fir	Allegheny mound ant, aphids, bagworm, balsam gall midge, grasshoppers, gypsy moth, mites, pales weevil, spruce budworm.
Douglas fir	Allegheny mound ant, aphids, bagworm, bark beetles, Cooley spruce gall adelgid, eastern pine shoot borer, grasshoppers, gypsy moth, mites, pales weevil, spruce budworm, white pine weevil.
Eastern red cedar	Aphids, mites, pine needle scale.
Fraser fir	Allegheny mound ant, aphids, bagworm, balsam gall midge, bark beetles, grasshoppers, gypsy moth, mites, pales weevil, spruce budworm.
Scotch pine	Adana tip moth, aphids, European pine shoot moth, European pine sawfly, introduced pine sawfly, mites, jack pine budworm, jack pine tip beetle, Nantucket pine tip moth, northern pine weevil, northern pitch twig moth, pine bark adelgid, pine chafer, pine needle midge, pine root collar weevil, pine shoot beetle, pine tortoise scale, pine thrips,redheaded pine sawfly, Zimmerman pine moth.
White pine	Aphids, European pine sawfly, introduced pine sawfly, northern pine weevil, mites, pine bark adelgid, pine chafer, pine needle midge, pine shoot beetle, Zimmerman pine moth.
Other pines (Austrian, Jack, Red)	Adana tip moth, aphids, European pine sawfly, European pine shoot moth, introduced pine sawfly, jack pine budworm, jack pine tip beetle, Nantucket pine tip moth, mites, northern pine weevil, northern pitch twig moth, pine chafer, pine bark adelgid, pine needle midge, pine root collar weevil, pine shoot beetle, pine thrips, pine tortoise scale, redheaded pine sawfly, Zimmerman pine moth.
All spruce	Aphids, eastern spruce gall adelgid, mites, pales weevil, spruce budworm, spruce needle miner.
Blue spruce	Aphids, Cooley spruce gall adelgid, eastern spruce gall adelgid, mites, pales weevil, spruce budworm, spruce needle miner.
Engleman spruce	Aphids, Cooley spruce gall adelgid, eastern spruce gall adelgid, mites, pales weevil, spruce budworm, spruce needle miner.
Norway spruce	Aphids, eastern spruce gall adelgid, mites, pales weevil, spruce budworm, spruce bud scale, spruce needle miner.
Sitka spruce	Aphids, Cooley spruce gall adelgid, eastern spruce gall adelgid, mites, pales weevil, spruce budworm, spruce needle miner.
White spruce	Aphids, eastern pine shoot borer, eastern spruce gall adelgid, mites, pales weevil, spruce budworm, spruce needle miner.

PESTICIDE EMERGENCY INFORMATION

For any type of an emergency involving a pesticide immediately contact the following emergency information centers for assistance.

Current as of November 1994

Human Pesticide Poisoning

MICHIGAN POISON CONTROL SYSTEM

From anywhere in Michigan, call

1-800-POISON 1

1-800-764-766 1

Special Pesticide Emergencies

Animal Poisoning

Your veterinarian:

Phone No.

or

Animal Health Diagnostic Laboratory (Toxicology) Michigan State University:

(517) 355-0281

Pesticide Fire

Local fire department:

Phone No.

and

Fire Marshal Division, Michigan State Police:
M–F: 8–12, 1–5

(517) 322-5847

Traffic Accident

Local police department or sheriff's department:

Phone No.

and

Operations Division, Michigan State Police:

****(517) 336-6605***

Environmental Pollution

Pollution Emergency Alerting System (PEAS), Michigan Department of Natural Resources:

Phone No.

and

For environmental emergencies:

****1-800-292-4706***

Pesticide disposal information

Michigan Department of Natural Resources. Waste Management Division.
Monday– Friday: 8 a.m.–5 p.m.

(517) 373-2730

**** Telephone Number Operated 24 Hours***

National Pesticide Telecommunications Network

Provides advice on recognizing and managing pesticide poisoning, toxicology, general pesticide information and emergency response assistance. Funded by EPA, based at Texas Tech University Health Services Center.
Monday – Friday:
8:00 a.m. – 6:00 p.m. Central Time Zone

1-800-858-7378

Revised by Larry G. Olsen, *Pesticide Education Coordinator, Michigan State University*

This publication contains pesticide recommendations based on research and pesticide regulations. However, changes in pesticide regulations occur constantly. Some pesticides mentioned may no longer be available, and some uses may no longer be legal. If you have questions about the legality and/or registration status for using pesticides, contact your county MSU Extension office.

To protect yourself and others and the environment, always read the label before applying any pesticide.

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