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How to Reduce the Risk of Pesticide Resistance

in Cherry Pests in Oregon

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Pesticides—including insecticides, acaricides, fungicides, and bactericides—are essential for growing healthy crops with reliable yields and quality. In many instances, pesticides have become less effective as target organisms have developed resistance. The first record of resistance dates to 1897, when orchardists began having problems controlling San Jose scale (*Quadraspidiotus perniciosus* [Comstock]) and codling moth (*Cydia pomonella* [L.]). Since then, pesticide resistance has become a worldwide threat to commercial agriculture. By the end of 2006, there were 645 specific cases of agricultural insecticide resistance, affecting 316 compounds.

There has also been a gradual increase in the occurrence of fungicide resistance since 1960. Fungicide resistance usually develops rapidly compared to insecticide resistance. However, poor disease control can also result from factors such as incorrect disease identification, adverse weather conditions, and poor application technique or timing. Always consider these possible causes before concluding that poor control is the result of resistance.

Timely action to prevent resistance development will ensure that horticultural industries gain maximum benefit from effective pesticides for as long as possible. This publication suggests strategies to prevent resistance development. It also provides detailed information on insecticides and fungicides currently registered for use on cherries in Oregon, including information regarding the pests for which each product is legally registered, mode of action, chemical groupings, and classification. Extension personnel, field consultants, and growers should use this information to reduce the risk of resistance to insecticides and fungicides.

Insecticide and acaricide resistance

According to the Insecticide Resistance Action Committee (IRAC), resistance to insecticides is "*a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species*."

When a chemical is used continuously, insecticide resistance may lead to reduced insect control. The typical response is to reapply the insecticide; when that fails, the dosage is raised, and the interval between applications is reduced. These strategies work only as long as it takes for complete resistance to be expressed across the entire insect population. The product is then abandoned, and another class of products with increased efficacy is used. The cycle repeats, and crop losses amount to millions of dollars internationally.

Not only does resistance lead to increased costs of production, but in some cases secondary or minor pests have become major pests as predator populations are reduced by pesticide use. Furthermore, resistance to a specific compound also confers cross resistance to other chemically related compounds that share a common target site and mode of action within the pest.

The coordinated use of two insecticides typically is more diverse than using a single pesticide. However, improper application of two insecticides in one study resulted in resistance to both pesticides when a single resistance would have arisen if only one pesticide had been used.

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Insecticide and acaricide resistance has occurred across the entire spectrum of arthropods, including Diptera, Lepidoptera, Hymenoptera, Heteroptera, Coleoptera, and Acarina. Insect pests of cherries with documented resistance to insecticides include the black cherry aphid, green peach aphid, European red mite, McDaniel spider mite, obliquebanded leafroller, western flower thrips, and many others.

Some pesticides are more prone to resistance problems than others. Chemistries implicated include carbamates, organophosphates, and pyrethroids. However, other products such as endosulfan and *Bacillus thuringiensis* (*Bt*), widely used in Oregon for insect control in cherry orchards, are not immune from resistance buildup. Two recent studies found that insects can develop resistance to crystalline toxins produced by the *Bt* bacterium. This is cause for concern due to the increased worldwide reliance on this product.

To avoid pesticide resistance, growers need to understand insecticide and acaricide modes of action and how different chemical groups target pests. They also need a clear understanding of how to use an effective multiple-pesticide strategy.

Cherry insecticide and acaracide tables

Chemicals currently registered for use on cherries in Oregon appear in Charts 1 and 2. Chart 1 lists cherry pests of major concern to growers in Oregon, along with all active ingredients (and most of the common trade names) registered for use on these pests. Restricted-entry intervals (REI) and preharvest intervals (PHI) are included. These restrictions change frequently and may vary among similar products. Check the latest information concerning label requirements and restrictions before selecting and applying a product. For up-to-date information, see the Washington State University Pesticide Notification Network (http://ext.wsu.edu/pnn/).

Chart 2 lists active ingredients alphabetically, together with all currently registered trade names. Chart 2 details the chemical class, mode of action, IRAC main group and primary site of action, and chemical subgroup or exemplifying active ingredient for each compound.

Product trade names currently registered by the Organic Materials Review Institute (OMRI) are shown in bold in Chart 2. Products listed by OMRI change frequently, and organic growers are advised to check the latest information concerning label registrations before selecting and applying a product (http://www.omri.org/).

Classifications used by IRAC (www.irac-online.org/) are used in this publication (Chart 1), and IRAC's cooperation is gratefully acknowledged.

Strategies for preventing insecticide and acaricide resistance

- When planting new blocks, consider cultivars with early-maturing fruit that may escape insect pest problems. This strategy is especially useful in early-production areas such as Milton-Freewater and may also confer a market advantage.
- Integrate chemicals with other control methods; e.g., cultural and biological control.
- Before you spray, make sure that pest population levels are high enough to justify control. Use appropriate local economic thresholds. Contact your local OSU Extension agent to obtain threshold levels.
- Understand the specific pest's life cycle and the phenological model for each pest (http://ippc2.orst.edu/cgi-bin/ddmodel.pl). When controlling larval stages, target younger larval instars, if possible, because these stages usually are much more effectively controlled by insecticides than older stages.
- Where possible, select insecticides and other pest management tools that preserve beneficial insects. For a natural-enemy-impact guide for tree fruit pesticides, see EM 8203-E, *Pest Management Guide for Tree Fruits in the Mid-Columbia Area*. Remember, when you kill natural enemies, you inherit their job.
- Use products at recommended doses. Lower (sublethal) doses quickly select populations with average levels of tolerance, while doses that are too high may impose excessive selection pressures.
- Make sure spray equipment is properly calibrated at least annually. Follow recommendations for water volumes, spray pressures, and optimal temperatures.
- Observe spray intervals on label recommendations.
- Alternate products from different IRAC mode of action groups to which there is no locally known cross resistance. When making multiple applications per year or growing season, alternate products from different mode of action classes, preferably in rotations of at least three. Utilize the WSU IPM Decision Aid website (http://entomology.tfrec.wsu.edu/das/).

- In the event of a control failure, do not reapply the same insecticide. Choose a pesticide with a different mode of action and to which there is no locally known cross resistance.
- Insecticide mixtures (cocktails) may offer a short-term solution to resistance problems. However, each component must have a different insecticidal mode of action and must be used at its full rate.
- If in doubt, consult a local Extension agent or agricultural adviser for up-to-date spray recommendations and advice on Integrated Pest Management (IPM) and Insecticide Resistance Management (IRM) programs.

Fungicide and bactericide resistance

Fungicide and bactericide resistance in cherries is not as common internationally as insect resistance. It is important to note that fungicide resistance occurs in relatively few pathogens; most fungicides are still very effective against the target organisms for which they were developed.

Resistance has been observed in powdery mildew (*Podosphaera clandestina)* to sterol biosynthesis inhibitors; in bacterial canker (*Pseudomonas syringae* pv. *syringae*) to streptomycin antibiotics and copper; in cherry leaf spot (*Blumeriella jaapii*) to sterol biosynthesis inhibitors class I; in blue mold (*Penicillium expansum*) to benzimidazole fungicides; in crown gall (*Agrobacterium tumefaciens*) to copper; and in gray mold (*Botrytis cinerea*) to fenhexamid. Resistance has also been observed to several systemic fungicides commonly used in the Oregon cherry industry such as Orbit and Rubigan.

Fungicide resistance can arise rapidly and may result in partial or complete loss of disease control. Resistance is first noticed when expected levels of disease control are no longer achieved with label-recommended dosages.

Fungicides generally have very specific modes of action, making them more susceptible than insecticides to resistance. Some fungal pathogens seem more likely than others to become resistant. Factors that affect the development of fungicide resistance include the type of fungicide, its frequency of use, whether it is used alone or in a rotation program, the target pathogen, and the ability of resistant forms to survive.

As with insecticides, growers need a clear understanding of fungicide and bactericide modes of action and how these chemical groups target disease organisms. This, coupled with the implementation of an effective multiple-pesticide spray program, is imperative if pest resistance is to be avoided.

Cherry fungicide and bactericide tables

Chemicals currently registered for use on cherries in Oregon appear in Cherry Charts 3 and 4. Chart 3 lists cherry diseases of major concern to growers in Oregon, along with all fungicidal and bactericidal active ingredients (and most of the common trade names) registered for use on these diseases. Restricted-entry intervals (REI) and preharvest intervals (PHI) are included. These restrictions change frequently and may vary among similar products. Check the latest information concerning label requirements and restrictions before selecting and applying a product. For up-to-date information, see WSU's Pesticide Notification Network (http://ext.wsu.edu/pnn/).

Chart 4 lists active ingredients alphabetically, together with all currently registered trade names. Chart 4 details the mode of action, Fungicide Resistance Action Committee (FRAC) group name, chemical activity, and FRAC code for each compound. Note that "chemical activity" is given in the broadest possible terms and may not apply to every compound within that group.

Product trade names currently registered by OMRI are shown in bold in Chart 4. Products listed by OMRI change frequently. Organic growers are advised to check the latest information concerning label registrations before selecting and applying a product (http://www.omri.org/).

Classifications used by FRAC (http://www.frac.info/frac/) are used in this publication (Chart 2), and FRAC's cooperation is gratefully acknowledged.

Strategies for preventing fungicide resistance

- Minimize the use of fungicides by setting thresholds and avoiding unnecessary prophylactic treatments. Contact your local OSU Extension agent to determine threshold levels.
- Understand the disease cycle and apply fungicides accordingly.
- Calibrate all spray equipment at least annually
- Follow recommendations for water volumes, spray pressures, and weather conditions to obtain optimal coverage and maximum effect.
- Maximize spray penetration through proper canopy management; i.e., pruning and training to allow air movement and light penetration.

- Maximize the use of fungicides with a multisite mode of action. These materials are less prone to fungicide resistance problems.
- Use recommended formulated mixtures or tank-mixes designed to help combat resistance. Fungicide mixtures (cocktails) may offer a short-term solution to resistance problems. However, each component must have a different fungicidal mode of action and must be used at its full rate.
- Use fungicides at effective doses and observe recommended spray intervals.
- Make full use of disease-resistant cultivars, including rootstocks and scions. 'Regina' and 'Lambert' have shown resistance to powdery mildew, while 'Chelan' was found immune. F 12/1 Mazzard rootstock is known to have resistance to bacterial canker (*Pseudomonas syringae)* as compared to other cherry rootstocks.
- Sterilize soil before replanting, disinfect orchard tools, and practice general hygiene to reduce the incidence or spread of diseases.
- Consider mulching and inoculating soils with beneficial organisms such as *Trichodermas*, which actively compete with detrimental fungi such as *Phytophthora*.
- Practice good crop hygiene by disposing of plant debris and by eliminating other sources of inoculum such as unpicked fruit, pruning piles, and garbage heaps.
- Avoid repeated applications of fungicides of the same group and/or mode of action. Use fungicides from different FRAC groups in rotation cycles of three or more.
- If in doubt, consult a local Extension agent or agricultural adviser for up-to-date spray recommendations and advice on IPM and Fungicide Resistance Management (FRM) programs.

Conclusion

Insect pest and disease resistance to pesticides remains a problem globally and in the Pacific Northwest. Every effort must be made to reduce the risk that resistance will develop in Oregon. Growers and pesticide applicators are advised to utilize the strategies in this publication.

A thorough understanding of the modes of action, chemical groups/classes, chemical activities, and codes will enable informed decisions about which chemicals to use in sound rotations. Chemicals listed as high risk by both IRAC and FRAC should be used as preventive measures rather than as curative responses when pests or diseases are out of control.

Because of the high cost of bringing new pesticides to market, and closer scrutiny and retesting of existing products, pressure is mounting on currently registered products. Organic growers may face even greater risk, since they have an even smaller arsenal of products.

The limited number of pesticide products available to homeowners poses another problem. Commercial fruit industries in close proximity to cities risk infestation by resistant pests and diseases as a result of repeated use of certain chemicals by homeowners.

Although international efforts by IRAC and FRAC have made tremendous advances in classifying chemicals, their lists do not cover all products, both synthetic and of natural origin, registered in the United States. Consequently, an effort is needed to coordinate efforts to develop a classification system that applies to the entire country.

IRAC Mode of Action Classification
Fully revised & reissued, July 2007

Version: 5.3

The IRAC Mode of Action (MoA) classification provides farmers, growers, advisors, extension staff, consultants and crop protection professionals with a guide to the selection of insecticides or acaricides for use in an effective and sustainable insecticide or acaricide resistance management (IRM) strategy. In addition to presenting the MoA classification, this document outlines the background to, and purposes of, the classification list and provides guidance on how it is used for IRM purposes. The list is reviewed and reissued at intervals as required.

What is resistance

Resistance to insecticides may be defined as "a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species" (IRAC). This definition differs slightly from others in the literature, but IRAC believes it represents the most accurate, practical definition of relevance to farmers and growers. Resistance arises through the overuse or misuse of an insecticide or acaricide against a pest species and results in the selection of resistant forms of the pest and the consequent evolution of populations that are resistant to that insecticide or acaricide.

MoA, target-site resistance and cross resistance

In the majority of cases, not only does resistance render the selecting compound ineffective but it often also confers cross resistance to other chemically related compounds. This is because compounds within a specific chemical group usually share a common target site within the pest, and thus share a common mode of action (MoA). It is common for resistance to develop that is based on a genetic modification of this target site. When this happens, the interaction of the selecting compound with its target site is impaired, and the compound loses its pesticidal efficacy. Because all compounds within the chemical subgroup share a common MoA, there is a high risk that the resistance that has developed will automatically confer cross resistance to all the compounds in the same subgroup. It is this concept of cross resistance within chemically related insecticides or acaricides that is the basis of the IRAC mode of action classification.

Effective IRM strategies use alternations or sequences of different modes of action (MoA)

The objective of successful Insecticide Resistance Management (IRM) is to prevent or delay the evolution of resistance to insecticides, or to help regain susceptibility in insect pest populations in which resistance has already arisen. Effective IRM is thus an important element in maintaining the efficacy of valuable insecticides. It is important to recognize that it is usually easier to proactively prevent resistance occurring than it is to reactively regain susceptibility. Nevertheless, the IRAC MoA classification will always provide valuable guidance to the design of effective IRM strategies.

Experience has shown that all effective insecticide or acaricide resistance management strategies seek to minimise the selection for resistance from any one type of insecticide or acaricide. In practice, alternations, sequences or rotations of compounds from different MoA groups provide a sustainable and effective approach to IRM. This ensures that selection from compounds in any one MoA group is minimised. The IRAC classification in this document is provided as an aid to insecticide selection for these types of IRM strategies.

Applications are often arranged into MoA spray windows or blocks that are defined by the stage of crop development and the biology of the pest(s) of concern. Local expert advice should always be followed with regard to spray windows and timings. Several sprays of a compound may be possible within each spray window, but it is generally essential to ensure that successive generations of the pest are not treated with compounds from the same MoA group.

Nontarget site resistance mechanisms

It is fully recognised that resistance of insects and mites to insecticides and acaricides can, and frequently does, result from enhanced metabolism by enzymes within the pest. Such metabolic resistance mechanisms are not linked to any specific site of action classification and therefore they may confer resistance to insecticides in more than one IRAC MoA group. Where such metabolic resistance has been characterized and the cross resistance spectrum is known, it is possible that certain alternations, sequences or rotations of MoA groups cannot be used. Similarly, mechanisms of reduced penetration of the pesticide into the pest, or behavioural changes of the pest may also confer resistance to multiple MoA groups. Where such mechanisms are known to give cross resistance between MoA groups, the use of insecticides should be modified appropriately.

Where the resistance mechanism(s) is unknown, the intelligent use of alternations, sequences or rotations of compounds from different MoA classes remains an entirely viable resistance management technique since such a practice will always minimise selection pressures.

The Mode of Action (MoA) classification

The following classification scheme developed and endorsed by IRAC is based on the best available evidence of the mode of action of available insecticides. Details of the listing have been agreed by IRAC companies and approved by internationally recognised industrial and academic insect toxicologists and biochemists.

It is our aim to ensure that insecticide and acaricide users are aware of mode of action groups and that they have a sound basis on which to implement season-long, sustainable resistance management through the effective use of alternations, sequences or rotations of insecticides with different modes of action. To help delay resistance it is strongly recommended that growers also integrate other control methods into insect or mite control programmes. Further advice is given in Appendix 2.

Note: Inclusion of a compound in the MoA list does not necessarily signify regulatory approval.

Rules for inclusion of a compound in the MoA list

- Chemical nomenclature is based on that appearing in *The Pesticide Manual*, 13th edition, 2003, Ed. C.D.S. Tomlin, published by The British Crop Protection Council. 1250 pp., ISBN 1 901396 13 4.
- To be included in the active list, compounds must have, or be very close to having, a minimum of one registered use in at least one country. Superseded, obsolete or withdrawn compounds with no current registration are listed separately.
- In any one MoA classification subgroup, where more than one active ingredient in that chemical subgroup is registered for use, the chemical subgroup name is used.
- In any one MoA classification subgroup, where only one active ingredient is registered for use, the name of that exemplifying active ingredient is used.
- Where more than one chemical subgroup or exemplifying active ingredient appears in a single mode of action group, each is named according to the above rules; chemical subgroups having precedence over single active ingredients.

General notes

This document has been prepared using the most up-to-date information available to IRAC. It is provided to user groups, grower organisations, extension personnel, regulatory authorities such as the US EPA and all those involved in resistance management, as an agreed definitive statement by the agrochemical industry on the mode of action of insecticides currently in use. Given the broad nature of this user community and the many uses that are demanded of this document, readers should be aware that IRAC has sought to provide a workable listing that serves the needs of as many of these users as possible.

In a continued effort to refine the list, readers are kindly asked to inform IRAC of factual errors or omissions, citing definitive evidence wherever possible. Such submissions should be directed to IRAC via the website at: http://ww.irac-online.org. Suggestions for improvements are likewise welcome.

Updates

The IRAC MoA classification is reviewed and reissued at intervals as required. The latest version is always available for reference via IRAC's website (http://www.irac-online.org).

Submissions for new active ingredients together with recommendations for their inclusion in specific new or existing MoA classes, together with citations or evidence for classification should be made to IRAC through the website. IRAC member companies review draft versions before an agreed final version of any update is published. In addition, a number of internationally well-known insect toxicologists and biochemists are also consulted regarding additions, deletions or other changes to the list.

Changes to the listing may have serious consequences. In those countries where insecticide labels display the IRAC MoA number or class name as an

aid to good IRM (see Appendix 1), changes may be especially costly to implement. In general, changes are therefore only endorsed when the scientific evidence supporting the change is compelling.

Appendix 1. Product labels: Indication of MoA of active ingredient and accompanying IRM advice

To assist users in the selection of insecticides for use in IRM strategies employing sequences, rotations or alternations of MoA groups, IRAC is encouraging producers to clearly indicate the IRAC MoA group number and description on the product label, and to accompany this with appropriate advice of the type indicated below. Thus, in addition to the detailed product information, handling, and safety information required by local regulations, a typical title label should clearly indicate the IRAC MoA Group number and description, and minimal, brief advice on IRM as indicated in the example below.

example

Insecticide® 50 SC

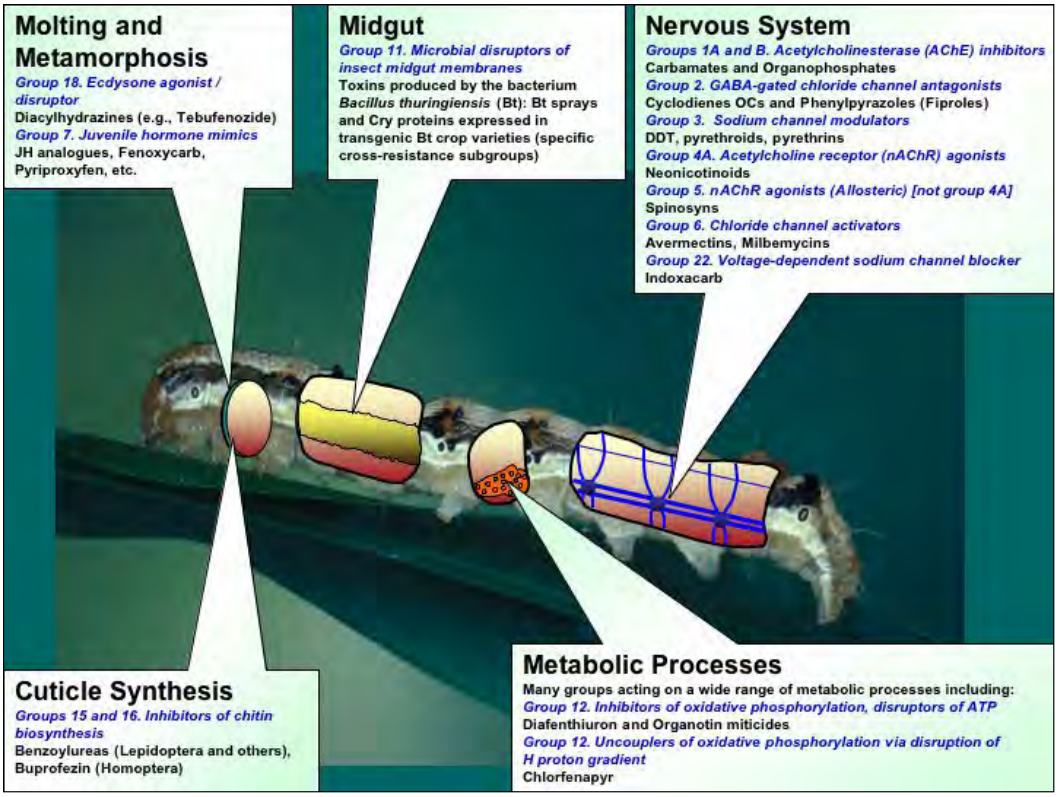
IRAC MoA Group 15
Inhibitors of chitin biosynthesis, type 0,
Lepidopteran
Benzoylureas

Active Ingredient: [Compound name]
Formulation details

"For resistance management purposes, Insecticide 50 SC is an IRAC Mode of Action Group 15 insecticide. Any insect population may contain individuals naturally resistant to Insecticide 50 SC and other Group 15 insecticides. If these insecticides are used repeatedly, the resistant individuals may eventually dominate the pest insect population. These resistant insects may not be controlled by Insecticide 50SC or by other Group 15 insecticides. To delay the development of resistance:

- Avoid exclusive repeated use of insecticides from the same chemical subgroup (indicated by the IRAC Mode of Action Group number).
- Alternate with products from other IRAC Mode of Action Groups.
- Integrate other control methods (chemical, cultural, biological) into insect control programs.

For further information on resistance management and advice on IRM programmes contact your local distributor."


Molting and Metamorphosis
Group 18. Ecdysone agonist / disruptor
Diacylhydrazines (e.g., Tebufenozide)
Group 7. Juvenile hormone mimics
JH analogues, Fenoxycarb, Pyriproxyfen, etc.
Midgut
Group 11. Microbial disruptors of insect midgut membranes
Toxins produced by the bacterium Bacillus thuringiensis (Bt): Bt sprays and Cry proteins expressed in transgenic Bt crop varieties (specific cross-resistance subgroups)
Nervous System
Groups 1A and B. Acetylcholinesterase (AChE) inhibitors
Carbamates and Organophosphates
Group 2. GABA-gated chloride channel antagonists
Cyclodienes OCs and Phenylpyrazoles (Fiproles)
Group 3. Sodium channel modulators
DDT, pyrethroids, pyrethrins
Group 4A. Acetylcholine receptor (nAChR) agonists
Neonicotinoids
Group 5. nAChR agonists (Allosteric) [not group 4A]
Spinosyns
Group 6. Chloride channel activators
Avermectins, Milbemycins
Group 22. Voltage-dependent sodium channel blocker
Indoxacarb
Cuticle Synthesis
Groups 15 and 16. Inhibitors of chitin biosynthesis
Benzoylureas (Lepidoptera and others), Buprofezin (Homoptera)
Metabolic Processes
Many groups acting on a wide range of metabolic processes including:
Group 12. Inhibitors of oxidative phosphorylation, disruptors of ATP
Diafenthiuron and Organotin miticides
Group 12. Uncouplers of oxidative phosphorylation via disruption of H proton gradient
Chlorfenapyr

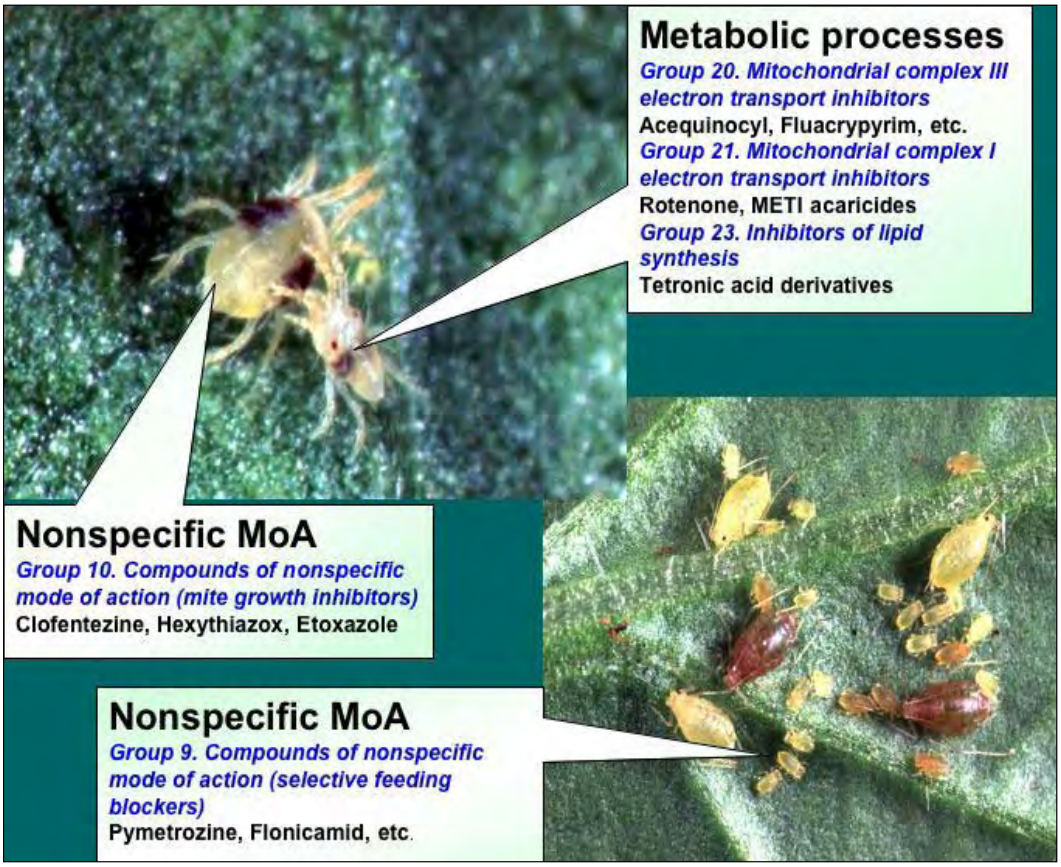

Metabolic processes
Group 20. Mitochondrial complex III electron transport inhibitors
Acequinocyl, Fluacrypyrim, etc.
Group 21. Mitochondrial complex I electron transport inhibitors
Rotenone, METI acaricides
Group 23. Inhibitors of lipid synthesis
Tetronic acid derivatives
Nonspecific MoA
Group 10. Compounds of nonspecific mode of action (mite growth inhibitors)
Clofentezine, Hexythiazox, Etoxazole
Nonspecific MoA
Group 9. Compounds of nonspecific mode of action (selective feeding blockers)
Pymetrozine, Flonicamid, etc.

Table 1. Insect Resistance Action Committee (IRAC) Mode of Action Classification v5.3, September 2007[1] (www.irac-online.org)

Main group and primary site of action	Chemical subgroup or exemplifying active ingredient	Active ingredients
1 Acetylcholine esterase inhibitors	**1A** carbamates	carbaryl
	1B organophosphates	azinphos-methyl, chlorpyrifos, diazinon, dimethoate, malathion, methidathion, phosmet
2 GABA-gated chloride channel antagonists	**2A** cyclodiene organochlorines	endosulfan
3 Sodium channel modulators	pyrethroids	cyfluthrin, beta-cyfluthrin, lambda-cyhalothrin, gamma-cyhalothrin, esfenvalerate, permethrin
	pyrethrins	pyrethrin (pyrethrum)
4 Nicotinic acetylcholine receptor agonists/antagonists	**4A** neonicotinoids	imidacloprid, thiamethoxam
5 Nicotinic acetylcholine receptor agonists (allosteric) (not group 4)	spinosyns	spinosad
9 Compounds of unknown or nonspecific mode of action (selective feeding blockers)	**9C** flonicamid	flonicamid
10 Compounds of unknown or nonspecific mode of action (mite growth inhibitors)	**10A** clofentezine	clofentezine
	hexythiazox	hexythiazox
11 Microbial disruptors of insect midgut membranes (includes transgenic crops expressing *Bacillus thuringiensis* toxins)	**11A1** *B.t.* subsp. *israelensis*	*Bacillus thuringiensis* subsp. *israelensis*
	11A2 *B. sphaericus*	*Bacillus sphaericus*
	11B1 *B.t.* subsp. *aizawai*	*Bacillus thuringiensis* subsp. *aizawai*
	11B2 *B.t.* subsp. *kurstaki*	*Bacillus thuringiensis* subsp. *kurstaki*
	11C *B.t.* subsp. *tenebrionis*	*Bacillus thuringiensis* subsp. *tenebrionis*
12 Inhibitors of oxidative phosphorylation, disruptors of ATP formation (inhibitors of ATP synthase)	**12B** organotin miticide	fenbutatin oxide
	12C propargite	propargite

Table 1—continued

Main group and primary site of action	Chemical subgroup or exemplifying active ingredient	Active ingredients
18 Ecdysone agonists / moulting disruptors	**18A** diacylhydrazines	methoxyfenozide
	18B azadirachtin	azadirachtin
21 Mitochondrial complex I electron transport inhibitors	METI acaricide	pyridaben
	rotenone	rotenone
23 Inhibitors of lipid synthesis	tetronic acid derivatives	spirodiclofen
28 Ryanodine receptor modulators	diamides	chlorantraniliprole
ns Miscellaneous nonspecific (multisite) inhibitors[2]	**nsa** borax	borax

Notes to be read in association with Table 1

[1] Inclusion of a compound in the list above does not necessarily signify regulatory approval.

[2] Category 'ns' is used for compounds or preparations with a nonspecific, multisite action.

Groups and Subgroups

Although sharing the same primary target site, it is possible that not all members of a single major MoA class have been shown to be cross resistant. Different resistance mechanisms that are not linked to the target site of action, such as enhanced metabolism, may be common for such a group of chemicals. In such cases, the MoA grouping is further divided into subgroups. For the purposes of this classification, it should be assumed that cross resistance exists between compounds in any one MoA subclass. Alternation of compounds from different subgroups within a class *may* be an acceptable part of an IRM strategy. Consult a local resistance expert for further advice.

Products containing multiple or stacked toxins will be differentiated from those containing single toxins only. This will be done by adding a suffix of "m" for multiple-toxin products and "s" for single-toxin products. Products containing spores will be differentiated from those without spores by adding "+" for spore-containing products and "-" for those that do not contain spores. For example, *Bacillus thuringiensis* subsp. *kurstaki* products containing multiple toxins and spores may be designated as 11Dm+, while the same product without spores and expressing only one toxin would be designated as Group 11Ds-.

Superseded, obsolete, or withdrawn compounds for which no current registration exists, and that are no longer in common usage, are not listed.

Table 2. Fungicide Resistance Action Committee (FRAC) CODE List 2007 Fungicides sorted by Mode of Action (MOA) (http://www.frac.info/frac/)

MOA	Target site and code	Group name	Chemical group	Common name	Comments	FRAC code
A: nucleic acids synthesis	A1: RNA polymerase I	PA-fungicides (**P**henyl**A**mide)	acylalanine	metalaxyl-M (=mefenoxam)	Resistance and cross resistance well known in various Oomycetes but mechanism unknown. **High risk.**	4
B: mitosis and cell division	B1: ß-tubuline assembly in mitosis	MBC-fungicides (**M**ethyl **B**enzimidazole **C**arbamates)	thiophanate	thiophanate-methyl	Resistance common in many fungal species. Several target site mutations, mostly E198A/G/K, F200Y. Positive cross resistance among the group members. Negative cross resistance to N-Phenylcarbamates. **High risk.**	1
C: respiration	C2: Complex II: succinate dehydrogenase	carboxamides	pridine carboxamide	boscalid	Resistance known for specific fungi. Target site mutation H257L. **Medium risk**. Resistance management required if used for risky pathogens.	7
	C3: Complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (*cyt b gene*)	QoI-fungicides (**Q**uinone **o**utside **I**nhibitors)	methoxyacrylate	azoxystrobin	Resistance known in various fungal species. Target site mutations G143A, F129L and additional mechanisms. Cross resistance shown among all members of the QoI group. **High risk.**	11
			methoxy-carbamates	pyraclostrobin		
D: amino acids and protein synthesis	D1: methionine biosynthesis (proposed) (*cgs gene*)	AP-fungicides (**A**nilino-**P**yrimidine)	anilino-pyrimidine	cyprodinil	Resistance known in *Botrytis* and sporadically in *Venturia*; mechanism speculative (CGS). **Medium risk.**	9

Table 2—continued

MOA	Target site and code	Group name	Chemical group	Common name	Comments	FRAC code
E: signal transduction	E1: G-proteins in early cell signaling (proposed)	quinoline	quinoline	quinoxyfen	Resistance known. **Medium risk**. Resistance management required.	13
	E2: MAP protein kinase in osmotic signal transduction	PP-fungicides (**P**henyl**P**yrrole)	phenylpyrrole	fludioxonil	Resistance found sporadically, mechanism speculative (OS-2 kinase). Low to **medium risk**. Resistance management required.	12
	E3: MAP/ Histidine-kinase in osmotic signal transduction (*os-1, Daf1*)	dicarboximide	dicarboximide	iprodione	Resistance common in *Botrytis* and some other pathogens. Several mutations in OS-1, mostly I365S. Cross resistance common between member groups **Medium to high risk**	2
F: lipids and membrane synthesis	F3: lipid peroxidation (proposed)	AH-fungicides (**A**romatic **H**ydrocarbons) (chlorophenyl, nitroaniline)	aromatic hydrocarbons	dicloran	Resistance known in some fungi. Low to **medium risk**. Cross resistance patterns complex due to different activity spectra.	14
	F5: phospholipid biosynthesis and cell wall deposition (proposed)	CAA-fungicides (**C**arboxylic **A**cid **A**mide)	cinnamic acid amide	dimethomorph, flumorph	Low to **medium risk**. Resistance management required	40

Notes to be read in association with Table 2

When a fungicide is classified as **high** or **medium risk** by FRAC, additional guidelines have been written for resistance management. For additional information concerning the risks and management practices associated with these products, see the FRAC Guidelines for Anilinopyrimidine, Benzimidizole, Carboxylic Acid Amides (CAA), Dicarboximide, Phenylamide, Quinone outside Inhibitors (QoI), and Sterol Biosynthesis Inhibitors (SBI) (http://www.frac.info/frac/index.htm).

Although the current FRAC list is extremely useful in classifying synthetic fungicides and bactericides, it does not cover the following naturally occurring and synthetic products presently registered in Oregon: -2,4-xylenol, gaba (gamma aminobutyric acid), hydrogen peroxide (dioxide), m-cresol, monopotassium phosphate, potassium laurate. These products are covered in Charts 3 and 4.

Table 2—continued

MOA	Target site and code	Group name	Chemical group	Common name	Comments	FRAC code
G: sterol biosynthesis in membranes	G1: C14- demethylase in sterol biosynthesis (*erg11/cyp51*)	DMI-fungicides (**De**Methylation **I**nhibitors) (**S**terol **B**iosynthesis **I**nhibitors SBI: Class I)	pyrimidine	fenarimol	There are great differences in the activity spectra of the different DMI fungicides. Resistance is known in various fungal species. Several resistance mechanisms are known, including target site mutation Y136F in cyp 51 gene, ABC transporters, and others. Generally wise to accept that cross resistance is present among DMI fungicides active against the same fungus. DMI fungicides are Sterol Biosynthesis Inhibitors but show no cross resistance to other SBI classes. **Medium risk.**	3
			imidazole	triflumizole		
			triazole	fenbuconazole, myclobutanil, propiconazole, prothioconazole, tebuconazole		
	G3: 3-keto reductase, C4- demethylation (*erg27*)	hydroxyanilide (SBI: Class III)	hydroxyanilide	fenhexamid	Low to **Medium risk**. Resistance management required.	17
U: unknown mode of action	Unknown	phosphonates	ethyl phosphonates	fosetyl-Al	Few resistance cases reported in few pathogens. Low risk.	33
				phophorous acid and salts		
NC: not classified	unknown	diverse	diverse	mineral oils, organic oils, potassium bicarbonate, material of biological origin	Resistance not known.	NC
M: multisite contact activity	multisite contact activity	inorganic	inorganic	copper (different salts)	Generally considered as a low-risk group without any signs of resistance developing to the fungicides. *For dodine, resistance was reported in *Venturia inequalis,* suggesting that dodine may not be a multisite inhibitor. Resistance management recommended. No cross resistance among group members M1 to M9	M1
		inorganic	inorganic	sulfur		M2
		dithiocarbamates and relatives	dithiocarbamates and relatives	ferbam ziram		M3
		phthalimides	phthalimides	captan		M4
		chloronitriles (phthalonitrile)	chloronitriles (phthalonitrile)	chlorothalonil		M5
		guanidines	guanidines	dodine*		M7

How to order this publication

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Chart 1. Cherry Insecticides and Miticides Registered in Oregon, 2008

Cherry insect or mite pest	Common name	azadirachtin (Agroneem EC)	azinphos-methyl (Guthion)	*Bacillus thuringiensis* (Dipel, Javelin)	*Beauveria bassiana* ATCC 74040 (Mycotrol)	beta-cyfluthrin (Baythroid XL)	canola oil (Pyola, Vegol)	carbaryl (Sevin)	chlorpyrifos (Lorsban)	cinnamaldehyde (Cinnacure A3005)	citronella oil (Biomite)	clarified hydrophobic extract of neem oil (Agroneem EC)	clofentezine (Apollo SC)	cyfluthrin (Baythroid 2 EC, Pyrethroid)	diazinon (Diazinon)	dimethoate (Diomethoate)	endosulfan (Thionex 50 W, Endosulfan 50 WP)	esfenvalerate (Asana XL)	farnesol (Biomite)	fenbutatin oxide (Vendex 50 WP)	flonicamid (Beleaf 50 SG)	gamma-cyhalothrin (Tenkoz, Proaxis)	garlic oil (Allityn Insect repellent)	geraniol (Biomite)	hexythiazox (Onager, Savey 50 DF)	imidacloprid (Provado 1.6 F)	kaolin (Surround WP)	lambda-cyhalothrin (Warrior)	malathion (Malathion)	methidathion (Supracide 2 E)	methoxyfenozide (Intrepid 2 F)	mineral oil (JMS Stylet Oil)	nerolidol (Biomite)	permethrin (Ambush 25W)	phosmet (Imidan)	potassium laurate (M-Pede, Concern Multi-purpose Insect Killer II-Omri)	potassium silicate (Sil-MATRIX)	propargite (Omite-30 WS)	pyrethrin (Pyrenone)	pyridaben (Nexter 75 WP, Pyramite)	pyriproxyfen (Seize 35, Valent Esteem)	rotenone (Pyrellin E.C.)	rynaxypyr (Altacor)	sodium borate (Prev-AM Ultra)	soybean oil (Golden pest spray oil)	spinosad (Conserve, Entrust, Success 2 L)	spirodiclofen (Envidor 2 SC)	spirotetramat (Movento)	sulfur (Drexel Suffa, Golden-Dew, Micro Sulf (N), Sulfur 6L, Sulfur DF)	lime sulfur	tetradecenyl acetate (3M Sprayable pheromone mating disruption/leafrollers)	thiamethoxam (Actara)
REI hours (h) or days (d)		12(4) h	15 d	4 h	4 h	12 h	12 h	12 h	4 d	4 h	4 h	12(4) h	12 h	12 h	24 h	48 h	24 h	12 h	4 h	48 h	12 h	24 h	4 h	4 h	12 h	12 h	4 h	24 h	12 h	48 h	4 h	4 h	4 h	12 h	24 h	12 h	4 h	7 d	12 h	12 h	12 h	12 h	4 h	12 h	4 h	4 h	12 h	24 h	24 h	48 h	–	NRB
PHI hours (h) or days (d)		24 h	15 d	0 d	0 d	7 d	0 d	3 d	DD	48 h	–	24 h	21 d	7 d	21 d	21 d	21 d	14 d	–	14 d	14 d	14 d	12 h	–	28 d	7 d	0 d	14 d	3 d	DD	7 d	0 d	–	3 d	7 d	0 d	0 d	NRB	0 d	300 d	300 d	12 h	10 d	–	DD	7 d	7 d	7 d	PF	DD	–	–
Aphids	Black cherry aphid					♦		♦	♦			♦		♦	♦		♦	♦			♦	♦						♦	♦			♦										♦						♦				
	Green peach aphid	♦			♦			♦									♦				♦	♦				♦		♦	♦			♦		♦		♦			♦									♦				♦
Borers	Ambrosia beetle																																	♦																		
	Pacific flatheaded borer								♦																																											
	Peachtree borer	♦	♦					♦	♦								♦	♦				♦						♦	♦			♦		♦					♦													
	Shothole borer								♦																																											
Bugs	Stink bugs	♦	♦		♦	♦		♦	♦	♦		♦		♦			♦	♦				♦				♦	♦	♦	♦					♦		♦			♦			♦										♦
	Syneta beetle																																		♦																	
Caterpillars	Redhumped caterpillar		♦	♦				♦				♦																			♦				♦				♦							♦						
Earwigs	European earwig	♦				♦	♦	♦						♦									♦				♦		♦			♦		♦		♦			♦							♦			♦			
Fruit flies	Western cherry fruit fly					♦		♦	♦					♦	♦	♦		♦				♦				♦		♦	♦						♦				♦			♦	♦			♦						♦
Grasshoppers	Grasshoppers	♦	♦		♦	♦		♦	♦			♦		♦	♦	♦		♦				♦	♦				♦	♦	♦						♦	♦			♦										♦			♦
Leafhoppers	Rose leafhopper																												♦																							
	White apple leafhopper					♦		♦						♦			♦	♦								♦								♦		♦				♦												
Leafminers	Western tentiform leafminer	♦	♦			♦	♦	♦	♦			♦		♦	♦	♦						♦	♦			♦	♦	♦	♦			♦		♦	♦	♦			♦		♦	♦			♦	♦						♦
Leafrollers	Fruittree leafroller	♦	♦	♦			♦	♦	♦			♦			♦		♦												♦		♦	♦			♦				♦							♦						
	Obliquebanded leafroller	♦		♦		♦			♦					♦	♦			♦									♦				♦			♦							♦	♦	♦			♦						
	Pandemis leafroller			♦		♦		♦	♦					♦																	♦										♦					♦						
Mealybugs	Grape mealybug	♦	♦		♦		♦	♦		♦		♦		♦	♦	♦							♦			♦	♦	♦	♦			♦		♦	♦	♦			♦			♦		♦	♦			♦	♦	♦		♦
Mites	Almond mite								♦																												♦	♦											♦	♦		
	Brown mite				♦				♦		♦				♦	♦			♦					♦								♦	♦				♦		♦	♦							♦		♦	♦		
	Cherry rust mite														♦					♦																	♦															
	Clover mite				♦				♦		♦				♦	♦			♦					♦								♦	♦				♦		♦	♦							♦		♦	♦		
	Eriophyid mite							♦																								♦					♦															
	European red mite		♦				♦	♦	♦		♦		♦		♦				♦	♦				♦	♦		♦		♦			♦	♦				♦	♦		♦					♦		♦		♦	♦		
	McDaniel spider mite												♦							♦					♦							♦					♦	♦		♦							♦					
	Rust mite										♦	♦							♦					♦								♦	♦			♦	♦			♦									♦	♦		
	Twospotted mite	♦						♦	♦	♦	♦	♦	♦		♦	♦			♦	♦				♦	♦		♦		♦			♦	♦			♦	♦	♦		♦						♦	♦		♦	♦		
Moths	Eyespotted bud moth		♦					♦	♦						♦		♦												♦		♦																					
	Mineola moth (leaf crumpler)		♦						♦																																											
Scale	Lecanium scale		♦					♦				♦			♦														♦			♦									♦											
	Oystershell scale							♦																					♦			♦																		♦		
	San Jose scale	♦	♦			♦		♦	♦			♦		♦	♦			♦				♦				♦		♦	♦	♦		♦			♦						♦				♦		♦	♦		♦		
Slugs	Pear sawfly					♦		♦							♦		♦	♦									♦		♦							♦													♦			
Thrips	Pear thrips				♦																																															
	Western flower thrips	♦			♦									♦								♦						♦																		♦						
Worms	Cherry fruitworm			♦				♦							♦			♦											♦		♦										♦					♦						
	Cutworm	♦		♦	♦	♦		♦	♦			♦		♦	♦		♦	♦				♦					♦	♦	♦					♦	♦	♦			♦							♦						
	Lesser appleworm					♦		♦	♦			♦		♦				♦				♦	♦					♦			♦																					

PF = Before petal fall
NRB = No registration on bearing crops
DD = Delayed dormant
– = Check label

(red) = Organophosphate
(orange) = Toxic to bees
(lavender) = Use only when temperature is above 35°F and below 90°F

Disclaimers

1) All active ingredients listed above were registered for use on cherry trees in Oregon at the time of printing in 2008. It is the applicator's responsibility to ensure that the products selected and applied on cherries in Oregon have current registration.

2) Select trade names of active ingredients above are mentioned as illustrations only. Oregon State University Extension Service neither discriminates against other registered products nor endorses any of these products for efficacy or otherwise. For a more comprehensive list of registered trade names in alphabetical order, see Chart 2, Cherry Insecticides and Miticides Registered in Oregon

3) Restricted-entry Intervals (REI) and Preharvest Intervals (PHI) are provided as a guide only. These restrictions change frequently, and similar products produced by different manufacturers may not have the same restrictions. Consequently, growers are advised to keep abreast of the latest information concerning individual label requirements and restrictions before selecting and applying a product. Remember, **THE LABEL IS THE LAW.**

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Oregon State University Extension Service

Chart 2. Cherry Insecticides and Miticides Registered in Oregon, 2008

Active ingredient	Trade name (bold = OMRI registered)	Chemical class	IRAC main group and mode of action	IRAC chemical subgroup or exemplifying active ingredient
azadirachtin	**Agroneem EC-OMRI, Aza-Direct Biological Insecticide**, Azatin XL Biological Insecticide, Ecozin 3% EC Botanical Insecticide, **Neemix 4.5 IGR-Organic Production-OMRI**	botanical	18. ecdysone agonists/moulting disruptors	18B. azadirachtin
azinphos-methyl	Azinphosmethyl 50 W Soluble, Guthion Solupak 50% WP Crop Insecticide (B)	organophosphate	1. acetylcholine esterase inhibitors	1B. organophosphates
Bacillus thuringiensis	**Agree Wg Biological Insecticide-OMRI**; Biobit HP Bio Insecticide Wettable Powder/Organic Production; Crymax Bioinsecticide; **Deliver Biological Insecticide/Fruit, Nuts, Vegs, & Soybean-OMRI**; Dipel DF/Organic Production; Dipel ES; **Javelin WG Biological Insecticide-OMRI**; Condor WP Bioinsecticide; Lepinox WDG Insecticide; Xentari Dry Flowable/Organic Production	microbial	11. microbial disruptors of insect midgut membranes (includes transgenic crops expressing *Bacillus thuringiensis* toxins)	11A1. *B.t.* subsp. *israelensis*; 11A2. *B. sphaericus*; 11B1. *B.t.* subsp. *tenebrionis*; 11B2. *B.t.* subsp. *kurstaki*; 11C. *B.t.* subsp. *tenebrionis*
Beauveria bassiana ATCC 74040	Botanigard 22 WP, Botanigard ES, Naturalis L, **Mycotrol O OMRI**	microbial	entomopathogenic fungus	NC (not considered)
beta-cyfluthrin	Baythroid XL	pyrethroid	3. sodium channel modulator	3. pyrethroids
canola oil	Concern Pesticidal Spray Oil, L/M Vegol Growing Season Spray Oil, Pyola	botanical	alters the cuticle structure of the leaf surface, thus repelling the insects, or acts as irritants to insects	NC (not considered)
carbaryl	Carbaryl 4 L, Drexel Carbaryl 4 L, Sevin Brand Carbaryl, Lesco Sevin Brand SL, Prokoz Sevin SL, Sevin 4 F Brand Carbaryl Insecticide (B), Sevin 80 Solupak, Sevin 80 WSP Carbaryl Insecticide (ES), Sevin Brand 80 S Carbaryl Insecticide (B), Sevin Brand 80 WSP Carbaryl Insecticide (B), Sevin Brand RP4 Carbaryl Insecticide (B), Sevin Brand XLR Plus Carbaryl Insecticide (B), Sevin SL Carbaryl Insecticide (ES)	carbamate	1. acetylcholine esterase inhibitors	1A. carbamates
chlorpyrifos	Agrisolutions Yuma 4 E, Chlorpyrifos 4 E AG, Eraser, Govern 4 E, Lorsban 50 W WSP, LORSBAN 75 WG, Lorsban-4 E, Micro-Flo Chlorpyrifos 4 E AG, Nufos 4 E, Pilot 4 E Chlorpyrifos, Pilot 4 E Chlorpyrifos, Quali-Pro Chlorpyrifos 4 E, Warhawk, Whirlwind	organophosphate	1. acetylcholine esterase inhibitors	1B. organophosphates
cinnamaldehyde	Cinnacure A3005	botanical	exact mode of action unclear; possible interference with glucose uptake or utilization	NC (not considered)
citronella oil	Biomite	botanical	NC (not considered)	NC (not considered)
clarified hydrophobic extract of neem oil	**Agroneem EC-OMRI**, Shield-All II Broad Spectrum Fungicide, **Trilogy Fungicide/Miticide/Insecticide-OMRI**	botanical	18. ecdysone agonists/moulting disruptors	18B. azadirachtin
clofentezine	Apollo SC	tetrazine	10. compounds of unknown or nonspecific mode of action (mite growth inhibitors)	10A. clofentezine
cyfluthrin	Baythroid 2 Emulsifiable Pyrethroid Insecticide (B), Renounce 20 WP Insecticide (B), Tombstone Insecticide	pyrethroid	3. sodium channel modulator	3. pyrethroids
diazinon	Diazinon 50 W, Diazinon AG-500, Diazinon AG600 WBC, Gowan Diazinon 4 E, Gowan Diazinon 50 WSB	organophosphate	1. acetylcholine esterase inhibitors	1B. organophosphates
dimethoate	Cheminova Dimethoate 4 E, Dimate 4 EC Systemic Insecticide, Dimethoate 267, Dimethoate 400, Dimethoate 4 E, Drexel Dimethoate 4 EC Systemic Insecticide/Miticide	organophosphate	1. acetylcholine esterase inhibitors	1B. organophosphates
endosulfan	Drexel Endosulfan 3 EC Insecticide, Endosulfan 3 EC, Endosulfan 50 WP, Hi-Yield Thiodan Garden Dust, Thionex 3 EC, Thionex 50 W	organochlorine	2. GABA-gated chloride channel antagonists	2A. cyclodiene organochlorines
esfenvalerate	Adjourn, Asana XL, Dupont Asana XL	pyrethroid	3. sodium channel modulator	3. pyrethroids
farnesol	Biomite	pheromone	NC (not considered)	NC (not considered)
fenbutatin oxide	DuPont Vendex 50 WP, Vendex 50 WP	organotin	12. inhibitors of oxidative phosphorylation, disruptors of ATP formation (inhibitors of ATP synthase)	12B. organotin miticides
flonicamid	Beleaf 50 SG	selective feeding blocker	9. compounds of unknown or nonspecific mode of action (selective feeding blockers)	9C flonicamid
gamma-cyhalothrin	Proaxis Insecticide, Tenkoz Proaxis Insecticide	pyrethroid	3. sodium channel modulator	3. pyrethroids
garlic oil	Allityn Insect Repellent	botanical	NC (not considered)	NC (not considered)
geraniol	Biomite	botanical	NC (not considered)	NC (not considered)
hexythiazox	Onager, Savey 50 DF	carboxamide mite growth inhibitor	10. compounds of unknown or nonspecific mode of action (mite growth inhibitors)	10A. hexythiazox
imidacloprid	Admire 2 F (B), Admire Pro Systemic Protectant, Agrisolutions Advise 2 FL, Agristar Impulse 1.6 FL, Agristar Macho 2.0 FL, Couraze 1.6 F, Imida E-AG 1.6 F, Imida E-Ag 2 F, Nuprid 1.6 F, Nuprid 2 F, Pasada 1.6 F, Provado 1.6 F (B)	chloro-nicotinyl	4. nicotinic acetylcholine receptor agonists/ antagonists	4A. neonicotinoids
kaolin	Surround at Home Crop Protectant, **Surround WP Crop Protectant-OMRI**	clay	Unknown MoA	NC (not considered)
lambda-cyhalothrin	Agrisolutions Taiga Z, Silencer, Warrior W/ZEON	pyrethroid	3. sodium channel modulator	3. pyrethroids
malathion	Atrapa 5 E, Atrapa 8 E, Atrapa ULV, Atrapa VCP, Drexel Malathion 5 EC Insecticide/Miticide, Fyfanon 8 LB Emulsion, Malathion 5, Malathion 5 EC, Malathion 57 EC, Malathion 8 Aquamul, Malathion 8 EC, Malathion ULV Conc, Schultz Malathion Conc., Spetracide Malathion Insect Spray Concentrate	organophosphate	1. acetylcholine esterase inhibitors	1B. organophosphates
methidathion	Supracide 25-W, Supracide 2 E	organophosphate	1. acetylcholine esterase inhibitors	1B. organophosphates
methoxyfenozide	Intrepid 2 F	diacylhydrazine	18. ecdysone agonists/moulting disruptors	18A. diacylhydrazines
mineral oil	Biocover SS, Biocover UL, First Choice Narrow Range 4L5 Spray Oil, First Choice Gavicide Super 90, Glacial Spray Fluid-Organic, IAP 4L15 Summer Spray Oil, IAP 440 All Purpose Spray Oil, IAPp 470 Dormant Spray Oil, IAP Dormant Oil, IAP Hi Supreme Spray Oil-Nw, IAP Organic Spray Oil, JMS Stylet-Oil, L/M Dormant Spray/Insects, L/M Superior Type Spray Oil, Mite-E-Oil Insecticide-Miticide/Spray, Omni Supreme Spray, **Organic JMS Stylet-Oil**, Spray Oil 10 E, Spray Oil 13 E, Spray Oil 22 E, Superior Spray Oil N.W., Supreme Oil, PHT 435 Oil, PHT V-415 Spray Oil, PHT V-440 Spray Oil, PHT V-470 Spray Oil, PHT V470 Oil, PHT Volck Clear, Purespray Foliar 13 E, Purespray Foliar 15 E, Purespray Foliar 22 E, Purespray Spray Oil 10 E, Spray Oil 415, Sunspray 6 E, Sunspray 6 E Western, Sunspray Ultra-Fine Year-Round Pesticidal Oil, Super 94 Spray Oil, Superior 70 Oil, Supreme Oil Insecticide, Valent Volck Clear/Western AG, Valent Volck Supreme Spray/ Western AG, Wil-Gro Hort Oil 98-2	mineral oil	mechanical suffocation by clogging spiracles or disruption of cellular membranes	NC (not considered)
nerolidol	Biomite	pheromone	NC (not considered)	NC (not considered)
permethrin	Allpro Aqualuer 20-20, Allpro Evoluer 4-4 ULV, Ambush 25 W, Aqua-Reslin (ES), Arctic 3.2 EC, Artic 3.2 EC, Astro, Biomist 3+15 ULV, Biomist 4+4 ULV, Perm-Up 24 WP, Perm-Up 3.2 EC, Permethrin, Permethrin 3.2 AG, Permethrin 3.2 AG, Permethrin 3.2 EC, Pounce 25 WP, Pounce 3.2 EC, Tenkoz Permethrin 3.2 EC, Times-Up T/C, Waylay 3.2 Ag Permethrin	pyrethroid	3. sodium channel modulator	3. pyrethroids
phosmet	Imidan 70-W AG, Imidan 70-WP, Imidan 70-WP (Sweet Cherries), Imidan 70-WSB	organophosphate	1. acetylcholine esterase inhibitors	1B. organophosphates
potassium laurate	M-Pede Insecticide/Fungicide, **M-Pede Insecticide/Fungicide-OMRI, Neudorff Insecticidal Soap Conc-OMRI**	fatty acid	membrane disruption	NC (not considered)
potassium silicate	Sil-MATRIX Fungicide/Miticide/Insecticide	unclassified	unknown MoA	NC (not considered)
propargite	Omite-30 WS Agricultural Miticide, Omite-30 WS Agricultural Miticide (CM), Omite-CR Agricultural Miticide (CM)	unclassified	12. inhibitors of oxidative phosphorylation, disruptors of ATP formation (inhibitors of ATP synthase)	12C. propargite
pyrethrin	Evergreen Crop Protection EC 60-6, Prentox Pyronyl 303 EC, Prentox Pyronyl Crop Spray, **Pyganic Crop Protection EC 1.4 II-OMRI, Pyganic Crop Protection EC 5.0 II-OMRI**, Pyola, Pyrellin E.C., Pyrenone Crop Spray (ES)	pyrethrin	3. sodium channel modulator	3. pyrethrin
pyridaben	Nexter, Pyramite	pyridazine	21. mitochondrial complex I electron transport inhibitors	21. METI acaricides
pyriproxyfen	Seize 35 WP IGR, Valent Esteem 0.86 EC IGR	insect growth regulator (IGR)	7. juvenile hormone mimics	7C. pyriproxyfen
rotenone	Pyrellin E.C.	botanical	21. mitochondrial complex I electron transport inhibitors	21. rotenones
rynaxypyr	Altacor	chlorantraniliprole	28. ryanodine receptor modulators	28. diamides
sodium tetraborate	Prev Am Ultra	multisite inhibitor	ns	nsa
soybean oil	Golden Pest Spray Oil	botanical	NC (not considered)	NC (not considered)
spinosad	**Entrust-OMRI, GF-120 Nf (Any Tree, Vine, Veg/Food Crop & Ornamental)-OMRI, GF-120 NF Naturalyte Fruit Fly Bait-OMRI, Spinosad 0.5% SC Insect Control Product-OMRI**, Success (Stone Fruits), Success Naturalyte Insect Control	microbial	5. nicotinic acetylcholine receptor agonists (allosteric) (not group 4)	5. spinosyns
spirodiclofen	Envidor 2SC	tetronic acid derivative	23. inhibitors of lipid synthesis	23. tetronic acid derivatives
spirotetramat	Movento	tetronic acid derivative	23. inhibitors of lipid synthesis	23. tetronic acid derivatives
sulfur	Ben-Sul 85, **Cosavet-DF Fungicide-Miticide-OMRI**, CSC 80% Thiosperse, Drexel Suffa, Dusting Sulfur, Hi-Yield Dusting Wettable Sulphur, Kumulus DF, Liquid Sulfur Six, Micro Sulf (N), Micro-Sul Dusting Sulfur O, Microthiol Micronized Wettable Sulfur, Sul-Preme 52 Flowable Sulfur, Sulfur 6 L, Sulfur DF, Sulphur W.G., Supersix Liquid Sulfur, Thiolux DF Micronized Sulfur, **Thiolux Jet DF Micronized Sulfur-OMRI**, Top Cop W/Sulfur, Wilbur Ellis Spray Sulfur	inorganic	multisite contact activity (proposed)	NC (not considered)
sulfur (lime)	BSP Lime-Sulfur Solution, BSP Sulforix, **Green Cypress Lime-Sulfur Solution-OMRI**, Rex Lime Sulfur Solution, Tetrasul 4S5	inorganic	multisite contact activity (proposed)	NC (not considered)
tetradecenyl acetate	3M Sprayable Pheromone Mating Disruption/Leafrollers	pheromone	pheromone	NC (not considered)
thiamethoxam	Actara	chloro-nicotinyl	4. nicotinic acetylcholine receptor agonists/ antagonists	4A. neonicotinoids

Disclaimers

1) All active ingredients listed above were registered for use on cherry trees at the time of printing in 2008. This situation may change in the future; e.g., azinphos-methyl (Guthion) usage is being phased out, and the product may no longer be used after September 30, 2012. It is the applicator's responsibility to ensure that products applied on cherries in Oregon have current registration. Remember, **THE LABEL IS THE LAW.**

2) The above list of trade names of active ingredients registered for use in commercial cherry farming in Oregon may be incomplete. Where registered products have been omitted inadvertently, Oregon State University Extension Service neither discriminates against these products nor endorses any product for efficacy or otherwise.

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Chart 3. Cherry Fungicides and Bactericides Registered in Oregon, 2008

Cherry disease	2,4-xylenol (Gallex)	azoxystrobin (Abound)	*Bacillus pumilus* strain qst 2808 (Sonata)	*Bacillus subtilis* strain qst713 (Serenade)	boscalid (Pristine)	captan (Captan)	chitosan (Elexa 4 Plant Defense Booster)	chlorothalonil (Applause 720, Bravo Ultrex)	cinnamaldehyde (Cinnacure)	clarified hydrophobic extract of neem oil (Agroneem EC)	copper hydroxide (Kocide DF)	copper metallic (Copper-Count-N, L/M Kop-R-Spray Conc)	copper octanoate (Neudorff Cueva Fungicide Conc-OMRI, Soap-Shield Flowable Liquid Copper Fungicide)
REI hours (h) or days (d)	–	4 h	4 h	4 h	12 h	4 d	4 h	6.5 d (12 h)	24 h	4 h	24 h	24 h	4 h
PHI hours (h) or days (d)	DD	0 d	0 d	0 d	0 d	0 d	–	BSS	48 h	24 h	AH	AH	0 d
Bacterial canker *(Pseudomonas syringae)*				♦							♦	♦	♦
Blossom blight *(Monilinia* spp.)		♦			♦	♦		♦			♦		♦
Blue mold *(Penicillium expansum)*		♦		♦				♦			♦		
Brown rot *(Monilinia* spp.)				♦	♦	♦		♦	♦		♦	♦	♦
Crown gall *(Agrobacterium tumefaciens)*	♦					♦							
Gray mold *(Botrytis cinerea)*		♦	♦	♦	♦	♦	♦	♦		♦	♦	♦	♦
Leaf spot *(Blumeriella jaapii)*		♦		♦	♦	♦	♦	♦		♦	♦	♦	♦
Phytophthora root rot													
Powdery mildew *(Podosphaera clandestina)*		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
Rhizopus rot *(Rhizopus stolonifer)*						♦							
Shothole (Coryneum blight)		♦		♦	♦	♦		♦		♦	♦	♦	

Cherry disease	copper oxide (cuprous oxide) (Nordox 75 WP)	copper oxychloride ($Cu_2Cl(OH)_3$) (C-O-C-S WDG)	copper sulfate (-pentahydrate) (Quimag Quimicos Aguila Copper Sulfate Crystal)	copper sulfate basic (Basic Copper 53, Basicop Fungicide/Bactericide, Cuprofix Ultra 40 DispersS)	cyprodinil (Vanguard WG Fungicide)	DCNA (dicloran) (Botran 75-W Fungicide)	dodine (Syllit FL Fungicide)	fenarimol (Rubigan EC)	fenbuconazole (Indar 75 WSP)	fenhexamid (Arysta Captevate 68 WDG)	ferbam (Ferbam Granulo Fungicide)	fludioxonil (Scholar)	gaba (gamma aminobutyric acid) (AuxiGro WP Plant Metabolic Primer)
REI hours (h) or days (d)	24 h	24 h	24 h	24 h	12 h	12 h	48 h	12 h	12 h	24 h	24 h	PHD	4 h
PHI hours (h) or days (d)	AH	AH	–	–	2 d	10 d	48 h	0 d	0 d	0 d	0 d	PHD	–
Bacterial canker *(Pseudomonas syringae)*	♦		♦	♦									
Blossom blight *(Monilinia* spp.)	♦		♦			♦			♦	♦	♦		
Blue mold *(Penicillium expansum)*	♦			♦									
Brown rot *(Monilinia* spp.)		♦		♦						♦	♦	♦	
Crown gall *(Agrobacterium tumefaciens)*													
Gray mold *(Botrytis cinerea)*				♦						♦			
Leaf spot *(Blumeriella jaapii)*	♦	♦	♦	♦			♦	♦	♦	♦	♦		
Phytophthora root rot													
Powdery mildew *(Podosphaera clandestina)*	♦	♦	♦	♦	♦			♦		♦			♦
Rhizopus rot *(Rhizopus stolonifer)*						♦						♦	
Shothole (Coryneum blight)	♦	♦	♦	♦									

Cherry disease	glutamic acid (AuxiGro WP Plant Metabolic Primer)	hydrogen peroxide (dioxide) (Oxidate)	iprodione (Iprodione 4 L, Rovral)	jojoba oil (Eco E-Rase-OMRI)	m-cresol (Gallex)	mefenoxam (r-enantiomer of metalaxyl) (Axle 2E Fungicide, Ridomil Gold EC Fungicide)	mineral oil, petroleum distillates, solvent refined light (JMS Stylet-Oil)	monopotassium phosphate (Nutrol o-50-32)	myclobutanil (Prokoz Hoist Specialty Fungicide, Rally 40 W, Spectracide Immunox)	peroxyacetic acid (Ecolab Tsunami 100, Ecolab Victory, Vigorox 15 F&V, Zeprolong VF)	petroleum base oil (Biocover MLT)	phosphorous acid (Fosphite Fungicide, Rampart Potassium Phosphite)	phosphorous acid, mono- and dipotassium salts of (Agri-fos, Arborfos)	potassium bicarbonate (Armicarb "O," Green Cure/Organic Production, Kaligreen, Milstop Broad Spectrum F)
REI hours (h) or days (d)	4 h	0 h	24 h	4 h	–	48 h	4 h	4 h	24 h	PHD	4 h	4 h	4 h	4 h
PHI hours (h) or days (d)	–	0 h	PF	0 d	DD	DD	0 d	–	0 d	PHD	60 d	0 d	0 d	0 d
Bacterial canker *(Pseudomonas syringae)*														
Blossom blight *(Monilinia* spp.)									♦					♦
Blue mold *(Penicillium expansum)*		♦								♦		♦	♦	♦
Brown rot *(Monilinia* spp.)		♦	♦						♦	♦		♦		♦
Crown gall *(Agrobacterium tumefaciens)*					♦									
Gray mold *(Botrytis cinerea)*		♦	♦					♦		♦				♦
Leaf spot *(Blumeriella jaapii)*		♦	♦				♦		♦			♦		♦
Phytophthora root rot						♦						♦	♦	
Powdery mildew *(Podosphaera clandestina)*	♦	♦		♦			♦	♦	♦		♦	♦	♦	♦
Rhizopus rot *(Rhizopus stolonifer)*														
Shothole (Coryneum blight)			♦						♦					♦

Cherry disease	potassium laurate (M-Pede)	potassium silicate (Sil-Matrix)	*Pseudomonas fluorescens* A506 (Blightban A506, NUFARM Blightban A506)	pyraclostrobin (Pristine, Cabrio EG)	quinoxyfen (Quintec)	sodium borate (Prev AM Ultra)	sulfur (Ben-Sul 85, Drexel, Kumulus DF, L/M Sulfur Dust, Micro Sulf (N), Micro-Sul Dusting Sulfur O)	lime sulfur (BSP Lime-Sulfur Solution, BSP Sulforix, Green Cypress Lime-Sulfur Solution-OMRI)	tebuconazole (Elite 45 WP Foliar Fungicide, Orius 45 DF Foliar Fungicide)	thiophanate methyl (T-Methyl 70 W WSB, Topsin 4.5 FL)	trifloxystrobin (GEM 500 SC)	triflumizole (Procure 480 SC AG Fungicide)	ziram (Ziram 76 DF Fungicide)
REI hours (h) or days (d)	12 h	4 h	PHD	12 h	12 h	12 h	24 h	48 h	12 h	12 h	12 h	12 h	48 h
PHI hours (h) or days (d)	AH	0 d	PHD	0 d	7 d	–	–	DD	0 d	24 h	24 h	24 h	14 d
Bacterial canker *(Pseudomonas syringae)*													
Blossom blight *(Monilinia* spp.)				♦			♦	♦	♦	♦	♦	♦	
Blue mold *(Penicillium expansum)*							♦						
Brown rot *(Monilinia* spp.)				♦			♦	♦	♦	♦			♦
Crown gall *(Agrobacterium tumefaciens)*													
Gray mold *(Botrytis cinerea)*			♦	♦		♦				♦			
Leaf spot *(Blumeriella jaapii)*	♦			♦			♦	♦	♦	♦	♦	♦	♦
Phytophthora root rot													
Powdery mildew *(Podosphaera clandestina)*	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
Rhizopus rot *(Rhizopus stolonifer)*													
Shothole (Coryneum blight)				♦			♦	♦			♦		♦

AH = After harvest up to petal fall
DD = Delayed dormancy only
PF = During bloom up to petal fall
BSS = Before shuck split
– = Not specified, follow label

Disclaimers

1) All active ingredients listed above were registered for use on cherry trees in Oregon at the time of printing in 2008. This situation may change in the future. It is the applicator's responsibility to ensure that the products selected and applied on cherries in Oregon have current registration.

2) Select trade names of active ingredients above are mentioned as illustrations only. Oregon State University Extension Service neither discriminates against other registered products nor endorses any of these products for efficacy or otherwise. For a comprehensive list of registered trade names in alphabetical order, see Chart 4, Cherry Fungicides and Bactericides Registered in Oregon.

3) Restricted-entry Intervals (REI) and Preharvest Intervals (PHI) are provided as a guide only. These restrictions change frequently, and similar products from different manufacturers may not have the same restrictions. Consequently, growers are advised to keep abreast of the latest information concerning individual label requirements and restrictions before selecting and applying a product. Remember, **THE LABEL IS THE LAW.**

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Chart 4. Cherry Fungicides and Bactericides Registered in Oregon, 2008

Active ingredient	Trade name (bold = OMRI registered)	Chemical group	Mode of action	Chemical activity	FRAC code
2,4-xylenol	Gallex	phenol	unknown (U)	contact/locally systemic	NC
azoxystyrobin	Abound Flowable Fungicide, Heritage Fungicide, Quadris S Fungicide	methoxyacrylate	respiration (C3)	contact/systemic	11
Bacillus pumilus strain qst 2808	**Sonata Biofungicide/Organic Production**	microbial	not classified (NC)	microbial	NC
Bacillus subtilis strain qst713	Serenade, **Serenade ASO-OMRI**, Rhizopro	microbial	not classified (NC)	microbial	NC
boscalid	Pristine Fungicide	pridine carboximide	respiration (C2)	systemic	7
captan	Arvesta Captan 50 WP, Arvesta Captan 80 WDG, Arvesta Captevate 68 WDG Fungicide, Captan 50 Wettable Powder, Captan 50 WP, Captan 80 WDG, Captan 80 WDG, Captan 80-WP, Captan 80 WDG, Captan PRO 50 WP Fungicide, Captan PRO 80 WDG, Captec 4 L, Captec 4 L, Captevate 68 WDG Fungicide, Drexel Captan 4 L Fungicide, Drexel Captan 80 WDG	phthalimides	multisite contact activity (M)	contact	M4
chitosan	Elexa 4 Plant Defense Booster	animal derived	not classified (NC)	elicitor	NC
chlorothalonil	Applause 720 Fungicide, Bravo Ultrex, Bravo Weather Stik, Bravo Weather Stik Ag Fungicide, Bravo Zn Agricultural Fungicide, Chloronil 720 Agricultural Fungicide, Chlorostar VI, Chlorothalonil 720 F Flowable Fungicide, Concorde DF Fungicide, Concorde Fungicide, Echo 720 Agricultural Fungicide, Echo 90 DF, Echo 90 DF Agricultural Fungicide, Echo Ultimate Ag Fungicide, Echo Zn Agricultural Fungicide, Equus 500 ZN Fungicide, Equus 720 SST Flowable Chlorothalonil Fungicide, Equus 720 SST Fungicide, Equus DF Dry Flowable Chlorothalonil Fungicide, Equus DF Fungicide, Farmsaver.Com Equus 500 ZN, Mainsail 6.0 F Fungicide, Mainsail WDG Fungicide	chloronitriles	multisite contact activity (M5)	contact	M5
cinnamaldehyde	Cinnacure	cinnamic acid amides	lipid and membrane synthesis (F5)	energy related (glucose uptake)	40
clarified hydrophobic extract of neem oil	**Trilogy Fungicide/Miticide/Insecticide-OMRI**	botanical	not classified (NC)	contact	NC
copper hydroxide	Agristar NU-COP HB, Champ DP AG Fungicide/Bactericide Dry Prill (NU), Champ Formula 2 Flowable (NU), Champion Wettable Powder AG Fungicide (NU), DuPONT Kocide 101 Fungicide/Bactericide, DuPONT Kocide 2000 Fungicide, DuPONT Kocide 3000 Fungicide/Bactericide, DuPONT Kocide 4.5 LF Fungicide/Bactericide, DuPONT Kocide DF Fungicide/Bactericide, Hi-Yield Copper Fungicide, Kocide 101 Fungicide/Bactericide, Kocide 101 Protech, Kocide 2000 Protech, Kocide 2000 T/N/O Fungicide/Bactericide, Kocide 4.5 LF Fungicide/Bactericide, Kocide DF Fungicide/Bactericide, Kocide DF Protech, Kocide LF Fungicide/Bactericide, NU COP 50 WP Agricultural Fungicide/Bactericide, NU-COP 3L, NU-COP 50DF Fungicide/Bactericide, Stretch Fungicide	inorganic	multisite contact activity (M1)	contact	M1
copper metallic	C-O-C-S WDG (PC), Cooke KOP-R-Spray Conc, Copper-Count-N, L/M KOP-R-Spray Conc	inorganic	multisite contact activity (M1)	contact	M1
copper octanoate	E.B. Stone Copper Soap Conc., **Neudorff Cueva Fungicide Conc-OMRI**, Soap-Shield Flowable Liquid Copper Fungicide	inorganic	multisite contact activity (M1)	contact	M1
copper oxide (cuprous oxide)	Nordox 75 WG Wettable Granule Fungicide	inorganic	multisite contact activity (M1)	contact	M1
copper oxychloride ($Cu_2Cl(OH)_3$)	C-O-C-S WDG	inorganic	multisite contact activity (M1)	contact	M1
copper sulfate (-pentahydrate)	Copper Sulfate Coarse Crystals, **Copper Sulfate Crystals-OMRI**, Quimag Quimicos Aguila Copper Sulfate Crystal, Triangle Brand Copper Sulfate Instant Powder	inorganic	multisite contact activity (M1)	contact	M1
copper sulfate basic	Basic Copper 53, Basicop Fungicide/Bactericide, C-O-C-S WDG, Cuprofix Disperss, Cuprofix Ultra 40 Disperss, Dexol Bordeaux Powder, Top Cop W/Sulfur	inorganic	multisite contact activity (M1)	contact	M1
cyprodinil	Vangard WG Fungicide	anilino-pyrimidine (AP)	amino acids and protein synthesis (D1)	systemic	9
DCNA (dicloran)	Botran 75 W Fungicide	aromatic hydrocarbon	lipid peroxidation (F3)	locally systemic	14
dodine	Syllit FL Fungicide	guanidine	multisite contact activity (M7)	contact	M7
fenarimol	Rubigan EC	pyrimidine	sterol biosynthesis in membranes (G1)	systemic	3
fenbuconazole	Indar 75 WSP Fungicide	triazole	sterol biosynthesis in membranes (G1)	systemic	3
fenhexamid	Arvesta Captevate 68 WDG Fungicide, Arvesta Elevate 50 WDG Fungicide, Arvesta Judge 50 WDG Fungicide, Captevate 68 WDG Fungicide, Elevate 50 WDG Fungicide	hydroxyanalides	sterol biosynthesis in membranes (G3)	contact	17
ferbam	Ferbam Granuflo Fungicide	dithiocarbamates and relatives	multisite contact activity (M3)	contact	M3
fludioxonil	Scholar	phenylpyrroles	signal transduction (E2)	contact	12
gaba (gamma aminobutyric acid)	Auxigro WP Plant Metabolic Primer	not classified (NC)	not classified (NC)	not classified (NC)	NC
glutamic acid	Auxigro WP Plant Metabolic Primer	not classified (NC)	not classified (NC)	not classified (NC)	NC
hydrogen peroxide (dioxide)	Ecolab Tsunami 100, Ecolab Victory, HDH Peroxy, Oxidate Broad Spectrum Bactericide/ Fungicide, Oxyfresh, Vigorox 15 F&V, Zeprolong VF	inorganic	unknown (U)	contact	NC
iprodione	Iprodione 4L AG, Iprodione 50 WP AG, Rovral Brand 4 Flowable Fungicide (B), Rovral Fungicide (B)	dicarboximides	signal transduction (E3)	locally systemic	2
jojoba oil	**ECO E-RASE-OMRI**	botanical	not classified (NC)	contact	NC
lime sulfur	BSP Lime-Sulfur Solution, BSP Sulforix, **Green Cypress Lime-Sulfur Solution-OMRI**, Hi-Yield Improved Lime Sulfur Spray, L/M Polysul Summer & Dormant Spray Conc, Rex Lime Sulfur Solution, Tetrasul 4s5	inorganic	multisite contact activity (M2)	contact	M2
m-cresol	Gallex	phenol	unknown (U)	contact/locally systemic	NC
mefenoxam (r-enantiomer of metalaxyl)	Axle 2 E Fungicide, Ridomil Gold EC Fungicide, Ridomil Gold SL Fungicide	phenylamine	nucleic acids synthesis (A1)	systemic	4
mineral oil, petroleum distillates, solvent refined light	First Choice Gavicide Super 90, Purespray Foliar 13 E, Purespray Foliar 15 E, Purespray Foliar 22 E, Purespray Spray Oil 10 E, Spray Oil 10 E, Spray OIL 13 E, Spray Oil 22 E, Biocover SS, Biocover UL, First Choice Narrow Range 415 Spray Oil, **Glacial Spray Fluid-Organic**, IAP 415 Summer Spray Oil, IAP 440 All Purpose Spray Oil, Iap Organic Spray Oil, JMS Stylet-Oil, **Organic JMS Stylet-Oil-OMRI**, PHT V-415 Spray Oil, PHT V-440 Spray Oil, PHT V-470 Spray Oil, PHT V470 Oil, PHT Volck Clear	mineral oil	not classified (NC)	contact	NC
monopotassium phosphate	Nutrol 0-50-32	inorganic	unknown (U)	systemic/contact	NC
myclobutanil	Eagle 20 EW, Eagle 40 WP Specialty Fungicide, Eagle WSP T&O Fungicide IN WSP, Laredo EC Agricultural Fungicide, Prokoz Hoist Specialty Fungicide, Rally 40 W, Rally 40 W Agricultural Fungicide in WSP (R), Spectracide Immunox Multi-Purpose Fungicide Spray Conc	triazole	sterol biosynthesis in membranes (G1)	systemic	3
peroxyacetic acid	Ecolab Tsunami 100, Ecolab Victory, Vigorox 15 F&V, Zeprolong VF	inorganic	unknown (U)	contact	NC
petroleum base oil	Biocover MLT	diverse	not classified (NC)	contact	NC
phosphorous acid	Agrisolutions Topaz Fungicide, Fosphite Fungicide-Master Label, Phostrol Agricultural Fungicide (NU), Rampart Potassium Phosphite, Rampart T&O Potassium Phosphite, Resist 57	phosphonates	unknown (U)	systemic	33
phosphorous acid, mono- and dipotassium salts of	Agri-Fos, Agri-Fos Systemic Fungicide, Arborfos, Crop-Phite Agricultural Fungicide, Exel Lg Systemic Fungicide, Fungi-Phite, Fungi-Phite, K-Phite Systemic Fungicide, Leaf-Guard Systemic Fungicide	phosphonates	unknown (U)	systemic	33
potassium bicarbonate	Armicarb 'O,' Green Cure/Organic Production, Kaligreen, **Milstop Broad Spectrum Foliar Fungicide-OMRI**	not classified (NC)	not classified (NC)	contact	NC
potassium laurate	M-Pede Insecticide/Fungicide, **M-Pede Insecticide/Fungicide-OMRI**	unknown (U)	fatty acid	contact	NC
potassium silicate	Sil-Matrix Fungicide/Miticide/Insecticide	not classified (NC)	not classified (NC)	contact	NC
propiconazole	Bumper 41.8 EC, Propiconazole-Fungicide, Orbit Fungicide	triazole	sterol biosynthesis in membranes (G1)	systemic	3
Pseudomonas fluorescens **A506**	Blightban A506, Nufarm Blightban A506	microbial	not classified (NC)	microbial	NC
pyraclostrobin	Cabrio EG Fungicide, Pristine Fungicide	methoxy carbamate	respiration (C3)	translaminar/systemic	11
quinoxyfen	Quintec	quinolines	G-proteins in early cell signalling (E1)	contact	13
sodium borate	Prev Am Ultra	not classified (NC)	not classified (NC)	contact	NC
sulfur	Ben-Sul 85, **Cosavet-DF Fungicide-Miticide-OMRI**, CSC 80% Thiosperse, Drexel Suffa, Dusting Sulfur, Kumulus DF, Liquid Sulfur Six, Micro Sulf (N), Micro-Sul Dusting Sulfur O, Microthiol Disperss Micronized Wettable Sulfur, Microthiol Disperss Micronized Wettable Sulfur, Sul-Preme 52 Flowable Sulfur, Sulfur 6 L, Sulfur DF, Sulphur WG, Thiolux Dry Flowable Micronized Sulfur, **Thiolux Jet Dry Flowable Micronized Sulfur-OMRI**, Top Cop W/Sulfur, Wilbur-Ellis Spray Sulfur	inorganic	multisite contact activity (M2)	contact	M2
tebuconazole	Elite 45 WP Foliar Fungicide In WSP (B), Elite 45 DF Foliar Fungicide (B), Orius 45 DF Foliar Fungicide, Orius 45 WP Foliar Fungicide In WSP, Trisum 45 WDG	triazole	sterol biosynthesis in membranes (G1)	systemic	3
thiophanate-methyl	Farmsaver.Com Thiophanate Methyl 85 WDG, Quali-Pro TM 4.5, Quali-Pro TM 85 WDG, T-Methyl 4.5 F Ag Fungicide, T-Methyl 70 W WSB, T-Methyl 70 W WSB, Thiophanate Methyl 85 WDG Fungicide, Topsin 4.5 FL, Topsin M 70 WDG, Topsin M 70 WP, Topsin M WSB	thiophanate	mitosis and cell division (B1)	systemic	1
trifloxystrobin	Gem 500 SC Fungicide, Gem Fungicide (B)	quinone outside inhibitor (QoI)	respiration (C3)	translaminar	11
triflumizole	Procure 480 SC Agricultural Fungicide (CM), Procure 50 WS Agricultural Fungicide (CM)	imidazole	sterol biosynthesis in membranes (G1)	systemic	3
ziram	Ziram 76 DF Fungicide, Ziram Granuflo Fungicide	dithiocarbamates and relatives	multisite contact activity (M3)	contact	M3

Disclaimers

1) All active ingredients and trade names listed above were registered for use on cherry trees in Oregon at the time of printing in 2008. This situation may change in the future. It is the applicator's responsibility to ensure that the products selected and applied on cherries in Oregon have current registration. Remember, **THE LABEL IS THE LAW.**

2) The above list of trade names of active ingredients registered for use in commercial cherry orchards in Oregon may be incomplete. Where registered products have been omitted inadvertently, Oregon State University Extension Service neither discriminates against these products nor endorses any product for efficacy or otherwise.

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