Michigan Christmas Tree Pest Management Guide 2023

TABLE OF CONTENTS

The information presented here does not supersede the label directions. To protect yourself, others and the environment, always read the label before applying any pesticide. Although efforts have been made to check the accuracy of information presented (January 2023), it is the responsibility of the person using is information to verify that it is correct by reading the corresponding pesticide label in its entirety before using the products. The information presented here is intended as a guide for Michigan Christmas tree growers in selecting pesticides and is for educational purposes only. The efficacies of products listed may not been evaluated in Michigan. Labels can and do change. For current labels and MSDS information, visit one of the following free online databases: **greenbook.net, cdms.com, and agrian.com**

Reference to commercial products or trade names does not imply endorsement by Michigan State University Extension or bias against those not mentioned.

This information was compiled by; Bill Lindberg, Erin Lizotte, Dr. Deborah McCullough and Dr. Monique Sakalidis, Michigan State University.

SEASONAL PEST CALENDAR

Michigan Christmas Tree Pest Calendar

Species	Insect pest	Disease	April early	April mid	April late	May early	May mid	May late	June early	June mid	June late	July early	July mid	July late	August early	August mid	August late	September early	September mid	September late	Control stage
Douglas-fir																					**Control stage**
	Cooley spruce gall adelgid																				Treat to control overwintering nymphs in the spring or fall, when new nymphs emerge as buds are expanding or, when nymphs are present in mid-July.
	Douglas-fir needle midge																				Apply insecticides when adults emerge in spring before they lay eggs. Yellow sticky traps can be used to detect emergence.
	Pales weevil																				Adults moving onto treees to feed on shoots. Pyramid traps baited with alcohol and turpintine may help detect adults.
		Rhabdocline needlecast																			Preventative fungicide- new growth 1/2" -2 long
		Swiss needlecast																			Preventative fungicide - new growth 1/2" -2 long
Pine																					**Control stage**
	Eastern pine shoot borer																				Target larvae before they bore into the shoot.
	European pine sawfly																				Target larvae.
	Pales weevil																				Remove or drench stumps from April though mid-May. From Aug-Sept., adults move onto treees to feed on shoots. Baited pyramid traps can detect adults.
	Pine chafer (Anomela beetle)																				Target adult beetles.
	Pine needle scale																				Target crawlers.
	Pine root collar weevil																				Target egg laying adult weevil.
	Pine shoot beetle																				Emergence of new generation of beetles, 450 - 500 gdd50.
	Pine tortoise scale																				Target crawlers.
	White pine weevil																				Apply early in the spring to control egg-laying weevils (~35 gdd50). In cool springs, emergence may be longer and require a second application. Baited pyramid traps can help detect emergence.
	Zimmerman pine moth																				Overwintering larva before they bore under the bark.
		Brown spot needle blight																			Begin fungicide application when needles are 1/2 elongated.
		Diplodia tip blight																			Bud-break (candle elongation).
		Dothistroma needle blight																			Apply at bud break and again in mid-june.
		Lophodermium needlecast																			Begin fungicide application to coincide with spore release.

Potential period of pest activity or presence, depending on weather.

Potential treatment window, depending on weather.

Scouting methods are: plants = inspect plants, deg day(gdd) = degree day models

Predictive (degree day) models available at enviroweather.msu.edu

Michigan Christmas Tree Pest Calendar

Species	Insect pest	Disease	April			May			June			July			August			September			
			early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	
Spruce																					**Control stage**
	Admes mite																				When larval and adult mites are active.
	Cooley spruce gall adelgid																				Time insecticide application to control overwintering nymphs in the spring or fall.
	Eastern spruce gall adelgid																				Time insecticide application to control overwintering nymphs in the spring or fall.
	Eriophyid mite																				When mites are actice, they are most active in the spring and fall.
	Spruce bud scale																				Time application for crawler emergence.
	Spruce spider mite																				When larval and adult mites are active. These are cool season mites which are most active in the spring and fall.
	Spruce gall midge																				Time applicaton for hatching larvae. Yellow sticky traps can be used to detect emergence.
	White pine weevil																				Apply early in the spring to control egg-laying weevils (~35 gdd50). In cool springs, emergence may be longer and require a second application. Baited pyramid traps can help detect emergence.
		Diplodia tip blight																			Preventative fungicide applied at budbreak.
		Phomopsis tip blight/canker																			First indication of budbreak then repeat application until the new shoots are fully developed.
		Rhizosphaera/Stigmina needlecast																			Preventative fungicide - new growth 1/2" -2" long, will require two to three applications.
True fir (Fraser, balsam and concolor)																					**Control stage**
	Balsam Twig Aphid																				Apply insecticide after eggs have hatched but before the nypmphs become stem mothers, 100-140 gdd50.
	Eriophyid mites																				When mites are actice, they are most active in the spring and fall.
	Spruce spider mite																				Threshold will depend on when the trees will be going to market. Scout for immature and adult mites. Most active in the spring and fall.
	Spruce -fir looper																				Control caterpillars if they are present in large numbers.
		Fir needle rust																			Mow or control ferns with a herbicide in the plantation.

Potential period of pest activity, presence, or treatment time depending on weather. Refer to the control stage column for more information.

Scouting methods are: plants = inspect plants, deg day(gdd) = degree day models

Predictive (degree day) models available at enviroweather.msu.edu

INSECT PESTS

A diverse complex of insect pests affect Christmas trees and nearly every part of the tree from the terminal leader to the roots, can be infested by at least one insect pest. Some insects affect multiple conifer species while others are specialists and affect only one species. It is important to know about pest biology and pesticide activity as insecticides must be applied when the susceptible stage of the insect is present.

Timing and Control

Monitoring degree-day accumulation will help you estimate when insects are active. Degree-day accumulation is a way of keeping track of how quickly temperatures warm up in the spring which greatly affects insect development. It is more accurate and reliable to base your scouting and control activities on accumulated degree-days than on the calendar. Generally, insect development progresses only if temperatures are at least 50 degrees F. Therefore, degree-day accumulations are usually based on a threshold temperature of 50 degrees F (DD50). Accumulated degree-days are calculated weekly by Michigan State University (MSU) and are available from the MSU Agricultural Weather site at www.enviroweather.msu.edu

Insect	Life stage	GDD_{50} Months	Control Options
admes mite *Eurytetranycus admes*	Eggs, larva or adults	Spring to fall	abamectin, bifenthrin, bifenazate, chlorpyrifos, clofentezine, cyflumetofen, etoxazole, fenazaquin, hexythiazox, horticutural oil, insecticidal soap, oxydemeton-methyl, peppermint and rosemary oil, propargite, spirodiclofen
ants *Formica spp.*		Spring to fall	bifenthrin, carbaryl, chlorpyrifos, spinosad (Seduce bait), thiamethoxam
aphids (*Cinara spp* ., spotted and white pine aphid)	when aphids abundant	Spring to fall	abamectin, acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, dinotefuran, flupyradifurone, heat-killed Burkholderia spp. strain, horticulture oil, imidacloprid, insecticidal soap, lambda-cyhalothrin, malathion, oxydemeton-methyl, peppermint and rosemary oil, pymetrozine, spirotetramat, sulfoxaflor, thiamethoxam
bagworm *Thyridopteryx ephemeraeformis*	after eggs have hatched and larvae are small (small bags can be seen on trees)	late May to mid June	acephate, azdirachtin, Bacillus thuringiensis subsp. Kurstaki stain ABTX-351 or EG7841, biefenthrin, carbaryl, chlorpyrifos, chromobacterium, cyfluthrin, diflubenzuron, emamectin benzoate, flubendiamid, heat-killed Burkholderia spp. strain, lambda-cyhalothrin, malathion, methoxyfenozide, permethrin, spinosad tebufenozide
balsam gall midge *Paradiplosis tumifex*	adults laying eggs galls apparent	150-300 550-700	acephate, azdirachtin, bifenthrin, chlorpyrifos, cyfluthrin, esfenvalerate, thiamothoxam

Insect	Life stage	GDD_{50}	Control Options
balsam fir sawfly *Neodiprion abieties*	Treat if the larvae are abundant in early to midsummer	June-July	acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, diflubenzuron, esfenvalerate, horticulture oil, imidacloprid, insecticidal soap, malathion, phosmet, spinosad, thiamethoxam
balsam shoot boring sawfly *Pleroneura brunneicornis*	Treat when caterpillars are small and before much feeding injury occurs		acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, diflubenzuron, esfenvalerate, horticulture oil, imidacloprid, insecticidal soap, malathion, phosmet, spinosad, thiamethoxam
balsam twig aphid *Mindarus abietis*	egg hatch stem mothers present (control target)	60-100 100-140	abamectin, acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, dinotefuran, esfenvalerate, imidacloprid, insecticidal soap, horticulture oil, lambda-cyhalothrin, malathion, oxydemeton-methyl, peppermint and rosemary oil, pymetrozine, spirotetramat, thiamethoxam
balsam wooly adelgid *Adelges piceae*	First generation of crawlers	May-July	**Not Currently Found in Michigan** acephate, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, dinotefuran, esfenvalerate, horticulture oil, imidacloprid, insecticidal soap, lambda-cyhalothrin, oxydemeton-methyl, potassium salts of fatty acids, spirotetramat, thiamethoxam
conifer root aphid *Prociphilus americanus*			imidacloprid
cooley spruce gall adelgid *Adelges cooleyi*	1st adults active - *Spruce*	25-120	acephate, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, dinotefuran, esfenvalerate, horticulture oil, imidacloprid, insecticidal soap, oxydemeton-methyl, potassium salts of fatty acids, spirotetramat, thiamethoxam
	1st adults active - *Douglas-*	90-180	
	1st galls visible - *Spruce*	200-310	
	1st nymphs - *Douglas-fir*	90-150	
	2nd nymphs - *Douglas-fir*	600-1000	
	2nd adults active	1500-1600	
douglas-fir needle midge *Contarinia pseudotsuga*	Time application within a week after first adults are detected in traps.	200-250	acephate, azdirachtin, bifenthrin, chlorpyrifos, cyfluthrin, esfenvalerate, thiamothoxam
eastern pine shoot borer *Eucosma gloriola*	1st adults active	75-200	acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, diflubenzuron, esfenvalerate, imidacloprid, malathion, permethrin, phosmet, spinosad

Insect	Life stage	GDD_{50} Months	Control Options
eastern pine weevil (formerly northern pine weevil) *Pissodes nemorensis*	1st adults active	25-100	acephate, azadirachtin, bifenthrin, chlorpyrifos, cyfluthrin, diflubenzuron, esfenvalerate, lambda-cyhalothrin, oxydemeton-methyl. phosmet
	2nd adults active	1200-1400	
eastern spruce gall adelgid *Adelges abietis*	1st adults active	25-100	acephate, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, dinotefuran, esfenvalerate, horticulture oil, imidacloprid, insecticidal soap, oxydemeton-methyl, spirotetramat, thiamethoxam
	egg hatch, galls begin forming	250-310	
	2nd adults active	1500-1600	
elongated hemlock scale *Fiorinia externa*	dormant prior to bud break	mid-March to mid-April	dormant oil
	When crawlers are active, may require many applications	June-October	acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, horticultural oil, imidacloprid, insecticidal soap, malathion, oxydemeton-methyl, spirotetramat
eriophyid mites *Setoptus and Nalepella spp.*	when mites are present	May - September	abamectin, carbaryl, fenazaquin, heat-killed Burkholderia spp. Strain, horticulture oil, spirodiclofen
European pine sawfly *Neodiprion sertifer*	1st larvae	100-195	acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, diflubenzuron, dinotefuran, esfenvalerate, horticulture oil, imidacloprid, insecticidal soal, lambda-cyhalothrin, malathion, phosmet, spinosad, thiamethoxam
European pine shoot moth *Rhyacionia buoliana*	1st larvae	50-220	acephate, azadirachtim, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, diflubenzuron, esfenvalerate, malathion, methoxyfenozide, phosmet, tebufenozide
	egg hatch	900-1000	
	adults active	700-800	
grasshopper *Melanoplus spp.*	Mid-summer		acephate, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, esfenvalerate, kaolin

Insect	Life stage	GDD_{50} Months	Control Options
spongy moth (formerly gypsy moth) *Lymantria dispar*	egg hatch, 1st larvae young caterpillars pupation	145-200 450 900-1200	acephate, azadirachtin, *Bacillus thuringiensis (Bt),* bifenthrin, carbaryl, chlorpyrifos, chromobacterium, cyfluthrin, diflubenzuron, emamectin benzoate, flubendiamide, heat-killed Burkholderia spp. strain insecticidal soap, lambda-cyhalothrin, methoxyfenozide,oxydemeton-methyl, phosmet, spinosad, tebufenozide
introduced pine sawfly *Diprion similis*	1st larvae	400-600	acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, diflubenzuron, dinotefuran, esfenvalerate, imidacloprid, insecticidal soap, lambda-cyhalothrin, malathion, phosmet, spinosad, thiamethoxam
jack pine budworm *Choristoneura pinus pinus*	young larvae feeding large larvae feeding defoliation noticeable	300-350 650-700	acephate, azadirachtin, *Bacillus thuringiensis,* bifenthrin, carbaryl, chlorpyrifos, chromobacterium, cyfluthrin, diflubenzuron, esfenvalerate, flubendiamide, Heat-killed Burkholderia spp. strain, methoxyfenozide, spinosad, tebufenozide
jack pine tip beetle *Conopthorus resinosae*	shear off injured tips	summer to fall	Insecticides not needed & likely to be ineffective
Japanese beetle *Popillia japonica*	adult foliar feeding	950-2150	azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, kaolin, lambda-cyhalothrin, malathion, methoxyfenozide, permethrin, phosmet
nantucket pine tip moth *Rhyacionia frustrana*	young larvae	mid-May -mid June	acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, diflubenzuron, esfenvalerate, imidacloprid, lambda-cyhalothrin, malathion, methoxyfenozide, permethrin, sphosmet, spinosad
northern pitch twig moth *Retinia albicapitana*	clip flagged branches or break open blister and crush larvae		Insecticides not needed & likely to be ineffective
pales weevil *Hylobius pales*	1st adults active 2nd adults active	25-100 1200-1400	acephate, azadirachtin, bifenthrin, chlorpyrifos, cyfluthrin, diflubenzuron, esfenvalerate, lambda-cyhalothrin, oxydemeton-methyl. phosmet
pine bark adelgid *Pineus strobi*	spray trunk with dormant oil before growth starts in spring or in mid-May when insects are active	April - mid-May	bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, horticulture oil, imidacloprid, insecticidal soap, oxydemeton-methyl, spirotetramat, thiamethoxam

Insect	Life stage	GDD_{50} Months	Control Options
pine bark beetle (pine engraver) *Ips spp.*			azadirachtin, bifenthrin, carbaryl
pine chafer *Anomela oblivia*	1st adults active	450-600	azadirachtin, cyfluthrin, esfenvalerate, lambda-cyhalothrin
pine false webworm *Acantholyda erythrocephala*	when larvae are feeding and building nests	late April to early June	Bacillius thuringiensus, lambda-cyhalothrin
pine needle midge *Contarinia baeri*	1st adults active	400-500	acephate, azdirachtin, bifenthrin, chlorpyrifos, cyfluthrin, esfenvalerate, thiamothoxam
pine needle scale *Chionaspis pinifoliae*	1st generation egg hatch 1st generation - hyaline stage (control target) 2nd generation egg hatch 2nd generation - hyaline (control target)	250-400 400-500 1250-1350 1500	acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, dinotefuran, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin, malathion, oxydemeton-methyl, spirotetramat
pine root collar weevil *Hylobius radicis*	1st adults active 2nd adults active	300-350 1200-1400	acephate, azadirachtin, bifenthrin, chlorpyrifos, cyfluthrin, diflubenzuron, esfenvalerate, lambda-cyhalothrin, oxydemeton-methyl. phosmet
pine root tip weevil *Hylobius rhizophagus*			cyfluthrin, lambda-cyhalothrin
pine shoot beetle *Tomicus piniperda*	new adults emerge, begin shoot feeding optimal control window	450-550 450-500	bifenthrin, chlorpyrifos, cyfluthrin
pine spittlebug *Aphrophora parallela*	when 95% of spittle masses on pines are empty	late June to mid July	bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, esfenvalerate, lambda-cyhalothrin, spirotetramat

Insect	Life stage	GDD_{50} Months	Control Options
pine thrips *Gnophothrips spp.*	Early in the spring before eggs are laid to control the 1st generation of emerging adults.		acephate, azadirachtin, carbaryl, bifenthrin, kaolin, dinotefuran,lambda-cyhalothrin, malathion, oxydemeton-methyl, soybean, garlic oils, capscium oleoresin extract, thiamethoxam
pine tortoise scale *Toumeyella parvicornis*	egg hatch begins; 1st crawlers egg hatch ends crawlers settling	400-500 1000-1200	acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, dinotefuran, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin, malathion, oxydemeton-methyl, spirotetramat
pine tube moth *Argyrotaenia pinatubana*			Insecticide rarely needed
pine tussock moth *Dasychira pinicola*	larvae feeding on foliage	late May to mid June	acephate, azadirachtin, *Bacillus thuringiensis (Bt),* bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, diflubenzuron, emamectin benzoate, flubendiamide, insecticidal soap, methoxyfenozide,oxydemeton-methyl, phosmet, spinosad, tebufenozide
pine webworm *Pococera robustella*			lambda-cyhalothrin
red-headed pine sawfly *Neodiprion lecontei*	1st larvae	400-600	acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, dinotefuran, esfenvalerate, imidacloprid, lambda-cyhalothrin, malathion, phosmet, spinosad, thiamethoxam
saratoga spittlebug *Aphrophora saratogensis*	When all or nearly all (90%) spittlemasses on sweetfern plants are empty. Control sweetfern in plantation.	late June to mid-July	bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, esfenvalerate, lambda-cyhalothrin, spirotetramat
spruce budscale *Physokermes piceae*	egg hatch, 1st crawlers	700-1150	acephate, azadirachtin, bifenthrin, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, dinotefuran, horticultural oil, insecticidal soap, malathion, oxydemeton-methyl, spirotetramat

Insect	Life stage	GDD_{50} Months	Control Options
spruce budworm *Choristoneura fumiferana*	1st larvae	200-300	acephate, *Bacillus thuringiensis,* bifenthrin, carbaryl, chlorpyrifos, chromobacterium, cyfluthrin, diflubenzuron, emamectin benzoate, esfenvalerate, flubendiamide, heat-killed Burkholderia spp. strain, methoxyfenozide, spinosad, tebufenozide
spruce-fir looper *Macaria signaria*	larvae feeding on foliage	July - October	bifenthrin, cyfluthrin, diflubenzuron, emamectin benzoate, methoxyfenozide, spinosad
spruce gall midge *Mayetiola piceae*	adult emerge eggs hatch (control window)	70-100 130-145	acephate, azdirachtin, bifenthrin, chlorpyrifos, cyfluthrin, esfenvalerate, thiamothoxam
spruce needleminers *Taniva albolineana, Epinotia nanana, Coleotchnites piceaella*	1st larvae	150-200	bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, esfenvalerate, permethrin, spinosad
spruce spider mite *Oligonychus ununguis*	1st egg hatch	150-175	abamectin, bifenthrin, bifenazate, chlorpyrifos, clofentezine, cyflumetofen, etoxazole, fenazaquin, heat-killed Burkholderia spp. strain, hexythiazox, horticutural oil, insecticidal soap, oxydemeton-methyl, peppermint and rosemary oil, potassium salts of fatty acids, propargite, spirodiclofen
striped pine scale *Toumeyella pini (King)*	egg hatch	750-800	acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos, cyfluthrin, dinotefuran, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin, malathion, oxydemeton-methyl, spirotetramat
white grubs *Phyllophaga and Polyphylla spp. Rhizotrogus majalis*			carbaryl, imidacloprid
white pine weevil *Pissodes strobi*	1st adults active 2nd adults active	25-220 1200-1400	acephate, azadirachtin, bifenthrin, chlorpyrifos, cyfluthrin, diflubenzuron, esfenvalerate, lambda-cyhalothrin, oxydemeton-methyl, phosmet
zimmerman pine moth *Dioryctria zimmermani*	1st larvae adult flight	25-100 1700	acephate, bifenthrin, chlorpyrifos, cyfluthrin, diflubenzuron, lambda-cyhalothrin, methoxyfenozide

REGISTERED INSECTICIDES AND MITICIDES

Read and follow all label instructions before using any pesticide product. Information derived from this publication does not constitute a label replacement or a recommendation. Before applying any pesticide, read and understand the entire pesticide label and any additional labeling related to the proposed use. The use of a pesticide in a manner not consistent with the label can lead to the injury of crops, humans, animals and the environment. Pesticides are good management tools for the control of pests on crops, but only when they are used in a safe, effective and prudent manner according to the label. Wherever possible, growers should rotate classes of insecticides and avoid using the same chemistry more than once per year, or better, once every other year. Note the resistance group number of each insecticides and avoid using chemistries from the same group.

IRAC Mode of Action	Active Ingredient	Insecticide & Formulation	Company	Rate per acre (unless otherwise noted)	REI (hrs)
3A (Pyrethroids)	**Bifenthrin**	Batallion	Atticus Ag	insect specific	12
		Batallion™ 2 EC	Atticus Ag	insect specific	12
		Bifen 2 AG Gold	WinField United	insect specific	12
		Bifenture® EC	UPL NA	insect specific	12
		Fanfare® EC	ADAMA	3.9 to 6.4 ounces	12
		Fanfare® ES	ADAMA	3.9 to 12.8 ounces	12
		OnyxPro	FMC Pro. Solution	insect specific	12
		Reveal®	Innvictis Crop Care	based on application method	12
		Reveal® Endurx™	Innvictis Crop Care	based on application method	12
		Sniper/Sniper Helios	Loveland Products	3.9 to 12.8 ounces	12
3A (Pyrethroids)	**Cyfluthrin**	Baythroid XL	Bayer CropScience	3.2 ounces per acre	12
3A (Pyrethroids)	**Esfenvalerate**	Asana® XL	Valent	insect specific	12
		S-FenvaloStar	LG Life Sciences	insect specific	12

IRAC Mode of Action	Active Ingredient	Insecticide & Formulation	Company	Rate per acre (unless otherwise noted)	REI (hrs)
3A (Pyrethroids)	**Permethrin**	Perm-UP® 25DF	UPL NA	6.4 to 12.8 ounces	12
1B (Organophosphates)	**Acephate**	Acephate 90 Prill	Adama	8.9 ounces in 100 gal water per acre	24
		Acephate 90 Prill Select™	Albaugh	0.55 pounds in 100 gal water per acre	24
		Acephate 90 WDG	Loveland Products	0.55 pounds in 100 gal water per acre	24
		Acephate 97UP®	UPL NA	0.5 pounds in 100 gal water per acre	24
		Bracket® 97	WinField United	0.5 pounds per 100 gal	24
1B (Organophosphates)	**Chlorpyrifos**	Chlorpyrifos 4E-AG	Drexel	2 pints	24
		Drexel Chlorpyrifos 4E AG	Drexel	2 pints	24
		Hatchet® Insecticide	Corteva Agriscience	1 quart	24
		Lorsban® Advanced	Corteva Agriscience	1 quart	24
		Lorsban®-4E	Corteva Agriscience	1 quart	24
1B (Organophosphates	**Malathion**	Fyfanon® 57% EC	FMC	82 ounces	12
		Malathion 5EC	Drexel	82 ounces	12
		Malathion 8 Aquamul	Loveland Products	0.75 to 0.8 gal in 100 gal	12
		Malathion 8 Flowable	Gowan	0.4 gal in 100 gal	12
1B (Organophosphates)	**Phosmet**	Imidan® 70-W	Gowan	1.33 to 1.5 pounds	312
1A (Carbamates)	**Carbaryl**	Carbaryl 4L	Loveland Products	0.75 to 1 qt, insect specific	12
		Carbaryl 4L	Drexel	0.75 to 1 qt, insect specific	12
		Drexel Carbaryl 4L	Drexel	based on application method	12
		Sevin® SL	Bayer Environmental Science	based on insect species	
		Sevin® XLR Plus	NovaSource	1 quart	12

IRAC Mode of Action	Active Ingredient	Insecticide & Formulation	Company	Rate per acre (unless otherwise noted)	REI (hrs)
4A (Neonicotinoids)	**Dinotefuran**	Safari® 20 SG Insecticide	Valent	4 to 8 ounces per 100 gal	12
4A (Neonicotinoids)	**Imidacloprid**	Acronyx™ 2 Flowable	Atticus Ag	3.2 to 6.4 ounces	12
		Admire® Pro	Bayer CropScience	1.4 to 2.8 ounces foliar/ 7 to 14 ounces soil	12
		Advise® Four	WinField United	1.6 to 3.2 ounces foliar/ 8 to 16 ounces soil	12
		Alias® 4F	ADAMA	1.6 to 3.2 ounces foliar/ 8 to 16 ounces soil	12
		Macho® 2.0 FL	Albaugh	3.2 to 6.4 ounces	12
		Macho® 4.0 Flowable	Albaugh	1.6 to 3.2 ounces	12
		Malice® 2F	Loveland Products	16 to 32 ounces	12
		Malice® 75 WSP	Loveland Products	1.1 to 2.1 ounces	12
		Midash Forte Insecticide	Sharda USA LLC	8 to 16 ounces	12
		Montana® 2F	Albaugh	3.2 to 6.4 ounces	12
		Montana® 4F	Albaugh	1.6 to 3.2 ounces	12
		Nuprid® 2SC Soil/Foliar Insecticide	Nufarm	16 to 32 ounces	12
		Prey® 1.6	Loveland Products	4 to 8 ounces	12
		Provoke™	Innvictis Crop Care	1.6 to 3.2 ounces	12
		Sherpa® Insecticide	Loveland Products	4 to 8 ounces	12
		Viloprid™ FC 1.7	Vive Crop Protection Inc.	based on application method	12
		Widow® Insecticide	Loveland Products	16 to 32 ounces	12
		Willowood Imidacloprid 4SC	Generic Crop Science LLC	based on application method	12
		Wrangler® Insecticide	Loveland Products	1.6 to 3.2 ounces	12
4A (Neonicotinoids)	**Thiamethoxam**	Flagship® 25WG	Syngenta	insect specific	12
4A (Neonicotinoids)	**Flupyradifurone**	Altus®	Bayer	7 to 14 ounces	12
4C (Neonicotinoids)	**Sulfoxaflor**	Transform® WG	Corteva Agriscience	insect specific	24

IRAC Mode of Action	Active Ingredient	Insecticide & Formulation	Company	Rate per acre (unless otherwise noted)	REI (hrs)
5 **(Spinosyns)**	**Spinosad**	Blackhawk® Naturalyte® Insect Control	Corteva Agriscience	1.1 to 4.4 ounces	4
		Conserve® SC	Corteva Agriscience	4 to 16 ounces	4
		Entrust	Corteva Agriscience	0.5 to 2.5 ounces	4
		Entrust® SC	Corteva Agriscience	2 to 8 ounces	4
		Seduce®	Certis USA	0.5 to 1 pound per 1000 sq feet	4
		SpinTor® 2SC Naturalyte®	Corteva Agriscience	2 to 8 ounces	4
6 **(Avermectins)**	**Abamectin**	Ardent 0.15 EC	Syngenta	8 to 16 ounces	12
		Avid 0.15 EC	Syngenta	8 to 16 ounces	12
		Lucid® Ornamental	Rotam North America, Inc.	insect specific	12
		Minx 2	Nufarm Americas, Inc.	8 to 16 ounces	12
		Reaper .15 EC	Loveland Products	insect specific	12
		Reaper Clearform**	Loveland Products	insect specific	12
		Willowood Abamectin 0.15LV	Generic Crop Science LLC	8 to 16 ounces	12
9B **(Pyridine azomethine derivatives)**	**Pymetrozine**	Endeavor	Syngenta	2.5 to 5 ounces per 100 gal	12
10A **(Hexythiazox)**	**Hexythiazox**	Hexamite	Albaugh Inc	12 to 24 ounces	12
		Hexygon IQ	Gowan Company	12 to 24 ounces	12
		Onager Miticide	Gowan Company	12 to 24 ounces	12
		Onager Optek	Gowan Company	12 to 24 ounces	12
		Savey 50 DF	Gowan Company	3 to 6 ounces	12
10A **(Clofentezine)**	**Clofentezine**	Apollo SC	ADAMA	4 to 8 ounces in 50 to 400 gal water	12

IRAC Mode of Action	Active Ingredient	Insecticide & Formulation	Company	Rate per acre (unless otherwise noted)	REI (hrs)
10B (Etoxazole)	**Atoxazole**	TetraSan 5 WDG	Valent USA	28 to 40 ounces	12
18 (Diacylhydrazines)	**Methoxyfenozide**	Inspirato™ 2 F	Atticus Ag	4 to 16 ounces	4
		Intrepid® 2F Insecticide	Corteva Agriscience	4 to 16 ounces	4
		Invertid 2F	Loveland Products	4 to 16 ounces	4
		TurnStyle™ Insecticide	UPL NA	4 to 16 ounces	4
		Vexer™	Innvictis Crop Care	4 to 16 ounces	4
18 (Diacylhydrazines)	**Tebufenozide**	Confirm® 2F Insecticide	Gowan	insect specific	4
20D (Bifenazates)	**Bifenazate**	Acramite 4SC	UPL NA Inc.	12 to 16 ounces	12
		Bifenamite 2SC	Albaugh, Inc	based on insect pressure	12
		Bizate 4SC	Loveland Products	12 to 16 ounces in 100 gal water	12
		Enervate 4SC	Atticus LLC	12 to 16 ounces in 100 gal water	12
		Floramite SC	OHP, Inc.	based on insect pressure	12
		Vigilant 4SC	Macdermid Ag. Solutions	12 to 16 ounces in 100 gal water	12
21A (METI)	**Fenazaquin**	Magister® SC	Gowan	24 to 36 ounces	12
		Magus® Miticide	Gowan	insect specific	12
23 (Tetramic acids)	**Spirodiclofen**	Envidor 2SC Miticide	Bayer Cropscience	18 to 24.7 ounces	12
23 (Tetramic acids)	**Spirotetramat**	Movento	Bayer Cropscience	5 to 10 ounces	24
25 (Beta-ketonitrile Derivatives)	**Cyflumetofen**	Sultan Miticide	BASF Ag Products	13.7 ounces per 100 gal water	12

IRAC Mode of Action	Active Ingredient	Insecticide & Formulation	Company	Rate per acre (unless otherwise noted)	REI (hrs)
Biopesticides	**Horticultural oil**	440 Superior Spray oil	Wilbur Ellis	0.25 to 0.75 gal	4
		BioCover™ MLT	Loveland Products	insect specific	4
		Damoil	Drexel	1 to 4 gal per 100 gal	4
		Glacial® Spray Fluid	Loveland Products	insect specific	4
		PureSpray™ Green	Petro-Canada	based on spray timing	4
		PureSpray™ Spray Oil 10E	Petro-Canada	based on spray timing	4
		SuffOil-X®	BioWorks, Inc.	1 to 2 gal per 100 gal water	4
		TriTek™	Brandt Consolidated	1 to 2 gal per 100 gal water	4
		Ultra-Pure® Oil	BASF	based on spray timing	4
Biopesticides	**Potassium salts of fatty acids**	M-Pede Insecticide	Gowan	1% to 4% v/v, insect specific	12
Biopesticide	**Chromobacterium**	Grandevo® CG	Marrone Bio Innovations	1.5 to 4.25 tablespoons per 1000 sq feet	4
		Grandevo® WDG	Marrone Bio Innovations	1 to 3 pounds per acre, insect specific	4
Biopesticide	**Heat-killed Burkholderia spp. strain**	Venerate® XC	Marrone Bio Innovations	insect specific	4
		Zelto™	Marrone Bio Innovations	2 to 4 quarts	4
un (unknown)	**Azadirachtin**	Aza-Direct*	Gowan Company	1 to 3.5 pints	4
		Molt-X	BioWorks, Inc.	insect specific	4
NA	**Kaolin**	Surround® WP Agricultural Crop Protectant	NovaSource	based on application method	4
NA	**Soybean, Garlic oils, Capsicum Oleoresin extract**	Captiva®	Gowan	1 to 2 pints	4
		Captiva® Prime	Gowan	1 to 2 pints	4

DISEASES

As we continually gain insight into pesticide and pest interactions, we have the opportunity to greatly improve the efficacy of our management practices. In order to optimize environmental and economic sustainability we have to understand the lifecycles of the pathogens in our Christmas tree fields and also the pesticides used to treat them. Monitoring temperature and wetting events is another critical part of managing disease and can assist in estimating when pathogens are likely present and able to cause infection. Real time and historical weather data and pest models are available via Michigan State University (MSU) at the Enviroweather website found at www.enviroweather.msu.edu.

Disease	Pathogen	Cultural control	Chemical control	Comments
armillaria root rot *Armillaria spp.*	All species	Choose a site that is well suited to the growth needs of the desired species. If possible, avoid planting on cutover sites, especially those that were red pine, Douglas-fir and other Christmas tree species. If possible, remove stumps and large roots before planting. Maintain healthy, vigorous trees.		At this point, no information is available on the effectiveness of fungicides for control of this disease.
balsam fir needle rust *Uredinopsis spp. and Milesina spp.*	Balsam fir Concolor fir potentially Fraser fir	Control is usually not necessary because weather conditions and competition from other fungi keep the damage below serious levels. However, in Christmas tree plantations, disease can cause economic loss.	triadimefon	Some formulations containing triadimefon may be registered but keep in mind that these products are best used preventatively. Apply at bud break and 10-14 day intervals. The necessity for control will depend on the level of diseases. If disease incidence is high, mow or use a registered herbicide to control ferns, which are the source of spores, this will reduce disease in subsequent years. **Do not use triadimefon on *Abies concolor.***
broom rust of fir *Melampsorella caryophyllacearum*	Balsam fir Concolor fir Fraser fir	Remove diseased trees through selective thinning. Infected branches can be pruned from high value trees. Inspect nursery crop and survey new planting areas for broom rust in native balsam or fir trees.	myclobutanil ziram	Typically, removing infected branches or trees will eliminate the problem. To break the life-cycle and control the spread of this disease, eradicating the chickweed is essential. Commercial growers should look for chickweed in the groundcover, between the rows and throughout the planting so it can be controlled where necessary.

Disease	Pathogen	Cultural control	Chemical control	Comments
brown spot needle blight *Mycosphaerella dearnessii*	Scotch pine	Cultural -Remove severely diseased trees and treat surrounding area with fungicides. Promote good air circulation through pruning and weed control. Shear healthy trees before infected tree. Pruning tools should be sterilized between trees. Avoid shearing infected trees when the foliage is wet. Do not leave live branches on the stumps of harvested trees.	chlorothalonil copper hydroxide copper sulfate mancozeb thiophanate-methyl	Make first application when needles are 1/2 elongated and the second application about 2-3 weeks later. Repeat after heavy rains and at two-week intervals as long as needed. Short-needled varieties are very susceptible. If a few trees are diseased remove and destroy those trees to prevent further spread of the disease.
charcoal rot *Macrophomina phaseolina*	Fraser fir Spruce	Charcoal rot is a disease that occurs when plants are under heat and drought stresses. Irrigate trees where available to help reduce drought stress. Avoid planting soybeans as a rotational crop.		At this point, no information is available on the effectiveness of fungicides for control of this disease.
cyclaneusma needlecast *Cyclaneusma minus*	Scotch pine	Usually does not warrant control efforts. In problem plantations, control weeds and maintain tree spacing to maximize air movement.	chlorothalonil copper hydroxide copper sulfate mancozeb	Many fungicides have shown activity protecting needles from infection. The long and unpredictable infection periods require multiple applications throughout the growing season to control this disease. In some cases, these applications have achieved control but do not improve the tree grade or density of the foliage. Pines typically hold1-2 years of growth and other factors controlling needle retention may cause heavy needle casting in the fall regardless of levels of infection.
cytospora (leucostoma) canker *Leucostoma kunzei*	Spruce, especially Colorado blue and Norway	Remove infected branches. Do not prune or shear infected trees during wet weather. Maintain tree vigor and do not plant trees on marginal sites. Avoid wounding the trees. Harvest as quickly as possible.		At this point, there are no effective chemical controls for Leucostoma canker (Cytospora canker).
diplodia shoot blight and canker *Sphaeropsis sapinea*	Austrian pine Red pine Scotch pine Occasionally-Colorado blue spruce and Douglas-fir	Do not allow water stress, maintain tree vigor, and prevent injury through insect control. Do not shear infected trees during wet weather. Prune out infected branches and sanitize pruning tools between cuts.	azoxystrobin mancozeb* myclobutanil thiophanate-methyl triadimefon	Diplodia tip blight can be controlled with one to three applications of an effective fungicide. Time your application at bud break (candle elongation). Repeat 10-14 days later, just before needles emerge from sheath. Repeat again 10-14 days after needle emergence.

Disease	Pathogen	Cultural control	Chemical control	Comments
dothistroma needle blight *Mycosphaerella pini*	Austrian pine Potentially Scotch pine	Provide for air circulation around the tree by decreasing planting density and controlling weeds that block air movement. Do not plant in low lying or cooler areas with susceptible pine.	chlorothalonil copper sulfate copper hydroxide	Two fungicide applications are recommended to control Dothistroma. Apply at bud break to protect the previous year's needles and one in mid-June to protect the current year's needles. Some have reported controlling Dothistroma with one application in June.
gall rust (pine/pine or Western) *Endocronartium harknessii*	Scotch pine	Remove branch galls and heavily galled trees before May 1 (before they produce spores). Purchase clean planting stock. Replant infested sites with non-host species.	triadimefon mancozeb	In research trials fungicide application provided fair to poor control. Repeat mancozeb applications after heavy rains and at two-week intervals as long as needed.
interior needle blight *Mycosphaerella spp., Phaeocryptopus nudus, Phyllosticta abietina, Toxosporium spp., Rhizosphaera spp*	Grand fir Noble fir	Use practices that increase air circulation (e.g. weed control), decreasing needle wetness is beneficial. Do not interplant the next rotation before the current rotation of trees has been completely harvested.	chlorothalonil	Applications of fungicides to new growth on affected Christmas trees during spring has increased the percentage of healthy older green needles. Make the initial application when shoots are 1 1/2 to 2 1/2 inches long, followed by an additional application about 3 to 4 weeks later if conditions are variable for disease development. Applications are not needed in the harvest year, especially for clear-cut operations.
isthmiella needlecast *Isthmiella faullii*	Balsam fir Concolor fir Fraser fir	Promote good air movement by controlling weeds and pruning lower branches. Shear healthy trees first and disinfect tools often. Do not shear during wet weather. Space trees adequately and do not interplant rotations. Plant clean nursery stock.	mancozeb*	Time fungicide application to protect current needles during spores released from infected needles during rainy periods in June - August.
lirula needlecast *Lirula nervata and Lirula mirabilis*	Balsam fir Concolor fir Fraser fir	Promote good air movement by controlling weeds and pruning lower branches. Shear healthy trees first and disinfect tools often. Do not shear during wet weather. Space trees adequately and do not interplant rotations. Plant clean nursery stock.		At this point, no information is available on the effectiveness of fungicides for control of this disease.

Disease	Pathogen	Cultural control	Chemical control	Comments
lophodermium needlecast *Lophodermium seditiosum*	Austrian pine Eastern white pine Red pine Scotch pine	Choose seed sources that are less susceptible and disease free nursery stock. Avoid prolonged periods of moisture and promote good air circulation by irrigating in the morning, controlling weeds and pruning lower branches. Shear healthy trees first and disinfect tools often. Do not shear during wet weather. Do not leave live branches on cut stumps.	azoxystrobin chlorothalonil mancozeb triadimefon	The most important time to protect trees is in August and September. Begin application to coincide with spore release beginning the end of July and through September. For most plantations, two applications, one about August 1 and the other about September 1 will give adequate control. If the weather in the late fall is unusually wet an additional application may be required. If using mancozeb, repeat after heavy rains and at two-week intervals as long as needed.
phomopsis twig blight and canker *Phomopsis spp.*	Colorado blue spruce Occasionally - White spruce Norway spruce	Cultural management of plant vigor can help reduce damage caused by plant pathogens, because wounds, water stress and the presence of other pest play important roles in plant susceptibility to infection and disease development. Remove diseased branches and trees as soon as possible.	mancozeb* thiophanate-methyl	Apply fungicides to protect spruce during maximum susceptibility. Fungicide should be timed to protect the new growth from infection and suppress the development of existing infection sites. Applications of protectant fungicides should start at the bud break and continue at 3-week intervals until new shoots are fully developed and hardened off.
phytophthora root rot *Phytophthora cactorum, P. citricola, P. cryptogea, and P. nicotiana among other species*	Various species of the fungus Phytophthora are present throughout the U.S. and are known to infect fir, spruce, and pine trees.	Do no plant on heavy soil or poorly drained sites. Prevent introduction of Phytophthora by inspecting stock before planting and clean equipment and tools regularly to prevent movement.	aluminum tris fluopicolide mefenoxam metalaxyl potassium salts of phosphorous acid potassium phosphite	Fungicides will not overcome poorly drained sites. Applications of systemic fungicides are used in nurseries. Use in Christmas tree plantations may not be practical or economical. Mefenoxam can be used as a dip, drench or foliar treatment. For best metalaxyl efficacy, 1/2 - 1 inch of irrigation or rainfall is required within 24 hours after application.
pine needle rust *Coleosporium asterum*	Red pine Scotch pine	Avoid planting on sites with poor air circulation. Kill weeds, aster and goldenrod prior to planting.		Remove goldenrod and aster before August in and around infected plantations by mowing or applying an herbicide.

Disease	Pathogen	Cultural control	Chemical control	Comments
rhabdocline needlecast *Rhabdocline pseudotsugae*	Douglas-fir	Plant disease-resistant seed sources of Douglas-fir such as Shuswap. Remove severely affected to prevent disease buildup by May 1. Improve air circulation through plant spacing and weed control. Remove and destroy infected trees from plantations. Avoid using Rocky Mountain seed sources and purchase disease free nursery stock. Do not shear during wet weather. Shear healthy trees first and sanitize tools often. Do not leave live branches on the stumps of harvested trees.	chlorothalonil mancozeb copper hydroxide copper sulfate thiophanate methyl	Start applying fungicides when trees are 4-5 years away from harvest. Since trees do not break bud at the same time, apply when first buds break, a second spray one week later, and a third spray two weeks after the second. A fourth application may be required three weeks after the third application if wet weather persists.
rhizosphaera needlecast *Rhizosphaera kalkhoffii*	Colorado Blue Spruce Occasionally-White spruce	Remove severely affected trees early in the rotation to prevent disease buildup. Provide adequate space between trees to increase air movement. Do not leave live branches on the stumps of harvested trees or shear during wet weather. Shear healthy trees first and disinfect tools often.	chlorothalonil copper hydroxide copper sulfate mancozeb*	Phytotoxicity can occur when spraying chlorothalonil on spruce at higher rates and with air-blast sprayers. Begin application when the new growth is 1/2 to 2" long. Make additional applications at 3–4-week intervals until conditions no longer favor disease development. For control to be successful it may take 2-3 years of yearly fungicide applications.
scleroderris canker *Gremmeniella abietina*	All pines Occasionally-Spruces Firs Douglas-fir	Remove infected branches. Do not shear during wet weather and sterilize tools often. Shear healthy trees first.	chlorothalonil	Begin application when the new growth is 1/2 to 2" long. Make additional applications at 3–4-week intervals until conditions no longer favor disease development.
sirococcus tip blight *Sirococcus spp.*	Red pine Scotch pines Colorado blue spruce, rarely White spruce	Remove and destroy heavily infected trees. Do not shear during wet weather.	azoxystrobin chlorothalonil triadimefon	Begin application when the new growth is 1/2 to 2" long. Make additional applications at 3–4-week intervals until conditions no longer favor disease development.

Disease	Pathogen	Cultural control	Chemical control	Comments
spruce needle rust *Chrysomyxa spp.*	Colorado blue spruce Black spruce White spruce Occasionally-Norway spruce.	Control is not typically warranted because disease rarely occurs in consecutive seasons. Remove and destroy alternate hosts near to plantation. Plant resistant species of spruce, such as Norway or Black Hills. White spruce is moderately resistant, but black and Colorado blue spruce are extremely susceptible.		At this point, no information is available on the effectiveness of fungicides for control of this disease. Avoid planting spruce near swamps that contain Labrador tea and leather leaf.
stigmina needlecast *Stigmina lautii*	Colorado Blue spruce Serbian spruce White spruce	Promote good air movement through weed control and pruning lower branches. Do not leave live branches on the stumps of harvested trees. Do not shear during wet weather. Shear healthy trees first and sanitize tools often. The Christmas Tree Pest Manual page referenced is for Rhizosphaera needlecast that is believed to be comparable to Stigmina needlecast.	chlorothalonil copper hydroxide mancozeb	Products that control Rhizosphaera needlecast should also control of Stigmina. Begin application when the new growth is 1/2 to 2" long. Make additional applications at 3–4-week intervals until conditions no longer favor disease development. Research in North Dakota indicates that fungicide applications may need to be applied yearly to be successful.
swiss needlecast *Phaeocryptopus gäumanni*	Douglas-fir	Remove severely affected trees early in the rotation to prevent disease buildup or older trees in fencerows. Improve air circulation in fields. To increase air movement, provide adequate space between trees, control weeds and prune lower branches. Do not shear in wet weather and sterilize tools often. Do not leave live branches on stumps of harvested trees.	azoxystrobin chlorothalonil mancozeb thiophanate-methyl	Begin applying fungicides for control beginning 3 years before you plan to harvest the trees. Needle infection occurs shortly after bud break, so you will want to time your application to protect these new needles from infection. Begin application when the new growth is 1/2 to 2" long. Make additional applications at 3–4-week intervals until conditions no longer favor disease development. Labels list a single application at a higher rate. Remember when treating it is better to be on the early side than too late. Repeat mancozeb applications after heavy rains and at two-week intervals as long as needed.
Weir's cushion rust *Chrysomyxa weirii*	Colorado blue spruce Engelmann spruce White spruce	Remove severely affected trees early in the rotation to prevent disease buildup or older trees in fencerows. Provide adequate space between trees to increase air movement around lower branches allowing the foliage to dry quicker.	chlorothalonil	Begin when bud break is about 10% complete. Two more applications should be made at 7 to 10-day intervals.
white pine blister rust *Cronartium ribicola*	White pine	Remove and destroy alternate hosts (gooseberry or currant) before August. When shearing, prune all brown branches that have cankers to prevent the fungus from entering the trunk.. Destroy and remove trees with trunk cankers.		At this point, no information is available on the effectiveness of fungicides for control of this disease. Remove and destroy alternate hosts (gooseberry or currant) in or near the plantation before August.

REGISTERED FUNGICIDES

Read and follow all label instructions before using any pesticide product. Information derived from this publication does not constitute a label replacement or a recommendation. Before applying any pesticide, read and understand the entire pesticide label and any additional labeling related to the proposed use. The use of a pesticide in a manner not consistent with the label can lead to the injury of crops, humans, animals and the environment. **FRAC Code is a number and/or letter combination assigned by the fungicide resistance action committee (FRAC) to group together active ingredients which demonstrate potential for cross-resistance. Fungicides with the same FRAC code are at risk for cross-resistance because they have the same target site.**

FRAC Code*	Active Ingredient	Product	Rate	REI	Labeled crop
1	Thiophanate-methyl	Incognito® 4.5 F	based on disease	12	Conifers, Pine (Red, Austrian, Scots, Christmas tree), Fir Douglas,
		Incognito® 85 WDG	56 oz.	12	Conifers (Pines and Douglas fir)
		Miramar™ Fungicide	based on tree species	12	Conifers, Pine (Red, Austrian, Scots, Christmas tree), Fir Douglas,
		Nufarm T-Methyl 4.5 F Fungicide	based on tree species	12	Conifers, Pine (Red, Austrian, Scots, Christmas tree), Fir Douglas,
		Talaris™ 70 WSB	based on tree species	12	Conifers (Christmas trees)
		Topsin® 4.5FL Fungicide	based on tree species	12	Conifers (Christmas trees)
		Topsin® M WSB Fungicide	based on tree species	12	Conifers (Christmas trees)
3	Triadimefon	Bayleton® 50 Turf and Ornamental	8 oz.	12	Christmas tree, except Concolor fir
		Bayleton® Flo	8 oz.	12	Christmas tree (Except Concolor fir)
3	Myclobutanil	Eagle® 20EW Specialty Fungicide	8 oz. per 100 gal, with not more than 19 oz./acre/application	24	Christmas trees

*__FRAC Code__ is a number and/or letter combination assigned by the fungicide resistance action committee (FRAC) to group together active ingredients which demonstrate potential for cross-resistance. Fungicides with the same FRAC code are at risk for cross-resistance because they have the same target site.

FRAC Code*	Active Ingredient	Product	Rate	REI	Labeled crop
4	Metalaxyl	Metalaxyl 2E AG	1.25 to 2.5 gals in 50 gal water as directed soil spray	48	Conifers, including Christmas trees
		Metastar 2E Fungicide	1.25 to 2.5 gals in 50 gal water as directed soil spray	48	Conifers, including Christmas trees
		ReCon™ 4 F	0.63 to 1.25 gal in min 50 gal water as directed soil spray	48	Conifers, including Christmas trees
		Xyler® FC Fungicide	based on tree age	48	Conifers in nurseries and plantations
4	Mefenoxam	Subdue® GR	50 to 250 lbs. to soil surface	48	Conifers, including Christmas trees
		Subdue® MAXX®	based on target disease	48	Conifers, including Christmas trees
11	Azoxystrobin	Aframe™	6 to 15.5 oz.	4	Christmas trees
		AzoxyStar®	6 to 15.5 oz.	4	Christmas trees
		Azoxystrobin SC	6 to 15.5 oz.	4	Christmas trees
		Azoxyzone™ Fungicide	6 to 15.5 oz.	4	Christmas trees
		AZterknot™	7.4 to 18.4 oz.	4	Christmas trees
		AZteroid® FC 3.3	3.9 to 9.7 oz.	4	Christmas trees
		Dexter® SC	6 to 15.5 oz.	4	Christmas trees
		GCS Azoxy 2SC	6 to 15.5 oz.	4	Christmas trees
		Heritage® Fungicide	3.2 to 8 oz.	4	Conifers, including Christmas trees
		Quadris® Flowable	6 to 15.5 oz.	4	Christmas trees
		Satori® Fungicide	6 to 15.5 oz.	4	Christmas trees
		Tetraban	6 to 15.5 oz.	4	Christmas trees
		Trevo®	6 to 15.5 oz.	4	Christmas trees
M01	Copper hydroxide, Copper oxychloride	Badge® SC	3 to 6 pints	48	Conifers in Christmas tree plantings
		Badge® X2	0.75 to 1.75 lbs.	48	Conifers in Christmas tree plantings

*__FRAC Code__ is a number and/or letter combination assigned by the fungicide resistance action committee (FRAC) to group together active ingredients which demonstrate potential for cross-resistance. Fungicides with the same FRAC code are at risk for cross-resistance because they have the same target site.

FRAC Code*	Active Ingredient	Product	Rate	REI	Labeled crop
M01	Copper hydroxide	Champ® Formula 2 Flowable	1.5 to 3 pints	48	Conifers, Christmas tree plantings
		ChampION++™ Fungicide/Bactericide	0.75 to 1.75 lbs.	48	Conifers, including Christmas trees
		Kocide® 2000-O	1.5 to 3 lbs.	48	Conifers, spruce, pines, firs, Christmas tree
		Kocide® HCu	1.5 to 4 lbs.	48	Conifers, Christmas tree plantings
		Nu-Cop® 30 HB	based on disease	48	Conifers, including Christmas trees
		Nu-Cop® XLR	1.8 to 4.2 pints	48	Conifers (Douglas fir, Fir, Spruce, Pine)
M01	Basic Copper sulfate	Cuproxat® Flowable Copper Fungicide	3 to 5.5 pints	48	Conifers, including Christmas trees
M03	Mancozeb	Dithane® F45 Rainshield® Fungicide	1.6 to 3.2 quarts	24	Conifers (Christmas trees)
		Dithane® M45 Fungicide	2 to 4 lbs.	24	Conifers (Christmas trees)
		Fore® 80WP Rainshield® Specialty Fungicide	1.5 lbs. per 100 gal	12	Conifers, including Christmas trees
		Fortuna™ 75 WDG Fungicide	1 to 2 lbs. or 1 to 2 lbs. per 100 gal	24	Christmas trees
		Koverall® Fungicide	1 to 2 lbs. or 1 to 2 lbs. per 100 gal	24	Christmas trees
		Koverall® Fungicide	1 to 2 lbs. or 1 to 2 lbs. per 100 gal	24	Christmas trees
		Manzate® Max	1.6 to 3.2 quarts	24	Christmas trees
		Manzate® Pro-Stick™ T&O	1 to 2 lbs. or 1 to 2 lbs. per 100 gal	24	Christmas trees
		Penncozeb® 75DF	2 to 4 lbs.	24	Christmas trees
		Penncozeb® 80WP	2 to 4 lbs.	24	Christmas trees
		Protect™ DF	1 to 2 lbs. per 100 gal (max 4 lbs. per acre)	24	Christmas tree and Douglas fir
		Roper® DF Rainshield™	1 to 2 lbs. or 1 to 2 lbs. per 100 gal	24	Christmas trees

*__FRAC Code__ is a number and/or letter combination assigned by the fungicide resistance action committee (FRAC) to group together active ingredients which demonstrate potential for cross-resistance. Fungicides with the same FRAC code are at risk for cross-resistance because they have the same target site.

FRAC Code*	Active Ingredient	Product	Rate	REI	Labeled crop
M03	Ziram	Ziram® 76DF	2 lbs. in 100 gal	48	Douglas fir Christmas tree
		Ziram® XCEL	2 lbs. in 100 gal	48	Douglas fir Christmas tree
M05	Chlorothalonil	Bravo Ultrex®	1.25 to 5 lbs., based on disease	12	Christmas tree
		Bravo® Weather Stik	1.5 to 5 pints, based on disease	12	Conifers, including Christmas trees
		Chlorothalonil 720	1.5 to 5 pints, based on disease	12	Conifers, including Christmas trees
		Daconil Ultrex® Turf Care®	1.5 to 5 pints, based on disease	12	Conifers, including Christmas trees
		Daconil Weatherstik®	1.5 to 5 pints, based on disease	12	Conifers, including Christmas trees
		Daconil Zn	2.25 to 8 pints, based on disease	12	Conifers, including Christmas trees
		Docket® DF	1.25 to 5 lbs., based on disease	12	Conifers, including Christmas trees
		Docket® WS	1.5 to 5.5 pints, based on disease	12	Conifers, including Christmas trees
		Echo® 720 Agricultural Fungicide	1.5 to 5 pints, based on disease	12	Conifers, including Christmas trees
		Echo® 720 Turf and Ornamental Fungicide	1.5 to 5 pints, based on disease	12	Conifers, including Christmas trees
		Echo® 90DF Agricultural Fungicide	1.125 to 4.5 lbs., based on disease	12	Conifers, including Christmas trees
		Echo® Ultimate Turf and Ornamental Fungicide	1.36 to 5 lbs., based on disease	12	Conifers, including Christmas trees
		Echo® Zn Agricultural Fungicide	2 to 8 pints	12	Conifers, including Christmas trees
		Eluvium™	1.5 to 5 pints, based on disease	12	Conifers, including Christmas trees
		Ensign® 720 Flowable Fungicide	1.5 to 5 pints, based on disease	12	Conifers, including Christmas trees
		Ensign® 82.5% Turf And Ornamental	1.8 to 5 lbs.	12	Conifers, pines and spruces

***FRAC Code** is a number and/or letter combination assigned by the fungicide resistance action committee (FRAC) to group together active ingredients which demonstrate potential for cross-resistance. Fungicides with the same FRAC code are at risk for cross-resistance because they have the same target site.

FRAC Code*	Active Ingredient	Product	Rate	REI	Labeled crop
M05	Chlorothalonil	Equus® 720 SST	1.5 to 5 pints, based on disease	12	Conifers, pines and spruces
		Initiate® 720 Flowable Fungicide	1.5 to 5 pints, based on disease	12	Conifers, including Christmas trees
		Initiate® ZN	2.25 to 8 pints, based on disease	12	Conifers, including Christmas trees
		Pegasus® 6L	1.5 to 5.5 pints, based on disease	12	Conifers
		Pegasus® DFX	1.36 to 5 lbs., based on disease	12	Conifers
		Praiz™	based on disease	12	Conifers, pines and spruces
		Previa®	24 to 88 oz, based on disease	12	Conifers, including Christmas trees
		PrimeraOne® Chlorothalonil 720 SFT Fungicide	1.5 to 5.5 pints, based on disease	12	Conifers, including Christmas trees
		PrimeraOne® Chlorothalonil DF	1.36 to 5 lbs., based on disease	12	Conifers, including Christmas trees
		Rialto™ 720 F	1.5 to 5.5 pints, based on disease	12	Conifers, including Christmas trees
P07	Fosetyl-Al	Aliette WDG	based on application method	12	Conifer nurseries
		Quali-Pro® Fosetyl-Al 80WDG	based on application method	12	Conifer nurseries
P07	Phosphorous acid, mono- and dibasic sodium, potassium, and ammonium salts	Alude™ Fungicide	based on application method	4	Conifers in commercial plantations
		Alude™ Fungicide	based on application method	4	Conifers (commercial nurseries and plantations, including Christmas trees
		Phiticide™	based on application method	4	Conifers, including Christmas trees
		Phostrol®	based on application method	4	Conifers, including Christmas trees

***FRAC Code** is a number and/or letter combination assigned by the fungicide resistance action committee (FRAC) to group together active ingredients which demonstrate potential for cross-resistance. Fungicides with the same FRAC code are at risk for cross-resistance because they have the same target site.

FRAC Code*	Active Ingredient	Product	Rate	REI	Labeled crop
P07	Phosphorous acid, mono-	Confine® Extra	based on application method	4	Conifers, including Christmas trees
	and dipotassium salts	K-Phite® 7LP T/O	based on application method	4	Christmas trees
		Rampart® T&O Fungicide	based on application method	4	Conifers (commercial nurseries and plantations, including Christmas trees
P07	Potassium phosphite	Rampart® Fungicide	based on application method	4	Conifers, including Christmas trees
P07	Mono- and di-potassium phosphite	Resist 57™	based on application method	4	Conifers, including Christmas trees
*__FRAC Code__ is a number and/or letter combination assigned by the fungicide resistance action committee (FRAC) to group together active ingredients which demonstrate potential for cross-resistance. Fungicides with the same FRAC code are at risk for cross-resistance because they have the same target site.					

Protecting Pollinators

David Smitley, Professor of Entomology, Michigan State University

Why are some people concerned about bees and other pollinators?

Beekeepers in Europe and North American have faced some difficult problems in the last 10 years, including a parasite of bees called the Varroa mite, increased exposure to systemic pesticides appearing in nectar and pollen, and loss of foraging habitat. Colony Collapse Disorder is no longer considered an important threat to honey bees. Research has shown it to be a syndrome caused a combination of several things, poor food sources, bee diseases and pesticides. Overall, beekeepers were losing an average of 30% or more of their colonies each winter due to Varroa mite and other stresses including pesticides.

What are neonicotinoid insecticides?

Neonicotinoids are a group of insecticides with a chemical structure that is similar to nicotine. They have been used extensively in agriculture and in yard and garden products. The five-neonicotinoid active ingredients are acetamiprid, clothianidin, dinotefuran, imidacloprid and thiamethoxam. They are more selective (e.g. they have greater toxicity to insects than to mammals) and less harmful to wildlife than most of the older classes of insecticides. The problem is that neonicotinoids are highly toxic to bees. In addition, they are systemic and can move into nectar and pollen, especially if they are applied as a soil systemic, or are sprayed over open flowers. Flowering weeds or flowering trees and shrubs in or near agricultural fields where neonicotinoid insecticides are applied as a seed-coat treatment, or where synthetic pyrethroid insecticides are sprayed, are lethal to honey bees, native bees and other pollinators.

What can I do to protect bees and other pollinators?

Christmas trees are wind pollinated, but bees may frequent flowering plants or weeds in the field or roadways. The diversity and abundance of bees and other pollinators is also a good indicator of the diversity and abundance of predators and parasitoids. Therefore, production practices that encourage bees also encourage natural enemies and biological control.

• When applying insecticides or miticides choose ones that are the least toxic to bees and other natural enemies. Look for the ‘bee box’ on pesticide labels.

• Consider spot treatments for highly localized pest problems.

• Time pesticide application either before dawn or after dusk when bees are foraging less.

• Horticultural oil and insecticidal soap can also be used on cool mornings (< 50° F), after sunset, or at any time that bees are not present because the spray residue is not toxic to bees.

• Consider establishing no spray zones that can act as a refuge for bees.

· Avoid using neonicotinoid insecticides as a seed-coat treatment, granular treatment or soil drench anywhere that flowering weeds grow, or where the roots of flowering ground covers, shrubs and trees grow, because they are absorbed through the roots, move systemically through the entire plant.

· Avoid spray drift onto flowering weeds, shrubs, or trees growing along the edges of Christmas tree fields.

If beekeepers are in the area or if growers want to encourage bees and natural enemies:

• Encourage as many wildflower, flowering weeds, and flowering brambles and shrubs as possible. The more flowers all season long, the better it is for bees.

• Avoid spraying any type of insecticide or miticide when the ground cover in Christmas tree fields has flowers. Some fungicides have also been found to suppress the immune response of bees. Even if only the trees are sprayed, the drift onto flowers in the ground cover will be highly toxic to bees. This can be prevented by mowing the groundcover strips between rows one day or less before spraying. That will remove the flowers before the spray. A week later when new flowers form there should be no problem for the bees because the new flowers will not have any pesticide residue.

• If Christmas tree fields are bordered by linden trees or any other flowering tree that is highly attractive to bees, avoid spraying when the trees are in bloom. For lindens, this will be for about a 2-week period in mid- June.

• Notify local beekeepers when Christmas trees are sprayed. This not a requirement, only a courtesy. The beekeepers already know that sprayed 0rchards or Christmas tree fields with flowering weeds could be a problem for their bees.

Enviroweather: Tools for Pest, Disease and Production Management
Enviroweather homepage (enviroweather.msu.edu)

Enviroweather is a free online resource that provides Michigan growers, farm managers, crop scouts, consultants and MSU Extension educators with local weather information and a suite of weather-based tools available to help manage a variety of crops. This includes summaries of weather conditions, models that predict insect, disease and crop development and water-use tools. All of this is freely accessible at enviroweather.msu.edu (or use your browser to search for Enviroweather).

So if you need current weather information for your farm to help schedule management activities for crop development or for managing pests and diseases, **Enviroweather is here to help!**

Enviroweather has released a new website that has a very different layout than our former "legacy" website, but the new site has many more features and is much more powerful than before. The "legacy" version of Enviroweather will be retired, but it will remain running in the background so that users can access this site from links on the new site. This arrangement will also allow users to switch back and forth between website versions as needed.

The new Enviroweather web platform contains multiple changes that were designed to satisfy critical needs and make improvements previously identified from user surveys and industry feedback. The new design was also necessary to update obsolete web software and aging website servers. Although the new site is different, it will be easier to use than the legacy website, and it is geared toward viewing on smartphones and tablets. One major change in the new site is that a user can create an account and save preferences on a dashboard. This will provide faster access to the weather information and crop and pest models that are most important for each user's production operation. The new site also includes a feature where a user can create "Custom Sites" that can be used to distinguish different sections of a farm that may need different management strategies.

As is true with any new technology, it will take a little time and effort to get used to a new way of doing things on the new Enviroweather website. To help with this, user guides are available through the Information link on the menu bar near the top of the page. In addition, each model or tool on the website has a "Description" tab that contains additional information on running and interpreting the model to help with decision-making.

Enviroweather is and always has been a work in progress, so you should expect to see some subtle changes over time as we continue to develop new features and recode our models to display on the new website. Models and applications that are not yet developed for the new site will link to models on the legacy website. **The legacy website will eventually be retired, so now is the time to transition over to the new version.**

Enviroweather will continue to participate in MSU Extension meetings and webinars to demonstrate how to use the new website including how to set up an account and a dashboard, how to save preferences and how to run and use Enviroweather models. Announcements for these will come through MSU Extension News at canr.msu.edu/outreach. Be sure to sign up for MSU Extension News e-newsletters for the crops and other topics that are most relevant for you.

Additionally to help you get going with the new site, Enviroweather can set up an account and dashboard for you. Contact Keith Mason at masonk@msu.edu or 517 355-3897 for details.

As always, Enviroweather welcomes your feedback, and the new website includes a straight-forward way to share your comments and ask questions about the new platform. The Feedback Form is available under "Information" on the menu bar. In addition you can always contact the Enviroweather Program Coordinator, Keith Mason at masonk@msu.edu or 517-355-3897 for assistance with the tools and features on either website.

Enviroweather is a collaborative project between the Michigan Climatological Resources Program and the MSU Integrated Pest Management Program and is supported by Project GREEEN, MSU AgBioResearch, MSU Extension, private donors, and the MSU Departments of Biosystems and Agricultural Engineering, Plant Soil and Microbial Sciences, Entomology, Forestry and Horticulture, along with our equipment partner Campbell Scientific, Inc.

Keith Mason - Enviroweather Coordinator
MSU Department of Geography, Environment and Spatial Sciences
enviroweather.msu.edu

Mite Management – Avoiding resistance

Dave Smitley, Michigan State University

In many types of intense agricultural systems spider mites tend to develop resistance to insecticides and miticides, sometimes to the point where hardly any products are effective (like in greenhouse production). In Christmas tree production insecticide-resistance can become a problem if insecticides are used frequently.

Spider mites may develop resistance to any of the recommended products listed if they are sprayed frequently for several years. In addition, it is possible for resistant spider mites to move into Christmas tree farms from nearby orchards and they can be brought-in on infested plant material. It is well-known that most populations of spider mites are completely resistant to carbaryl (Sevin, etc.). The chemical group most susceptible to resistance problems is the synthetic pyrethroids. If spider mites become resistant, an application of a synthetic pyrethroid may cause an outbreak of spider mites by eliminating predator mites and other predators that keep spider mites under control. However, spider mites can become resistant to any pesticide if it is used frequently.

The bottom-line is to scout frequently so you know how well your miticides work and to be prepared to switch to a different product if it is not working. The following table can help you choose the best product and to rotate. Alternatively, if you are not using insecticides or miticides, you are unlikely to see any problems with spider mites.

Pesticide Efficacy for Mite Control and Relative Impact on Predatory Mites

Chemical class	Compound (*active ingredient*)	Life stage target[1]	Efficacy	Residual control	Toxicity to predatory mites[2]
Pyrethroids	Asana XL, S-fenvalostar (*esfenvalerate*), OnyxPro, Sniper (*bifenthrine*), Baythroid XL (*cyfluthrin*)	Motiles	Good	4-6 weeks	H
Organophosphates	Chlorpyrifos 4E AG, Govern 4E, Hatchet, Lorsban Advanced, Lorsban 4E, Lorsban 75WG, Nufos 4E, Quali-Pro Chlorpyrifos 4E, Warhawk, Whirlwind, Yuma 4E Insecticide, Vulcan (*chlorpyrifos*)	Motiles	Fair	4-6 weeks	H
Avermectins[3]	Avid 0.15EC, Ardent 0.15EC, Lucid Ornamental, Nufarm Abamectin,Minx, Quali-Pro Abamectin 0.15EC, Timectin 0.15EC T&O (*abamectin*)	Motiles	Good	3-4 weeks	M
Neonicitinoids	Admire Pro, Couraze 2F, Couraze 4F, Mallet 75WSP, Nuprid 1.6F, Pasada 1.6F, Prey, Provado 1.6F, Sherpa, Widow, Wrangler (*imidacloprid*)		Poor		M
Tetronic acids	Envidor 2SC Mitecide (*spirodiclofan*)	Eggs, Motiles	Good	6-8 weeks	S
Thiazoles[3]	Savey 50DF, Onager, Hexygon DF (*hexythiazox*)	Eggs, Larvae	Good	6-8 weeks+	S
Carbazates	Acramite 4SC, Floramite SC, Sirocco (*bifenazate*)	Eggs, Motiles	Good	4 Weeks	M
Sulfite esters	Omite (*propargite*)	Motiles	Good	3-4 weeks	S
Horticultural oils[4]	Damoil (*mineral oil*), Purespray 10E, Purespray Green (*petroleum oil*)	Eggs, Motiles	Good	2-6 Weeks	S
Quinolines	Shuttle (*acequinocyl*)	Eggs, Motiles	Good	3-4 Weeks	M
Quinazolines	Magister, Magus (*fenazaquin*)	Motiles	Good	6-8 Weeks+	M
Pyridazinone	Sanmite (*pyridaben*)	Eggs, Motiles	Good	3-4 Weeks	M
Insect growth inhibitors	Apollo SC (clofentazine)[5]	Eggs, Larvae, Nymphs	Good	3-4 Weeks	S
Insect growth regulators	TetraSan (*etoxazole*)	Eggs, Larvae, Nymphs	Good	4 Weeks	M

1. Motile forms include mite larvae, nymph and adult stages.

2. S-relatively safe to mite predators, M-moderatly toxic, H-highly toxic.

3. Avermectin, thiazole, and tetronic acid miticides are slower acting so growers should not be surprised if mites appear alive following application, it may take 7-10 days to see complete mortality.

4. Horticultural oils can cause phytotoxicity, particularly when used in the summer, and can lighten the blue coloring in blue spruce trees . A 1% concentration of a highly refined horticultural oil is usually a safe rate to spray anytime of the year, but a 2% or higher concentration may damage bloom on glaucous varieties of spruce, and cause other undesirable symptoms.

5. The Apollo label should be read and followed carefully to ensure proper use and slow the development of insecticide resistance.