



# Integrated Pest Management

A Brief Guide to Pest Management  
For Fruit Trees



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# Introduction



This report is based on a workshop held July 18, 2012 covering the basics of Integrated Pest Management. This is the third in a series of learning modules covering the basics of fruit tree growing in the Pacific Northwest. The workshops were hosted by Evergreen in Vancouver, BC; the hands on portions of the workshops are carried out in Evergreen's mobile urban orchard which consists of 60 dwarf apple trees.

This workshop was facilitated by Dr. Kent Mullinix, a pomologist who has worked with fruit trees for the past 35 years. He attended the University of Missouri where he earned a B.Sc. in Agriculture, M.Sc. in Horticulture (specializing in Pomology) and Ph.D. in Agriculture Education (curriculum and program development, crop sciences and soil conservation). He also earned a Ph.D. from the University of British Columbia in Plant Science (specializing in integrated pest management). He is a Professional Agrologist with the British Columbia Institute of Agrologists and currently works as the Director of Sustainable Agriculture and Food Security at the Institute for Sustainable Horticulture, Kwantlen Polytechnic University.

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**Vancity**



**Gencon  
Foundation**

# Overview



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This workshop reviewed different pest management approaches and offered some solutions and options to dealing with the most common pest issues in fruit tree production. The information shared here focuses on 'soft' and organic methods, primarily for small scale or home growing.

*Integrated Pest Management (IPM) is a knowledge intensive, ecologically based decision making process that uses a variety of management tools and methodologies to suppress pest populations to acceptable levels but relies primarily on natural mortality factors.*

IPM approaches don't necessarily eliminate pests but rather suppress them, and this wording is very important! Ideally, farming techniques create an environment that is not conducive to pests or disease in the first place, and can keep pest populations in balance naturally. IPM focuses strongly on supporting natural mortality factors (e.g. pests natural enemies). It requires a great deal of sampling, monitoring, and decision making to be effective.

IPM can work for all types of pests from insects and mites, to fungi, bacteria, weeds and vertebrates! This guide overviews a number of control methods– we recommend doing further research on the pests you are dealing with, and on the methods and products you would like to use. Remember that knowledge is your first line of defense – the more you know about pest biology, their natural history, and the damage they cause, the more you can do to effectively control them.

# Pesticides



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## *Why is our reliance on pesticides a problem?*

*The answer might be obvious to some. However, pesticides continue to be the primary pest management tool in commercial agriculture. There are four main issues with pesticide reliance: resistance, resurgence, induced pests and environmental damage.*

**Resistance:** Most pesticides are not 100% lethal. Up to 2% of the target insect population may have natural resistance. As the survivors reproduce, the genetic resistance to the pesticide increases. Dosage of the pesticide needs to be increased, creating a detrimental cycle.

**Resurgence:** Pesticides will kill 98% of the pests and 99.5% of the enemy. With fewer remaining natural enemies the surviving pest population will boom!

**Induced Pests:** There are natural controls to any pest population. If you destroy the predators of common and mild pests, you can create infestations of pests that wouldn't have been a problem otherwise.

**Environmental damage:** DDT, dioxin etc. remain in the environment and continue to harm mammals, fish and humans long after they are used.

**DID YOU KNOW:** Every cell of Monsanto's genetically engineered corn and cotton manufactures its own insecticide. Five years ago Monsanto claimed this was the end of having to use insecticides externally. But within only 5 years resistant insects have emerged!



# IPM Approach



## The IPM approach

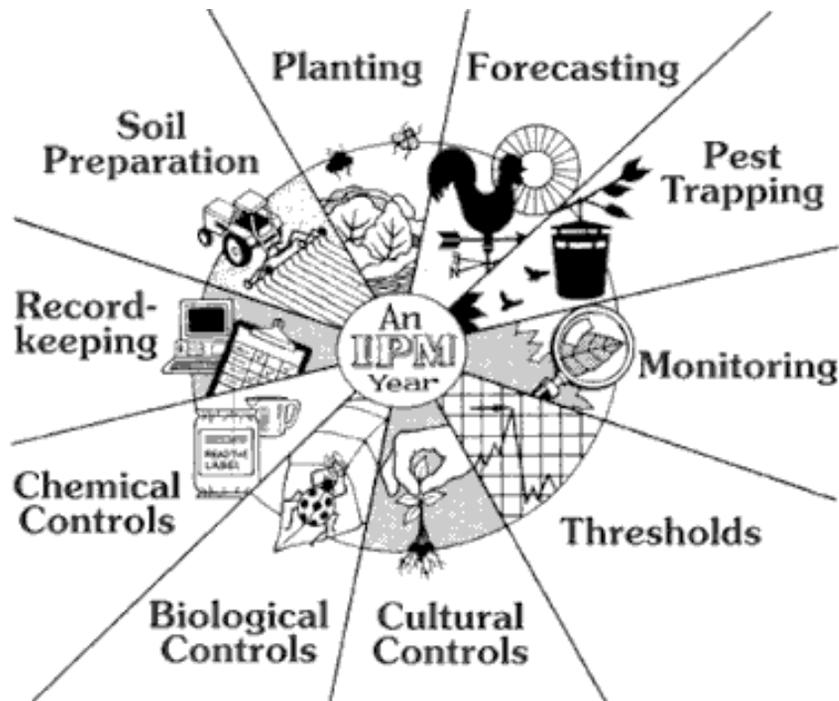


Image: IPM Institute of North America Inc.

#1: Monitor pests and beneficial species. Sampling and monitoring are critical to IPM

#2: Estimate population densities, determine distribution, assess damage potential. Do this by sampling through: traps, sweep nets, visual examination, pheromone traps

#3: Decide on treatment, based on action threshold. Threshold determined by experience and educated guessing

#4: Keep records and evaluate effectiveness of treatments

# Classification



## Key, Secondary, Occasional Pests

**Key Pests:** Most significant and cause the most damage on a continued basis. Many are exotic species - they have been imported and have no natural enemies. Examples of these pests include:

**Apple:** Scab, codling moth, apple maggot

**Cherry:** Cherry fruit fly

**Pear:** Psylla

**Secondary Pests:** A pest that is not a problem under normal conditions because it is controlled by a natural enemy. It becomes a problem when the natural system is altered by pesticide use – the natural enemy is killed off while the pest demonstrates a natural resistance to the pesticide.

**Occasional Pests:** Pests that exceed acceptable levels only occasionally, usually due to environmental influences or human activities.

## Direct and Indirect Pests

**Direct pests:** Eat and/or damage the fruit.

**E.g.:** Apple Maggot, Codling Moth, Birds

**Indirect pests:** Feed on foliage or the tree itself, damaging the crop indirectly by harming the photosynthetic capacity of the tree.

**E.g.:** Anthracnose, Voles (who eat the root system away)

# Phenology Models



## Phenology Models

Arthropods, microorganisms and fruit trees are all ectothermic; their metabolism, and development, are regulated by the amount of ambient heat they are exposed to.

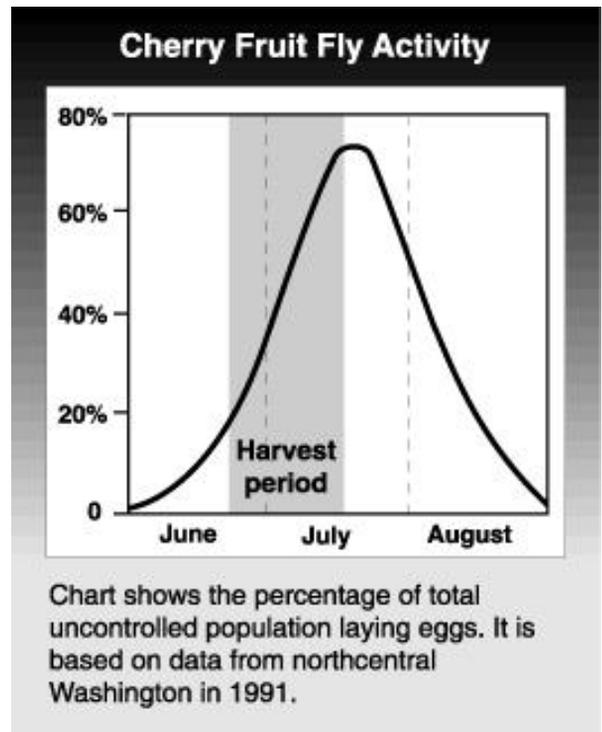
*For example, codling moth eggs will not hatch until they accumulate a specific amount of ambient heat.*

You can calculate how quickly specific pests (insects, fungi) will develop based on heat unit accumulation around your tree. The 'phenology models' illustrated below predict development which enables more accurate sampling and treatment of pests.

**Degree Day Look-up Table for Western Cherry Fruit Fly**  
Lower threshold: 41°F Upper threshold: None

Maximum temperature	Minimum temperature																							
	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81	
40	0	0	0	0	0	0	0	0																
43	0	0	0	0	0	0	0	0	1	2														
46	1	1	1	1	1	1	1	2	2	3	5													
49	2	2	2	2	2	2	3	3	3	5	6	8												
52	3	3	3	3	3	4	4	4	5	6	8	9	11											
55	4	4	4	4	4	5	5	6	6	8	9	11	12	14										
58	5	5	5	5	6	6	6	7	8	9	11	12	14	15	17									
61	6	6	6	7	7	7	8	8	9	11	12	14	15	17	18	20								
64	7	7	8	8	8	9	9	10	11	12	14	15	17	18	20	21	23							
67	8	9	9	9	10	10	11	11	12	14	15	17	18	20	21	23	24	26						
70	10	10	10	11	11	12	12	13	14	15	17	18	20	21	23	24	26	27	29					
73	11	11	11	12	12	13	14	14	15	17	18	20	21	23	24	26	27	29	30	32				
76	12	12	13	13	14	14	15	16	17	18	20	21	23	24	26	27	29	30	32	33	35			
79	13	14	14	15	15	16	16	17	18	20	21	23	24	26	27	29	30	32	33	35	36	38		
82	15	15	16	16	17	17	18	19	20	21	23	24	26	27	29	30	32	33	35	36	38	39	41	
85	16	16	17	17	18	19	19	20	21	23	24	26	27	29	30	32	33	35	36	38	39	41	41	
88	17	18	18	19	19	20	21	22	23	24	26	27	29	30	32	33	35	36	38	39	41	42	44	
91	19	19	20	20	21	22	22	23	24	26	27	29	30	32	33	35	36	38	39	41	42	44	45	
94	20	21	21	22	22	23	24	25	26	27	29	30	32	33	35	36	38	39	41	42	44	45	47	
97	21	22	22	23	24	24	25	26	27	29	30	32	33	35	36	38	39	41	42	44	45	47	48	
100	23	23	24	24	25	26	27	28	29	30	32	33	35	36	38	39	41	42	44	45	47	48	50	
103	24	25	25	26	27	27	28	29	30	32	33	35	36	38	39	41	42	44	45	47	48	50	51	
106	26	26	27	27	28	29	30	31	32	33	35	36	38	39	41	42	44	45	47	48	50	51	53	
109	27	28	28	29	29	30	31	32	33	35	36	38	39	41	42	44	45	47	48	50	51	53	54	
112	28	29	30	30	31	32	33	34	35	36	38	39	41	42	44	45	47	48	50	51	53	54	56	
115	30	30	31	32	32	33	34	35	36	38	39	41	42	44	45	47	48	50	51	53	54	56	57	

To find the total degree days for a day, locate the low and high temperatures and follow the rows to where they intersect. For temperatures between those listed, use the nearest shown. This chart can be duplicated for easy reference in the field.



# IPM Strategies



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## Cultural Controls

**These are simple management practices to make an ecosystem less friendly to pests:**

- Strategic plant selection for resistance to common diseases to your area. See examples at right.
- Planting sacrificial trees. For example, a golden delicious apple tree attracts more codling moths than other species. Plant a few of these trees and during the stage of life when the moth burrows into the apple, pick and destroy all the apples. This prevents further infection in other trees.
- Planting refuge areas for natural enemies of pests (e.g. native strawberries).
- Good nutrition management. Healthy trees are better able to fend off pests, but beware of adding too much nitrogen. Pests love soft new green growth.
- Thoughtful pruning can increase tree health and decrease area for insects to hide.
- Sound horticulture. Fruit trees take a lot of work and management!



*Liberty – A scab resistant apple. Photo: Dr. John Cline*



*Gold Rush – A powdery mildew resistant apple. Photo: USDA Agriculture Research Service*

# IPM Strategies



## Mechanical/Physical Controls

Manual or mechanical methods that deter or eliminate pests. Generally non-disruptive to beneficial organisms and ecosystems.

**Mechanical:** Includes tilling, flaming underneath the tree, noise makers, etc.

**Physical:** This includes hoeing for weed control, pulling weeds, pruning out pests, creating barriers, adding mulches, placing traps, manual removal of insects or cankers, etc.

## Organic and Inorganic Materials

Spray them or spread them!

**Repellents:** Capsaicin/hot pepper and garlic can be used as natural repellents. Kaolin clay is used to create inhospitable environments for insects.

**Mechanical/physical:** Diatomaceous earth and horticultural oils can be used against soft bodied insects/fungi.

**Soaps:** Used to deter/smother insects.

**Minerals:** Sulfur/lime sulfur are used against fungi and insects; copper is used against some types of bacteria.

**Oils/Sprays:** Acetic acid, clove oil and fatty acids are used as herbicides.

**Compost teas:** Can be antimicrobial, of varying use and function. Research is still being done.

# IPM Strategies



## Behavioural Controls

*Affects insects by taking advantage of their natural responses to colours, odors and light.*

**Pheromones:** Hormones that insects emit during mating season to attract one another. Using pheromones for pest management is species specific and non-toxic.

**Kairomones:** This is the chemical released when plants are injured or weakened. They are used to attract pests to healthy, resilient trees, and trap them.

**Colour attractants:** Taking advantage of insect behavioural responses to bright colours.



*Photo: Fritz Gellar-Grimm*

Pheromone traps (above) and dispensers (left) disrupt target species mating behavior by emitting chemically produced pheromones.

Pheromone emitters inundate the pest area with these chemical signals, saturating the air and confusing the insects so that males can no longer find females to reproduce.



*Photo: Eugene E Nelson*

# IPM Strategies



## Chemical Controls (i.e. Pesticides)

Pesticides are materials applied to render habitat lethally toxic to target organisms. Many of the following terms are used to define different types of pesticides – when making pest management decisions, it is important to know what each of these words actually means. Read labels carefully!

Pesticides are classified according to the type of pest they target: insecticides, fungicides, rodenticides, miticides, herbicides, bactericides.

**Synthetic:** created in labs vs. **Natural:** found in the natural environment

(Synthetic chemicals are prohibited in organic farming)

**Microbial:** Cultivating naturally occurring pesticides to target specific species

**'Broad spectrum':** Is lethal to many different species

**'Target specific':** Is only lethal to specified species. Microbial pesticides are very narrow spectrum

Some pesticides are **disruptive** (highly lethal) and others are **soft** (less lethal)

Some are **persistent** in the environment and others are not (i.e. BT dissipates in 2 days, DDT persists indefinitely)

Some are highly **toxic**, others are not

# Chemical Controls



## Types of chemical controls

**Synthetic:** Nervous system poisons that are generally very toxic, broad spectrum, and disruptive (note that the nervous systems in insects/humans is the same).

**Botanicals:** Derived from plants but can be disruptive (e.g. Rotenone).



*Chemical insecticide Rotenone kills more than just its codling moth target. It is also highly toxic and deadly to fish.*

**Natural:** These include soaps, oils, minerals, diatomaceous earth and kaolin clay. These last two are not poisonous but create an abrasive and inhospitable environment. Soft, but may be disruptive.

## Pathogenic Biopesticides/Microbials

These are soft and target specific

**Granulovirus:** Natural enemy of leaf roller, a viral pathogen of that kills moths.

***Bacillus thuringiensis (Bt):***  
Bacterial pathogen that kills moths, beetles, worm pest etc.

# IPM Strategies



## Biological Control

Tactic where natural enemies are used to suppress pest populations.

This is the cornerstone of Integrated Pest Management. Every pest has natural enemies, whether they be predators, parasites, or parasitoids. Using natural enemies for pest management takes time as naturally occurring enemy populations tend to grow slower than pest populations. However, eventually they can become a stable component of the ecosystem, regulating the pest population. By employing methods of conservation and augmentation to protect and provide habitat, we can increase the population of these pest predators.



In California, foreign moths completely destroyed some apple crops. After searching intensively in Europe (where the moth came from) scientists found its natural predator, a ladybug beetle, which they introduced to fix the problem.

## Predatory Arthropods

These are the good bugs in your garden you want to KEEP! Spiders, beetles and predatory mites are all natural enemies to various insect pests. They can kill off thrips, aphids, white flies, leps and soft bodied insects. Adult and/or larvae ladybug beetles (of which there are 45 species) are ruthless predators of aphids

## Parasitoids and Parasitic Nematodes

A **parasitoid** is an insect (for example many species of wasp) who lays eggs in other insects, or hosts. The larvae use the host as food and eventually kill them.

**Parasitic nematodes** are small round worms that kill insects but are harmless to other organisms. You can buy several species of worm commercially to use in your pest management strategy – they are currently being tested for effectiveness against various pests and diseases such as codling moth.

# Common Problems: Apple



## Plant pests (Weeds)

Apple trees are poor competitors as the root zone is shallow and easily overtaken by weeds or other plant pests. For the same reason, fruit tree roots are easily destroyed so be gentle when pulling out weeds or grass. Hoeing is a good solution! Mulch can help prevent weeds from coming up, but be careful about trapping too much moisture in the soil.

## Vertebrate pests

**Birds:** Birds will peck ripened fruit. Nets or noise makers can help to ward them off.

**Voles:** Voles can kill trees by chewing off the bark of the trunk area. They like having shelter to hide in such as weeds or grass, so for management it is best to keep an orchard clean of any tall weeds or grasses. Traps can be used in areas particularly prone to infestation.

## Arthropod pests

**Codling moth:** Codling moth goes through the larval stage inside apples. For small orchards or a personal tree, you can bag your apples with sandwich bags. For larger orchards use mating disruption and proper sanitation to moderate. It is important to make sure all infected apples are picked off the tree, crushed up, 'cooked' outside in the sun in a black plastic bag and then destroyed.



*L: Codling Moth  
Photo: Shane Farrell*

*R: Vole damage to tree  
Photo: Fred Hoffman*

# Common Problems: Apple



## Arthropod pests continued...

**Apple maggot:** In order to manage apple maggot, spray trees with kaolin clay (every 7-14 days), use sticky traps and keep the orchard well sanitized.

**Leaf rollers:** Look for curled leaves as a sign of infestation. Spray new shoots with lime sulfur and monitor throughout the spring and during other growth periods. If you have a smaller orchard or just a few trees, you can go through and pick out every single bug.

**Mites, scales, aphids, mealy bug:** Apply oils in the delayed dormant stage, encourage ladybugs in summer. For mites, apply insecticidal soaps at petal fall and during the summer.



*L: Apple maggot.  
Photo: Missouri  
Botanical Garden*

*R: Leaf rollers.  
Photo: Utah State  
University*

**Tent caterpillar:** These insects have many natural predators (birds/beetles/parasitoids). The best way to manage tent caterpillars is to simply prune them out!

*Only the first two or three caterpillars in a brood receive enough nutrition in the egg to have the brain power to make it back to the nest after going out for food. Therefore, if you kill the first two or three to emerge from the nest, the rest will become lost and die.*

# Common Problems: Apple



## Apple diseases

**Anthracnose:** The most deadly of apple diseases, this fungus only exists in the Pacific Northwest (nowhere else in North America). Fall infection from splashing spores creates spring cankers. Cut out cankers before sporulation in early August, after which the rain will wash them down to be splashed up in spring again. Old trees can withstand infection but often young trees cannot. Anthracnose manifests itself as bulls eye rot on apples. Copper compounds can be used against it, particularly in the fall before it rains.

**Scab:** A fungus that overwinters in leaves and then sporulates in the spring when it rains. If you can prevent the overwintering fungus from sporulating by getting rid of all the overwintering leaves then you can prevent infection. Rake up leaves, bag them and get them out of the orchard to eliminate the source of the disease. Primary control is sanitation, but you can also apply sulfur from every 10 days from bud break to three weeks past petal fall.

**SCAB RESISTANT APPLES:** Pristine, Priscilla, Liberty, Williams Pride, Chehalis, Prima, Enterprise.

**Powdery Mildew:** A fungus with spores overwintering in the buds. It has numerous infection cycles per year and infects fruits, shoots, and leaves. It is best to apply sulfur pre-bloom and bicarbonate soda every ten days thereafter.

**Very susceptible:** Jonagold, Granny Smith  
**Resistant:** Fuji



*Above: Anthracnose canker on an apple branch. Early stages are characterized by stringy looking wood and orange residue. Photo: Derrek Sigler*

# Common Problems: Pear



## Insects and Mites

**Codling Moth and Leaf Rollers:** Pears are not as susceptible as apple trees to these insects, but treatment is the same if infestation occurs.

**Psylla and Mites:** To deal with Psylla and other soft bodied insects like mites, it is critical to apply oils at the delayed dormant stage. The delayed-dormant period begins in February as buds begin to swell, and continues until the beginning of the green tip bud development stage. Insecticidal soaps and lime-sulfur can also help.

## Diseases

**Bacterial Canker (Asian Pear):** Use copper on the entire tree at the delayed dormant stage and during bloom.



*Pear Trellis Rust. Photo: Fritz Geller-Grimm*



*Fireblight. Photo: Sebastian Stabinger*

**Fireblight:** Cut out/remove all infected and dead tissue. Spray copper from early bloom until early August, especially if conditions are wet.

**Pear Trellis Rust:** Very common, this variety of rust uses juniper as its host. Even if you meticulously clean your orchard floor after the season to prevent spores from overwintering, the spores will still live on in nearby juniper trees. The only way to control the disease is to eliminate the host juniper trees.

# Common Problems



## Stone Fruit Arthropod Pests

**Cherry Fruit Fly:** To treat for larvae, apply permethrin weekly during the summer and remove the contaminated fruit. Use yellow sticky traps for adult fruit flies.

**Leafrollers, Aphids, Mites:** See treatment for pome fruits (apple, pear).

## Stone Fruit Diseases

**Peach Leaf Curl:** This disease affects both peaches and nectarines and occurs when a tree's environment is too moist. Prevention is achieved through coverage, however you can also apply lime sulfur and/or copper during the fall and through dormancy.

**Brown Rot:** This disease can manifest on any stone fruit tree in the form of blossom and twig blight, cankers and fruit rot. Sanitation and good air circulation are critical to control it; the cankers and the dropped fruit must be cut out/collected and removed from the orchard. Apply sulfur to prevent the spores from setting, particularly in spring and before and after rains.

**Coryneum Blight:** Affects all stone fruit trees. This is a shot hole fungus that can be identified through leaf scars and fruit rot. This disease thrives in cool wet weather. Management techniques include pruning out infected twigs and applying copper or lime sulfur at leaf fall before scars callus and the rain comes.

**Bacterial Canker:** This disease infects trees during times of cool, wet weather, and overwinters in the vascular system of the trees. You can identify it by amber oozing from the tree. Management includes pruning dead or dying branches and cutting out cankers, but not in spring or fall when the tree is most susceptible to infection. Sound nutrition and horticulture are important – a healthy tree may be able to control the infection itself.

# Resources



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This document contains an overview of strategies and solutions for integrated pest management for fruit trees. This can be a hugely complex topic – depending on your exact climate, and the trees you are growing, you may encounter other issues, or desire more information on a particular problem mentioned in this manual. There are many in-depth resources available on particular pests and how to manage them. Here are just a few:

BC Ministry of Agriculture Pest Management Site:

<http://www.agf.gov.bc.ca/cropprot/tfipm/treefruitipm.htm>

Orchard Pest Management. Washington State University Extension:

<http://jenny.tfrec.wsu.edu/opm/>

Ontario Ministry of Agriculture, Food and Rural Affairs:

<http://www.omafra.gov.on.ca/english/crops/facts/apscab.htm>

University of California Agriculture and Natural Resources:

<http://www.ipm.ucdavis.edu/>

Orchard Pest Management Resources. Oregon State University:

<http://extension.oregonstate.edu/yamhill/orchard-pest-management-resources>

Tree Fruit. Cornell University:

[http://www.fruit.cornell.edu/tree\\_fruit/index.htm](http://www.fruit.cornell.edu/tree_fruit/index.htm)