Pest Management Strategic Plan
for
Caneberry Production
in
Washington and Oregon

Summary of workshops held in 2003 (original) and in 2008 (updated)
Portland, OR (2003)
Aurora, OR (2008)

Author: Tom Peerbolt, Peerbolt Crop Management

Editors: Anna Peerbolt and Beth Robinson, Peerbolt Crop Management

Issued: June 2009

Contact Persons:

Tom Peerbolt
Peerbolt Crop Management
5261 Princeton St.
Portland, OR 97203
(503) 289-7287
tom@peerbolt.com

Joe DeFrancesco
Integrated Plant Protection Center
Oregon State University
2040 Cordley Hall
Corvallis, OR 97331-2915
(541) 737-0718
defrancj@science.oregonstate.edu

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Environmental Protection Agency (EPA) is engaged in the process of re-registering pesticides under the requirements of the Food Quality Protection Act (FQPA). The agency is examining dietary, ecological, residential, and occupational risks posed by certain pesticides. EPA's regulatory focus, currently, is on the organophosphates (Organophosphate), carbamate and suspected B2 carcinogen pesticides. EPA may propose to modify or cancel some or all uses for some chemicals on caneberries. The additional regulatory studies that EPA requires registrants to complete may result in some companies voluntarily canceling certain registrations rather than incurring the additional costs of the required studies. In addition, continued focus on risks of pesticides may lead some caneberry processors to require growers not use certain chemistries.

To facilitate the EPA, the United States Department of Agriculture (USDA) has requested that all commodity groups develop a Pest Management Strategic Plan (PMSP) to identify the critical research, regulatory, and educational needs for their specific commodity. A cross-section of caneberry growers, researchers, university extension service personnel, industry representatives, and crop advisors met for a day and a half workshop in March 2003 to corroborated a draft PMSP and identify critical research, regulatory, and educational needs.

Since that time, some of the pesticides that were commonly used are no longer available, and new, less toxic chemistries have been developed. Also some of the pest management needs identified in 2003 have been met and new needs have been identified. A small group of caneberry growers, researchers, university extension service personnel, industry representatives, and crop advisors met for a one-day workshop to update specific areas of the PMSP (e.g. critical needs, insects and diseases that cause the most harm to caneberries, and pest management needs in each crop stage of caneberry production). The rest of the PMSP updating has been accomplished via small group meetings and email. The result is this completed update of the original document.

In 2003, we noted that the caneberry industry was faced with losing a number of essential chemicals critical for pest management in caneberry production. The loss of some of those chemicals has put more pressure on researchers and growers to find alternative methods of control. At the same time, a number of unproven, newer, low-risk chemistries have become available and continue to be introduced. The caneberry industry faces efficacy and economic uncertainties surrounding these shifts in control strategies. In addition, widespread reductions in funding has reduced or weakened the ability of Land Grant University personnel to conduct field research and extension programs

SUMMARY of the MOST CRITICAL NEEDS in WASHINGTON and OREGON CANEBERRY PEST MANAGEMENT

The following priority areas must be addressed in order to maintain the long-term viability of the caneberry industry.

RESEARCH

- Develop methods for control of insect contaminants in machine harvested fields. A unique problem for caneberry growers is the presence of insect contaminants in harvested fruit caused by the mechanical harvesting methods. Vibrating rods move through the plant canopy causing ripe fruit, along with any insects present, to drop on to a conveyer belt. Many of these insects can be removed by mechanical or visual methods, but some species have characteristics that make this very difficult. The method of choice to prevent this contamination has been broad spectrum insecticide application prior to and during harvest.
- Develop better diagnostics and understanding of vector biology for Black Raspberry Necrosis Virus and other aphid-borne viruses. This is a primary problem for the Willamette Valley growing area in Oregon.
- Develop information on the impact and epidemiology of common aphid-borne viruses of red raspberries and the interaction between these viruses and RBDV. This is a primary problem for the major growing areas in Northern Washington.
- Develop and evaluate economic thresholds for incorporation into forecast models that will predict pest occurrence and severity. Much work remains to be done to help in the decision-making process for pest management.
- Develop strategies, which may include resistant cultivars, for control of Raspberry Bushy Dwarf Virus. Raspberry Bushy Dwarf Virus is the cause of major economic losses for raspberry growers. It causes fruit to become crumbly and unfit for high-end uses. Fields that would normally be productive for ten to twelve years must be removed after four to six years. The virus is vectored by pollinators, making control very difficult.
- Improve diagnostics for virus identification by growers in the field.
- Identify replacements for Diazinon, fenamiphos (Nemacur), Methyl Bromide, and azinphos-methyl (Guthion). These were a priority in 2003. In 2008 these are even more critical due to the loss of all but Diazinon which is now more restricted.
- Develop integrated insect/nematode management practices including: cultural, biological and chemical controls.
- Develop insecticides with shorter PHIs and REIs for use as a cleanup spray to control insect contaminants just prior to or during harvest.
- Develop strategies, which may include resistant cultivars, for control of *Phytophthora* and other Root Rot agents. Root Rot is a major limiting factor in caneberry production, especially in raspberries.
- Develop control strategies for perennial weeds. Quackgrass, Thistle, Equisetum, Nutsedge, and Bindweed are particularly difficult to control with current weed management methods.
- Develop long range investment in new innovative pest management technologies. In order to remain economically viable in a global marketplace, it is necessary to develop practical and realistic long-range goals that include innovative technologies such as

mechanical weed control, precision sprayers, and mechanical primocane removal to reduce cost, improve quality and increase yields.
- Develop an integrated nematode management program that includes cultural, biological and chemical tools. An integrated approach to nematode management has become especially critical due to the recent loss of fenamiphos (Nemacur), which leaves the raspberry industry no effective nematode control options.

REGULATORY

- Streamline the process for registration of pesticides for use on minor crops. The obstacles involved in obtaining a registration for use in minor crops create major pest management challenges for the caneberry industry.
- Strive for more equity in rulings that relate to international trade, minimum residue levels (MRLs), and tariffs. The USA caneberry industry faces increased overseas competition. Issues, such as labor costs and regulatory restrictions, place USA-grown caneberries at a competitive disadvantage. This has become a critical issue for caneberry growers. In addition, shipment of caneberries to overseas markets is increasing and the disparities that currently exist in MRLs between the USA and other countries has created trade barriers; global harmonization of MRLs is becoming an increasing important issue for USA-grown caneberries.
- Allow multiple Section 18s for products that are not only efficacious but also needed for resistance management. More often than not, especially for diseases, more than one product is needed to control an emergency pest outbreak in order to reduce the likelihood of resistance. Current EPA policy does not recognize resistance management as a criterion for issues of multiple Section 18 products.

EDUCATION

- An increasingly critical need for renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet research, education, and information dispersal needs. Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies.
- Full support of the IR-4 Project is needed in order to adequately assist caneberry producers in obtaining minor crop pesticide registrations.
- Education for growers on thresholds, pest identification and IPM techniques. A variety of methods may be used, including workshops, field days, bulletins, videos and CDs, web sites, in-field booklets, etc.
- Continue to educate growers on resistance management for all pesticide types.
- Support and strengthen IPM programs at colleges and universities.
- Keep the USDA/ARS Northwest Center for Small Fruits Research in Corvallis, Oregon

fully funded.

- More grower education need in resistant management strategies because the rapid introduction of new pest management products has not been accompanied by adequate information to insure their long- term viability.

WORKGROUP MEMBERS

(Those with an asterisk participated in the 2003 original workshop. Those with a plus sign participated in the 2008 updating workshop.)

Aaron Bagwell, Whatcom Farmers Coop, Whatcom County, Washington*+
Joe Beaudoin, Caneberry Grower, Southwest Washington*
Henry Bierlink, Washington Red Raspberry Commission, Executive Director*
Wayne Bochsler, Caneberry Grower, Willamette Valley, Oregon+
Paul Borgen, Fieldman for Pratum Coop, Oregon*+
Pete Bristow, WSU Small Fruit Pathologist*
Jess Carkner, Organic Fieldman, Sakuma Brothers, Skagit County, WA*
Steve Carlson, UAP Fieldman, Oregon
Angel Chiri, EPA/BEAD, Washington, D.C. *
Brian Cieslar, Enfield Farms, Agronomist, Whatcom County, WA*+
Len Coop, OSU Entomologist*
Catherine Daniels, WSU Pesticide Coordinator*
Joe DeFrancesco, OSU Pest Management Specialist*+
Rob Dhaliwal, WRRC Commissioner, Caneberry Grower, Whatcom County, WA*
Bill Dinger, RainSweet, caneberry processor, Oregon*+
Jerry Dobbins, Caneberry Grower, Southwest Washington*
Aaron Doum, Blackberry Grower, Oregon*
Tom Egan, Fitzmaurice Fertilizer, Salem, Oregon+
Craig Ford, Townsend Farms, Skagit County, WA*+
Sandy Halstead, EPA Region 10*
Linda Herbst, USDA Western Region Pest Management Center, Assistant Director*
Randy Honcoop, Raspberry Grower, Whatcom County, WA*
Jeffrey Jenkins, OSU/Dept. of Environmental and Molecular Toxicology*
Paul Jepson, OSU/IPM Coordinator*
Diane Kaufman, OSU Caneberry Extension Agent*+
Gina Koskela, OSU Small Fruit Research Assistant*
Rufus La Lone, Fieldman and Entomologist, J.M. Smucker Company*
Jim Love, Blackberry Grower, Oregon*+
Bob Martin, USDA/ARS Small Fruit Virologist*+
Rick Melnicoe, USDA Western Region Pest Management Center, Director*
Steve Midboe, Whatcom Coop Fieldman, Whatcom County, WA*+
Pat Moore, WSU Small Fruit Breeder*
Katie Murray, OSU Pest Management assistant. +
Todd Murray, Whatcom County IPM Program, Whatcom County, WA*
Derek Peacock, Hurst Berry Farm, Sheridan, OR *+
Tom Peerbolt, Peerbolt Crop Management, Fieldman, SW Washington & NW Oregon*+

Anna Peerbolt, Peerbolt Crop Management, Office Manager*+
Jack Pinkerton, USDA/ARS Small Fruit Nematologist*+
Julie Pond, Peerbolt Crop Management, Scouting Supervisor/Research Assistant+
Beth Robinson, Peerbolt Crop Management, Office Assistant, GIS Manager+
Julieann Schedeen, Oregon Caneberry Grower*
Alan Schreiber, Washington State Commission on Pesticide Registration*
Lynell Tanigoshi, WSU Small Fruit Entomologist*
Inga Zasada, USFA/ARS Small Fruit Nematologist+

Major funding for the original project was accomplished through a grant from the USDA Western Integrated Pest Management Center at University of California, Davis. Additional support was provided through the Washington Red Raspberry Commission. The 2008 update was accomplished through a grant from the USDA Western Integrated Pest Management Center at UC Davis. We are grateful for the contributions of these organizations and their active participation in this process.

The mention of any specific product in this document does not represent endorsement by any member or organization within the Caneberry PMSP Work Group.

PRODUCTION FACTS and BACKGROUND

The term "caneberry" is used to describe raspberries and blackberries, their cultivars, and the hybrid berries (a cross between a raspberry and a blackberry), such as Boysenberry and Loganberry. Environmental requirements for growing the crop, production practices, pests, and pest management strategies are oftentimes the same for all the caneberries. However, any differences that do occur between the different caneberries will be highlighted in this document.

Raspberries

There are two major types of commercial raspberries. The vast majority are red raspberries. However, Oregon also produces a sizable crop of black raspberries, also known as black caps. The figures below, unless otherwise noted, refer to the red raspberry crop.

Western Washington

- Washington harvested 55 million pounds of raspberries on 9,600 acres with a value of $92 million in 2008.
- Washington raspberry production accounts for 91% of the nation's raspberry production.
- The entire area of Washington State west of the Cascade Mountains is considered raspberry production area. However, Whatcom County (on the Canadian border) produces 90% of the state total, followed by Skagit County (5%) and Clark and Cowlitz counties combined (5%).

Western Oregon

- Oregon harvested 4.9 million pounds of raspberries on 1,500 acres with a value of $7.8 million in 2008.
- Oregon raspberry production accounts for 9% of the nation's raspberry production.
- The Willamette Valley in Western Oregon is Oregon's major production region.
- Clackamas County growers farm the most acres, followed by growers in Washington, Multnomah and Marion Counties. Other counties with reportable acres are Linn and Yamhill.
- Berry growers in Oregon account for nearly all the nation's processed black raspberries (approximately 2.8 million pounds produced on 1,500 acres with a value of $5.2 million in 2008).

Most raspberries are a biennial plant and produce a crop in early summer in Oregon and Washington. The root system is perennial and plants are capable of living for several years. Their growth habit is to produce vegetative primocanes the first year that then become flowering and fruiting floricanes the second year, which then die. Each established field will contain both primocanes and floricanes at the same time. Under ideal soil conditions and good cultural maintenance, a planting may remain productive for 10 years or more in this region. A small amount of acreage (less than 2%) in Oregon and Washington is devoted to the production of primocane-fruiting raspberries. These plants are also a long-lived perennial but, unlike June-bearing raspberries, produce a fruit crop in late summer and early fall on one-year old canes. Fruit from primocane-fruiting raspberries is usually sold on the fresh market and for U-Pick operations. Pest management concerns and controls are oftentimes the same for June-bearing and

primocane-fruiting raspberries; however, timing of control measures may be different.

Although more than 10 different cultivars are grown commercially, the Meeker cultivar now dominates (80% of planted acres) due to several characteristics, which make it suitable for the processed markets. These include superior yield, good color and fruit firmness, compatibility with machine harvesting, vigorous growth, and relatively low susceptibility to *Phytophthora* Root Rot compared to other cultivars. The Willamette cultivar accounts for 19% of the total acreage, with the balancing acreage of 1% spread over several cultivars that are picked mostly for fresh market sales. Of all the raspberries produced in Washington and Oregon, 85-95% is destined for processing, with the small remainder sold as fresh market.

A raspberry field is established by planting certified, nursery-grown rootstock. Plants are set 2 to 3 ft. apart in rows 10 ft. apart. The first year planting produces vegetative canes only (primocanes). In the fall, these primocanes are trained to a trellis wire about 5 ft. from the ground. In summer of the following season, these overwintering canes (now called floricanes) will flower and produce fruit. It is necessary to bring in honeybees for the 6-week bloom period for adequate pollination to occur. A new flush of primocanes begins to emerge from the root crown area every spring. In order to maximize yield, control cane growth, and reduce fungal disease, many growers practice chemical cane burning to suppress this first flush of primocanes. A second flush of primocanes emerges a month later, growing to 8-12 feet tall by summer's end. Floricanes are cut out each fall after harvest, and the remaining primocanes are tied in bundles and secured to the top trellis wire. Primocane-fruiting raspberries are managed differently; after the last harvest in late fall, canes are mowed to the ground. Next year's fruit crop will be produced on canes that emerge from roots or base of the plant the following spring; chemical cane suppression is not generally practiced. Canes of primocane-fruiting raspberries are not tied to a trellis wire although, sometimes, temporary support wires or twine is use to keep canes upright.

Raspberry canes are maintained in a hedge-type row, which allows for the machine harvesting operation. Less than 5% (Rufus) of the raspberry crop is harvested by hand. The harvest period of about six weeks is intense. During this period, fields are typically harvested once every 2 to 3 days. In some cases, where fruit is destined for the high quality IQF (Individually Quick Frozen) market, fields are picked daily to maximize quality and minimize the potential for *Botrytis* Fruit Rot development.

There are four USDA grade categories in processed raspberries: IQF, preserve, puree, and juice. Both fresh market and IQF growers face the need to harvest a crop that is devoid of insect and mold contaminants (such as caterpillars, weevils, spiders, aphids, and Botrytis). In the case of IQF, the receiving processors generally have a zero tolerance for insect contaminants. Growers also face dockage or rejection for mold. In addition, insect tolerances are very low for preserve/puree grades. Processors can downgrade or reject not only the contaminated shipment, but also the rest of that grower's crop. Fresh market berries have a short shelf life and are highly perishable. There are a couple of different marketing avenues for fresh market: (1) picked, boxed, and shipped out of state; (2) sold locally either at a farmer's market or roadside stand. In Northern Washington's Whatcom and Skagit counties raspberry beetle, aphids and weevils are the major contaminants. In southwest Washington and Oregon the major contaminants are

leafrollers and weevils. Insecticides used as pre-harvest clean up sprays are driven by the presence of these contaminants.

Among the diseases requiring fungicide applications are Fruit Rots and Phytophthora Root Rot, Spur Blight, Yellow Rust, Anthracnose, Cane Blight and Cane Botrytis. Perennials represent the major weed problems, particularly Quackgrass, thistle, Nutsedge, Horsetail and dandelion. Annual weeds such as annual chickweed, groundsel, pigweed and nightshade are also a problem.

The raspberry industry has been proactive in pursuing Integrated Pest Management (IPM) strategies, although growers are partially limited by the need to treat fields prior to harvest with a broad spectrum insecticide to control fruit-contaminating insects, since the harvested fruit must conform to processor/buyer, USDA specifications.

Blackberries

- In 2008, Oregon growers produced 39.2 million pounds of blackberries on 6,300 acres, with a farm-gate value of about $23 million.
- Oregon leads the nation in blackberry production, accounting for over 90% of the production.
- Most notable blackberry cultivars in order of poundage are: Marion, Oregon Thornless Evergreen (commonly referred to as Evergreen), and Boysen.
- The 'Marion' blackberry (commonly referred to as "Marionberry" accounts for approximately two-thirds of the total blackberry crop.
- Blackberries, at present, are not a large commercial crop in Washington.

Almost all of Oregon's blackberries are grown west of the Cascade Mountains in the Willamette Valley. Marion County has the most blackberry acreage in the state (approximately 50%), followed by Clackamas County (approximately 20%). Other Willamette Valley counties producing blackberries include Benton, Lane, Linn, Multnomah, Polk, Washington and Yamhill.

Like raspberries, blackberries are perennial plants that produce fruit on biennial canes: The canes grow one year (primocanes) and produce fruit the following year (floricanes). The floricanes die after they have fruited. New canes are produced each year from the roots or the base of old canes. These primocanes are kept on the ground and allowed to grow throughout the season, generally reaching a length of 10 to 20 feet long. The floricanes are removed each year after harvest. The new primocanes, which will fruit the following year, need to be trained to a trellis of posts and wire. Depending on the production system (below), training is completed by late summer, or late winter prior to bud-break. A trellis system is necessary to support the canes and subsequent fruit load, and help facilitate harvesting with a harvesting machine.

Some blackberry acreage is converted to an alternate-year (AY) system of production after the first few years of every-year (EY) production. The AY system allows plants to produce fruit once every two years, instead of annually. Resultant yields can be 120 – 150% of EY production systems during the "up" cropping year. In an AY system, both floricanes and primocanes are cut and removed after harvest. Subsequently, only primocanes are produced the following year, with a fruit harvest the next year. This can reduce production costs with labor savings (floricane

removal and primocane training is quicker and easier), and fewer pesticide and fertilizer inputs in the non-bearing year. Regardless of type of production system, harvest season lasts about 4 weeks with the method of harvest determining the picking intervals. Picking intervals are every four to five days for mechanically harvested fruit; every seven to ten days for handpicked fruit. Harvest begins in early July for most blackberry cultivars; however, harvest of Oregon Thornless Evergreen and other late-ripening cultivars begins in mid-August.

Ninety to 95% of the blackberry crop is processed into pack styles similar to red raspberries (IQF, preserve, puree, or juice) with the remainder being sold for fresh market. Fresh market berries are sold locally or shipped within the USA, while processed berries are sold and used nationally and internationally.

Blackberries are sensitive to cold winter temperatures and hot summer temperatures, each of which can have an adverse effect on yield and fruit quality.

FOUNDATION for this PEST MANAGEMENT STRATEGIC PLAN

The remainder of this document is an analysis of pests and pest management during the various growth stages of caneberries. Key management practices and their alternatives (current and potential) are discussed. In this document, product names are mentioned and rates may be given for chemical controls but should not be relied upon, as rates, labels, and registrations often change. Differences between production regions in Washington and Oregon, or between the different types of caneberries, are discussed where appropriate.

Caneberry growers are working toward using an integrated approach to pest management, being mindful that cultural, biological and chemical management tools can be used alone or in combination with one another to achieve satisfactory results. Scouting and monitoring are practiced in caneberry fields and help determine the occurrence and population levels of a pest. If control measures are deemed necessary, they are then applied and properly timed to affect the most venerable stage of the pest. When it is determined that a chemical pesticide is needed to control a certain pest, growers consciously choose a product that is not only effective in controlling the particular pest but is the least toxic to mammals, vertebrates, aquatic life, and the environment. The protection and conservation of natural predators and beneficial insects and mites that may be present in their fields and the surrounding areas are considered, and the least toxic product is chosen. Cover crops are also commonly used to enhance habitat for natural predators that may provide enough pest control so chemical or other controls are not needed.

Caneberries have a wide array of disease, insect, nematode and weed pests. The raspberry and blackberry industries of Oregon and Washington fund research in each of these four pest categories; however, there exists insufficient research funds to support research progress on all pests. Subsequently, little is known about the life cycle, ecology and control of many caneberry pests. Great potential exists for chemical and non-chemical control of caneberry pests but, until significant new research funding becomes available, many caneberry pest management questions remain unanswered.

Due to the relatively small size of the caneberry industry in the USA, and the increasing cost to obtain a pesticide registration, agrochemical companies are reluctant to register a pesticide for use in caneberries. The caneberry industry is heavily dependent on the IR-4 Project for pesticide registrations. The cost associated with pesticide re-registrations, or for defending existing pesticide registrations due to the Food Quality Protection Act, has placed an additional burden on the caneberry industry. Seeking relief from the high cost of obtaining and maintaining pesticide registrations is a high priority for the caneberry industries of Oregon and Washington.

Effective insect, disease, nematode and weed management relies upon excellent feedback and communication between growers, university extension service personnel, researchers and crop consultants. Growers and others who are a part of the caneberry industries of Oregon and Washington have expressed concern about the continued attrition of university extension services, which breaks this feedback loop. Reversal of this decline is considered to be a critical issue for progress with IPM. Without the two-way exchange of information, the relevance and timeliness of research suffers, and implementation is delayed. The impact of reduced university extension capacity should be acknowledged and measured, and taken into account by regulatory

agencies. Progress in the areas of research and education that are itemized in this document will rely upon maintaining, in the future, the partnership between growers, university extension service personnel, crop consultants, and research

Pests and Management Options by Crop Stage

I. NEWLY ESTABLISHED PLANTINGS

Soil samples are often taken prior to planting to determine fertility levels and pH of the soil. Lime can be incorporated pre-plant if analysis reveals the need to increase the soil pH. Phosphorous and other fertilizers can also be incorporated at this time. A soil test to determine nematode population and Verticillium should be taken prior to planting; fields with significant levels of nematodes, especially the Dagger nematode, should be avoided or treated pre-plant with a soil fumigant.

In preparation for planting, the soil is worked to produce a smooth surface. Subsoiling is often completed prior to disking. Tissue culture plants are commonly used to establish red and black raspberries and are planted in early spring. Growers generally establish new blackberry plantings by propagation from rooted “tips” of primocanes. The plants grow vegetatively the first year and will produce a "baby crop" on those canes the second year. In some regions, however, growers don't harvest the baby crop but will wait until the third year to harvest a full crop. In Northern Washington, where raspberry growth is more vigorous, the baby crop is harvested. Irrigation is recommended after planting and periodically, as needed, until rainfall begins in early fall.

The use of a pre-plant soil fumigant is recommended and a common practice in many regions where the soil is known to contain soil dwelling pests and the choice of planting ground in limited. Soil fumigation not only helps control these pests so the planting can get established and be productive for many years, it is also a critical need for those growers who also propagate and sell caneberry planting stock; regulations require that plants for sale be free of pests. Methyl-bromide had been the soil fumigant of choice because of its consistent, effective, reliable results in controlling a wide range of soil pests (insects, nematodes, diseases, and weeds). It is most commonly used in combination with Chloropicrin to increase its activity on additional fungal pathogens. However, the production of Methyl Bromide in the USA has been phased out and it is no longer available or allowed as a pre-plant soil fumigant in most crops, including caneberries. Finding a suitable, cost-effective alternative to Methyl Bromide is a high priority for caneberry growers.

FARMING ACTIVITIES

The following farming activities take place during the pre-plant through planting period for newly established plantings:

- Soil testing for nutrients, nematodes, Verticillium.
- Establish cover crop and removal
- Drain tile installation, if needed
- Liming, if needed
- Seed bed preparation
- Pre-plant soil fumigation for insect, disease, nematode, and weed control
- Install irrigation
- Planting (mechanical - 5%, hand - 95%)
- Irrigation

- Fertilization
- Herbicide application
- Scouting

INSECTS

Soil-dwelling pests, such as symphylans, root weevil larvae and cutworm larvae, may be present in soil intended for caneberry production. Pre-plant soil fumigation is primarily used for nematodes and will also provide good insect control.

Chemical control:

- **Dazomet** (Basamid) Efficacy ranges poor to good. Used little.
- **1, 3-Dichloropropene** (Telone II) or **1, 3-Dichloropropene + Chloropicrin** (Telone C17, C35) Pre-plant soil fumigation. Excellent control.
- **Methyl Bromide/Chloropicrin** *(The present restrictions and phasing out of Methyl Bromide make this use virtually impossible at this time).* Pre-plant soil fumigation. Excellent control.
- **Sodium Methyldithiocarbamate** (Vapam) Efficacy is rated poor to good. Pre-plant soil fumigation. Efficacy dependent on soil type, moisture, application method.

Biological control:

- None

Cultural control:

- Pre-plant: Disking can kill the majority of in-field weevil and cutworm populations.

Aphids

Amphorophora agathonica

In the northern, cooler growing areas, it is a common practice to treat for aphids during the establishment year to prevent an economic reduction in plant vigor caused by their feeding. In the warmer, southern areas this practice is uncommon.

Chemical control:

Organophosphate

- **Diazinon** As a result of EPA's review of organophosphates, only one application of Diazinon per season is allowed, which limits its use for aphids if it is needed for raspberry beetle or raspberry crown borer control. Efficacy is good to excellent.
- **Malathion** Efficacy is excellent for quick knock down but offers no residual control.

Pyrethroids

- **Bifenthrin** (Brigade and other brandss) Use can cause a mite flare-up. Potential resistance because of heavy use for control of other pests. Efficacy is excellent.
- **Esfenvalerate** (Asana XL) Efficacy is fair to poor.

Other

- **Imidacloprid (**Admire-Pro) soil applied formulation or (Provado and other brands) foliar applied formulation. Efficacy is excellent.
- **Oxydemeton-methyl (MSR)** For use in Washington on non-bearing caneberries only. Efficacy is excellent.
- **Potassium salts of fatty acids** (M-Pede and other brands) Efficacy is poor to fair. Organically approved.
- **Spinosad** (Success) Efficacy is poor. Not used by growers for aphids.
- **Thiamethoxam (**Actara) Efficacy is excellent.

Biological control:

- None

Cultural control:

- Enhance habitat for beneficials. Used, but not a stand-alone management tool.

<u>Critical Needs for Insect and Mite Management in Newly Established Plantings:</u>

Research:

- Preplant insect controls with insecticide incorporation.
- Identify preplant fumigant alternatives for insect control.

Regulatory:

- Expedite the registration of Platinum (soil-applied thiamethoxam) for aphid and root weevil larvae control.

Education:

- Provide information to growers about pre-plant scouting, insect identification and thresholds (when developed).
- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

DISEASES

Some disease organisms reside in the soil and will infect caneberries once they are planted. Sites with a history of these diseases are best avoided when considering caneberry production. However, certain cultural practices, as well as biological and chemical controls, can help mitigate the negative effects of these diseases.

Armillaria Root Rot

Armillaria spp.

This native soil fungus is often found on newly cleared land: but rarely affects caneberry production. Fresh sawdust mulch may also contain the pathogen. White, felt-like masses of the fungus grow beneath the cambium layer of the lower canes. Leaves decline and turn yellow, wilt, and die. This may occur on only one side of the plant or in only one or two canes per hill.

Chemical control:

- **Chloropicrin *Only used as a combination product.*** *(The present restrictions and phasing out of Methyl Bromide make this use virtually impossible at this time).* Pre-plant soil fumigation. Fumigate when soil is warm, preferably the summer prior to spring planting. Good control.
- **Methyl Bromide/Chloropicrin** *(The present restrictions and phasing out of Methyl Bromide make this use virtually impossible at this time).* Pre-plant soil fumigation. Fumigate when soil is warm, preferably the summer prior to spring planting. Good control.

Biological control:

- None

Cultural control:

- Avoid movement of soil to reduce the spread of the disease.
- Avoid use of sawdust for mulch.
- Infected plants and native vegetation should be removed and destroyed. Be certain to remove all roots pencil-size or larger from the soil.

Black Raspberry Necrosis Virus (BRNV)

Black raspberry is the only caneberry that displays symptoms from this virus and can be very severely impacted. Red raspberry and blackberry are symptomless when infected with BRNV by itself. Recent collection from the wild of black raspberry selections that display very good aphid resistance increases that potential of future cultivars that could incorporate this trait.

Chemical control:

- Possible benefits from control of the aphid vector. See aphid control options.

Biological control:

- None

Cultural control:

- Isolation from other *Rubus* fields is advantageous. However, since this virus is common in native *Rubus spp*. inoculum sources are almost always nearby in the Pacific Northwest, west of the Cascade Mountains.
- Virus-free planting material.

Crown and Cane Gall

Agrobacterium tumefaciens and A. rubi

All caneberries are susceptible to Crown and Cane Gall, but blackberries (in particular Boysen and Evergreen) are especially sensitive to this bacterial disease. Infection is through cane or crown injuries. Symptoms are small rough areas of gall tissue; galls can cause canes to split open.

Chemical control:

- **1, 3-Dichloropropene** (Telone II) or **1, 3-Dichloropropene + Chloropicrin** (Telone C17, C35) Pre-plant soil fumigation. Fair to good control.
- **Gallex**- painted on very young galls to reduce further development. Galls may return the next year or, if treated late, may continue to develop. Efficacy is fair.

Biological control:

- **Agrobacterium radiobacter K84 or K1026.** (Galltrol-A, Nogall). Efficacy is fair to excellent. Dip roots and crown area prior to planting. This only provides protection for the specific roots/root hairs treated by the dip. As root development occurs, the disease can infect new tissue if it is present in the soil.

Cultural control:

- Avoid susceptible varieties.
- Inspect planting stock carefully for evidence of gall.
- Plant certified nursery stock or tissue culture plants. If this technique is utilized, plant into fumigated soil to minimize likelihood of infection.
- Take care not to injure plants when planting to prevent sources of infection.

Root Rot

Phytophthora spp.

Most caneberries can get Root Rot, but red and black raspberries are especially susceptible while blackberries are resistant. In raspberries, Root Rot is arguably the most important factor limiting plantings especially in area of heavy soils or poor drainage. Roots become rotted and lack fibrous roots; canes and leaves on mature plants wilt, turn yellow and die. Experience shows that fumigation delays the onset of disease but does not cure it.

Chemical control:

- **Chloropicrin** only used as a combination product (i.e. with Telone, Methyl Bromide), but is the primary control for phytophthora. Efficacy of Methyl Bromide combination is good to excellent. Serious industry concerns due to proposed restrictions.

- **1, 3-Dichloropropene** (Telone II) Efficacy is good. In widespread use; relied upon heavily in raspberry production. Serious concern about possible future use restrictions.
- **1, 3-Dichloropropene + Chloropicrin** (Telone C17, C35) Pre-plant soil fumigation. Efficacy is rated as fair. In widespread use; relied upon heavily in raspberry production. Serious concern about restrictions.
- **Mefenoxam** (Ridomil Gold) Efficacy is fair – excellent. Applied at planting. Registered for use in raspberries only. High risk of resistance due to continual high use and no good alternative controls. Resistance is suspected on some sites with long-term usage patterns.
- **Methyl Bromide** Critical use exemption for nursery production. Under continuous review by government agencies. Efficacy is rated as fair.
- **Sodium Methyldithiocarbamate** (Vapam) Fair to poor efficacy. May be applied through an irrigation system. The chemical does not penetrate deep enough into the soil to be effective. Control can be very spotty.

Biological control:

- None

Cultural control:

- Certified planting stock.
- Improve drainage and/or avoid poorly drained fields.
- Incorporation of calcium (gypsum or lime) to raise concentration of calcium has been shown to inhibit the spread of the disease.
- Plant in soil that has not grown caneberries for several years.
- Plant on raised beds.
- Planting resistant cultivars may be an option in some situations.
- Solarizing the soil before planting can delay the onset of the disease for up to two years.

Tomato Ringspot Virus (ToRSV)

The virus is vectored by nematodes (*Xiphinema americanum*) and spread within a field is usually slow. Nematodes can be moved on any equipment that moves soil including wheels of harvesters, sprayers, tractors etc. Even though the virus moves slowly through a field it can have a devastating impact on production. Plants grow very poorly, producing few short canes with small crumbly fruit.

Chemical control:

Soil fumigation prior to planting kills the nematodes in the upper layer of soil and will give a few years of protection. However, the nematodes down lower in the soil are not killed and thus the vector and virus can survive.

- **Chloropicrin** in combination with other fumigants (i.e. Telone, Methyl Bromide). Chloropicrin is now facing major new use restrictions. Very good control.
- **1, 3-Dichloropropene** (Telone II) Excellent control. In widespread use; relied upon heavily in raspberry production. Serious concern about possible future use restrictions.
- **Methyl Bromide** Critical use exemption for nursery production. Under continuous review by government agencies. Efficacy is excellent.
- **Sodium Methyldithiocarbamate** (Vapam) Fair to poor control. May be applied through

an irrigation system. The chemical does not penetrate deep enough into the soil to be effective. Control can be very spotty.

Biological control:

- None

Cultural control:

- None

Verticillium Wilt

Verticillium dahliae and *V. albo-atrum*

Black raspberries are especially susceptible to this disease. New canes often wilt and bluish stripes or ribbons of infected tissue may extend up the canes from the ground. Leaves can wilt or take on a scorched appearance. Plants decline and eventually die. Interaction with the Root-Lesion Nematode can increase disease incidence and severity.

Chemical control:

- **Metamsodium** (and other brands) Used as a pre-plant soil fumigation treatment. Efficacy is only fair.
- **Methyl Bromide** Critical use exemption for nursery production. Under continuous review by government agencies. Efficacy is rated as fair.
- **Methyl Bromide/Chloropicrin** Pre-plant soil fumigation. Fair to good control. (Restrictions on the availability and usage of Methyl Bromide have made its use for field control of Verticillium in caneberries virtually impossible.)

Biological control:

- None

Cultural control:

- Avoid planting black raspberries in soil where other Verticillium-susceptible crops (e.g. tomatoes, hops, potatoes) were grown. Efficacy fair to good.
- New over old training techniques (efficacy needs more research).
- Rotations using non-susceptible grasses and cereals can help suppress the disease. But disease spores can survive for many years. Efficacy rated as fair to unknown.
- Use certified planting stock to prevent inoculating virgin ground.
- Use resistant/ tolerant cultivars.

Critical Needs for Disease Management in Newly Established Plantings:

Research:

- Develop better sampling strategies for Verticillium, *Phytophthora* and other Root Rots.
- Develop better management for Crown Gall.
- Develop more effective controls for Phytophthora (Root Rot), including tolerant cultivars.

- Develop alternative techniques (such as cover crop use) for the management of soil borne organisms.
- Develop techniques for Verticillium management.

Regulatory:

- Expedite Methyl Bromide alternatives.

Education:

- Since the original caneberry PMSP was created in 2003, we have seen a reduction in the funding and a dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dissemination needs.
- Need for grower accessibility to updated efficacy tables. (Similar to what is done with weed control).
- Educate growers on how to use new chemistries and resistance management.

WEEDS

In a long-lived crop like caneberries, control of weeds, especially perennial weeds, is critical prior to planting. In prospective fields, perennial weeds are often treated with a systemic herbicide, such as glyphosate, in the fall or spring prior to planting. Control of annual weeds prior to planting is accomplished by disking the field several times, allowing annual weeds to germinate between diskings. A newly planted field will be treated with a pre-emergence herbicide. Several herbicides are registered for use in non-bearing caneberries, which provide additional options for weed control in newly planted fields if a crop won't be harvested for more than 365 days after application.

Treatment of row middles varies widely. Middles are sometimes planted to a permanent sod and mowed periodically. Other growers choose to keep row middles vegetation-free and accomplish this by cultivating periodically throughout the growing season or disking and then treating with a pre-emergence herbicide. In nearly all cases, growers apply herbicide treatments in a banded area (approx. 3 feet wide) directly over the planted row to reduce cost and minimize environmental impact.

Chemical control:

- **Bentazon** (Basagran) Postemergence. Non-bearing only. Temperatures below 55°F, drought, or rain within 8 hours will reduce activity.
- **Clethodim** (Prism or Select) Postemergence. Non-bearing crops. Controls grasses only. Fair to good control of quack and annual bluegrass.
- **Fluazifop** (Fusilade DX) Postemergence. Non-bearing crops. Controls grasses only. Annual bluegrass and all fine fescues are resistant. Good control of other grasses.

- **Flumioxazin** (Chateau) Pre-emergence. Non-bearing only. New label and not a lot of grower experience. Caution is being advised on root plantings due to potential damage as well as making sure that new shoots have not emerged. Could be good rotation material to manage resistance.
- **Glyphosate** (numerous names) Non-selective, postemergence, 14 day PHI. Herbicide damage from Glyphosate drift or misuse is fairly common in caneberries. Fair to good control and useful but requires supervision and training to prevent damage.
- **Isoxaben** (Gallery 75 DF) Preemergence. Non-bearing only. Controls several broadleaf weeds; will not control grasses. Partially suppresses field Bindweed and Curly Dock. Fair to good control.
- **Napropamide** (Devrinol) Preemergence. Effectiveness is limited if not incorporated with irrigation or rainfall either while applying or very soon after application. Performance is also reduced by excessive plant residue on soil surface. Primarily a grass herbicide. Efficacy is poor to good.
- **Oryzalin** (Surflan) Preemergence. Good control and safe for small plants. In wide usage.
- **Paraquat (**Gramoxone Extra or Gramoxone Max) Non-selective, postemergence, contact herbicide. Window for use is usually just before primocane emergence in spring and in newly established crops this is a difficult window to use since the new growth emerges so early. Damage can occur to new primocane shoots if present when applied.
- **Sethoxydim** (Poast) PHI 45 days. Postemergence. Controls grasses only. Long PHI limits use even though it's the only grass specific herbicide that can be used in established caneberry plantings. Resistant grasses include annual bluegrass and all fine fescues, but Quackgrass can be suppressed. Efficacy is fair- good, if label application directions are followed closely.
- **Simazine** (Simazine 90 WDG or 90DF, Princep Caliber90, Simazine 4L) Inexpensive. Pre-emergence. Poor to good control. In widespread use. Should be used only when soil around roots has settled and new planting has been established for several weeks, due to phytotoxicity.

Biological control:

- None

Cultural control:

- Cultivation
- Flaming
- Hand hoeing

<u>Critical Needs for Weed Management in Newly Established Plantings:</u>

Research:

- Research on resistance management for current herbicides.
- New control measures for hard to control perennials. (Nutsedge, Bindweed, Horsetail, and Canada thistle.)
- Screening for new herbicides especially those with different modes of action.

Regulatory:

- Expedite the registration of herbicides that are in the IR-4 pipeline, such as halosulfuron, rimsulfuron and flumioxazin.

Education:

- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

NEMATODES

There are two genera of plant-parasitic nematodes that can cause damage in Oregon and Washington raspberry fields: the Root-Lesion Nematode (*Pratylenchus penetrans*) and the Dagger nematodes (*Xiphinema americanum* and *X bakeri*). Root-lesion nematodes cause direct damage to root tissue. The Dagger nematode (*X. americanum*) causes little or no direct root damage but is capable of transmitting *Tomato ringspot virus* which, even at low population levels, can reduce raspberry growth and cause crumbly fruit. *Xiphinema bakeri* causes direct root damage to red raspberries.

Dagger Nematode

Xiphinema americanum

The Dagger nematode is a migratory ectoparasite found only in the soil. It can vector Tomato ringspot virus (ToRSV).

Chemical control:

Preplant soil fumigation, preferably in the fall, is necessary to control Dagger nematodes. Growing a shallow-rooted grass crop for 1 to 2 years will bring nematodes to upper soil levels where fumigation more easily controls them.

- **1, 3-Dichloropropene** (Telone II) Excellent. In widespread use; relied upon heavily in raspberry production. Concern about restrictions.
- **Chloropicrin** in combination with other fumigants (i.e. Telone). Chloropicrin is now facing major new use restrictions. Efficacy: excellent.
- **Methyl Bromide** Critical use exemption for nursery production. Under continuous review by government agencies. Efficacy: excellent.
- **Sodium Methyldithiocarbamate** (Vapam) May apply through an irrigation system. Fair to Poor. The chemical does not penetrate deep enough into the soil to be effective.

Biological control:

- Biological control products are available in the marketplace, but have not been effective in research studies on caneberries.

Cultural control:

- Grow a shallow-rooted grass crop (i.e. fescue, orchard grass), free of broadleaf weeds, for 1 to 2 years to manage ToRSV (vectored by *X. americanum*). *Xiphinema americanum* population densities will increase on grass crops.
- Test soil for *Xiphinema* spp. nematode prior to planting.
- Use certified planting stock.
- Weed-free fallow for 2 or more years (if practical) or rotate with *X. americanum* nonhost crop for 12-18 months such as brassicas.

Root-Lesion Nematode

Pratylenchus penetrans

These nematodes are migratory endoparasites; part of the population is in soil and part is in the roots at all times. Infected plants are dwarfed, off-color, and grow poorly.

Chemical control:

Preplant soil fumigation, preferably in the fall before spring planting.

- **1, 3-Dichloropropene** (Telone II) Excellent control. In widespread use; relied upon heavily in raspberry production. Serious concern about restrictions.
- **Chloropicrin** in combination with other fumigants (i.e. Telone). Chloropicrin is now facing major new use restrictions. Excellent control.
- **Methyl Bromide** Critical use exemption for nursery production. Under continuous review by government agencies. Excellent control.
- **Sodium Methyldithiocarbamate** (Vapam) Fair to poor control. May be applied through an irrigation system. The chemical does not penetrate deep enough into the soil to be effective.

Biological control:

- Biological control products are available in the marketplace, but have not been effective in research studies on caneberries.

Cultural control:

- Saia Oats, Marigold, and Canadian Pearl Millet have been shown to suppress *P. penetrans* in research trials. However, the economics and practicality of these crops in the Pacific Northwest and in caneberry production systems requires evaluation.
- Test soil for *P. penetrans* prior to planting.
- Weed-free fallow for 2 or more years (if practical) or rotate with *P. penetrans* nonhost crop for 12-18 months such as brassicas. Fair control.
- Use certified planting stock.

Critical Needs for Nematode Management in Newly Established Plantings:

Research:

- Evaluate use of cover crops for nematode control.
- Screen for resistant and tolerant cultivars.

- Identify and register pre and post-plant nematicides and fumigants.
- Development of diagnostic protocols for the detection of virus in *X. americanum* based upon previously developed techniques.
- Study the epidemiology of nematode-transmitted virus to improve disease management.
- Refine plant-parasitic nematode thresholds for caneberries.

Regulatory:

- Continue to monitor regulatory changes in fumigant use and registration.

Education:

- Continue to educate growers on sampling, monitoring and thresholds.
- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

II. DORMANCY to PRE-BLOOM

The start of the bloom period differs between raspberries and blackberries as well as between different blackberry cultivars. Also, Northern Washington tends to be 10 – 14 days later than Southern Washington and Oregon in budbreak and initiation of bloom.

Early-December to Early May
Raspberries -- Southwestern Washington
Early-December to Mid-May
Raspberries -- Northwestern Washington
Raspberries, black raspberries, and most blackberries – Oregon
Early-December to Late- June to Early-July
Evergreens and other late-ripening blackberries – Oregon

FARMING ACTIVITIES

The following farming activities, many that are pertinent to AY production systems on a calendar basis, may take place during the dormant to pre-bloom period:

- Pruning and tying canes to trellis wire
- Maintain raised beds
- Subsoil row middles to improve drainage
- Soil testing
- Herbicide application
- Fertilization
- Replanting, if needed
- Cane suppression
- Tuck raspberry primocanes under training wires
- Peg primocanes out of the row middles (in EY blackberry production)
- Train new canes (in AY blackberry production)
- Irrigation
- Insecticide applications
- Fungicide applications
- Hand hoeing, as needed
- Scouting and monitoring for insects, diseases, and weeds.
- Mowing or cultivating row middles, as appropriate
- Rodent control (dormancy use only)

INSECTS AND MITES

Aphids

Amphorophora agathonica

In the northern, cooler growing areas, treating for aphids to prevent an economic reduction plant vigor caused by their feeding is more common than in the warmer, southern areas.

Chemical control:

Organophosphate

- **Diazinon** As a result of EPA's review of organophosphates, only one application of Diazinon per season is allowed, which limits its use for aphids if it is needed for raspberry beetle or raspberry crown borer control. Efficacy good to excellent.
- **Malathion** Efficacy is excellent.

Carbamate

- **Carbaryl** (Sevin). Efficacy is poor.

Pyrethroids

- **Bifenthrin** (Brigade and other brands) Use can cause a mite flare-up. Potential resistance because of heavy use for control of other pests. Toxic to pollinators. Efficacy is excellent.
- **Esfenvalerate** (Asana XL) Can cause a mite flare-up. Rarely used in this period.

Other

- **Imidacloprid (**Admire-Pro).- Soil applied formulation. Or (Provado and other brands): -- Foliar applied formulation. Efficacy is fair.
- **Potassium salts of fatty acids** (M-Pede and other brands) Efficacy is poor to fair. Organically approved.
- **Spinosad** (Success) Efficacy is poor.
- **Thiamethoxam** (Actara) Efficacy is excellent.

Biological control:

- None

Cultural control:

- Enhance habitat for beneficials. Used, but not a stand-alone management tool.

Armyworms and Climbing Cutworms

Many species

Larvae may be present as buds begin to swell and open although this is rarely economic. Active at night, they can feed on the buds and new growth. Infestations are usually spotty within a field. While rare if present at high enough levels, their feeding can significantly reduce yield.

Chemical control:

Organophosphate

- **Diazinon** An overall limit of 2lb a.i./acre for an entire season, with the option of allocating the limited amount toward soil drench and/or foliar application, impacts the use of this material for cutworm management. Efficacy is fair to good.

- **Malathion** Not as efficacious as others (fair) under cooler temperatures. Very toxic to pollinators and parasitic wasps.

Carbamate

- **Carbaryl** (Sevin) Seldom used for this purpose. Efficacy is fair.

Pyrethrum

- **Pyrethrin** (Pyganic) Organically approved. Efficacy is poor to fair.

Other

- **Spinetoram** (Delegate) New label. Looks promising. Very similar to Spinosad. Limited experiences but will likely replace Spinosad. Toxic to bees if not dried. Can be used at night if dried by morning.
- **Spinosad** (Success) Entrust formulation is approved for organic production. Efficacy is good to excellent on small to medium-sized larvae. Not effective on larger larvae.
- **Tebufenozide** (Confirm) Efficacy is good.

Biological control:

- ***Bacillus thuringiensis*** (Bt). Efficacy is good if caterpillars are small.

Cultural control:

- Conserve natural predators such as carabids.

<u>Dryberry Mite</u>

Phyllocoptes gracilis

Dryberry Mite is an occasional problem in blackberries only. Affected berries turn red, then brown and dry; the whole fruit may be dry or just patches on the fruit. Control best achieved with a delayed dormant application.

Chemical control:

Organophosphate

- **Diazinon** Not very effective.

Other

- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Efficacy is good to excellent.
- **Elemental sulfur** (several types and brands). Organically acceptable. Efficacy is good.

Biological control:

- None

Cultural control:

- None

<u>Leafrollers</u>

Obliquebanded leafroller *(Choristoneura rosaceana)*
Orange Tortrix *(Argyrotaenia franciscana)*
Other species of leafrollers can also be minor or spotty contributors to the problem

Leafrollers are one of the major reasons for insecticide use, especially in Oregon and Southern Washington. Various species of leafroller larvae web and feed on caneberry foliage. This damage in itself is rarely economic, but larvae, if not controlled prior to harvest, can contaminate hand-picked and machine harvested fruit. Obliquebanded leafroller (OBLR) is the dominant species in Whatcom County, Washington; whereas Orange Tortrix (OT) dominates in Skagit, Clark, and Cowlitz counties of Washington, as well as Oregon's Willamette Valley.

Chemical control:
Evaluation of control efficacy can be difficult, as egg hatch following treatment can mask effectiveness.

Organophosphate

- **Diazinon** As a result of EPA's review of organophosphates, only one application of Diazinon per season is allowed, which limits its use for leafrollers if it is needed for raspberry beetle or raspberry crown borer control. Limit of 2 lb a.i./acre for an entire season, with the option of allocating the limited amount toward soil drench and/or foliar application. Efficacy is good to excellent.
- **Malathion** Not as efficacious as others under cooler temperatures. Very toxic to pollinators and parasitic wasps. Fair to good.

Carbamate

- **Carbaryl** (Sevin) Use can cause a mite flare-up. Poor adulticide. Works better in warmer temperatures. Hard on beneficials and pollinators. Widespread use due to cost effectiveness and availability to growers who don't have restricted use license. Efficacy is fair to good.

Pyrethrums and Pyrethroids

- **Bifenthrin** (Brigade and other brands) Use can cause a mite flare-up. Can be used once pre-bloom and once post-bloom only. Widely used as clean up spray (pre-harvest) rather than in this early season window. Toxic to parasitic wasps. Efficacy is excellent.
- **Pyrethrin** (Pyganic) Pyganic is OMRI approved for organic production. Efficacy is good for quick knock down but very hard on beneficials. Can cause a mite flair-up.
- **Zeta-cypermethrin** (Mustang) Use comparable to Bifenthrin. Efficacy is believed to be good, but little grower experience. This is not in widespread use yet, but could be a good fit because of restrictions on the number of Bifenthrin applications allowed.

Other

- **Spinetoram** (Delegate) Similar to Spinosad. New product; limited grower experience but will probably replace Spinosad in market. Toxic to bees if not dried. Can be used at night if dried by morning.
- **Spinosad** (Success or Entrust) Entrust is the organic formulation. Effective. Commonly used. Toxic to some beneficials such as parasitic wasps.
- **Tebufenozide** (Confirm) Effective in this early window.

Biological control:

- ***Bacillus thuringiensis*** (Bt) various labels have various rates. Widely used but difficult to get control when relied upon exclusively due to caterpillars being in rolled leaves and product doesn't get to them. Most effective on early instars. Approved for organic production. Efficacy: good.

Cultural control:

- Keep crates from damp soil/grass
- Pruning techniques (new over old)
- Sanitation
- Weed control

Mites

Twospotted Spider Mite *(Tetranychus urticae)*
Yellow Spider Mite *(Eotetranychus carpini borealis)* and others
Mites are not a problem in trailing blackberries, although they can be an occasional problem in erect and semi-erect blackberries. Both mite species are major economic pests in raspberries. There are very few mite control applications needed in this early season window.

Chemical control:

- **Bifenazate** (Acramite-50WS) Allowed one application per year. Works well with Savey.
- **Bifenthrin** (Brigade and other brands) Good to excellent efficacy on adults and nymphs but does not affect eggs. Since it kills most natural control agents but leaves mite eggs intact. Mite flair-up can follow.
- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Used at delayed dormant stage. Efficacy fair to good.
- **Hexakis (50%) or Fenbutatin-oxide** (Vendex 50WP) PHI 3 days. Takes up to 10 days to work. Not as effective in cool temperatures. Safe for beneficials. Registered for raspberries only. Efficacy good to excellent.
- **Hexythiozox** (Savey 50 WP) Expensive. Ovicidal only. Good to excellent control of next generation. Safe to beneficials. Works well tank mixed with Acramite.
- **Horticultural oils** can be effective for early budbreak infestations. Efficacy is rated as good.
- **Potassium salts of fatty acids** (M-Pede) Poor efficacy, short residual. Organically approved.

Biological control:

- **Anthocoris (**naturally occurring). Can purchase for inoculative releases but too expensive to be practical. Excellent naturally occurring control in many areas.
- **Predatory mites** (naturally occurring and can be purchased for release). Inundative releases of predatory mites are not practical. Naturally occurring predatory mite populations can be a major factor in mite management at this stage. Inoculative releases are occasionally used and have been researched but the long time for predatory mites to build up populations for good control limits efficacy.
- **Stethorus** can be abundant in some regions and be a major factor in mite management. While they can be available commercially, it isn't practical to do inoculative releases due to expense.

Cultural control:

- Avoid moisture stress.
- Conserve natural predators.

- Dust suppression.

Raspberry Crown Borer

Pennisetia marginata

Organophosphates are widely used to manage this pest. The insect's long life cycle, coupled with larval development taking place inside the core of berry canes, makes chemical control difficult. Organophosphates remain critical for management of this pest. The Raspberry Crown Borer requires two years to complete its life cycle. First year larvae overwinter in cells just below the bark at the base of canes. They begin to feed in early March on cane buds around the plant crown, and then bore into the canes during the spring. Evidence of crown borer damage cannot be ignored as the pest population can increase rapidly. This pest will become a limiting factor for production of many caneberry cultivars should the registration of effective soil applied compounds be revoked. Many growers have minimized the use of Organophosphates for borer control by treating 2 consecutive years in a row, then skipping 2-4 years before repeating the treatment cycle. This method also aids in pesticide resistance management.

Chemical control:

Organophosphate

- **Diazinon** Need to drench the soil for efficacy. The maximum allowable rate of 2 lb a.i./A of Diazinon is required for successful control of Raspberry Crown Borer. Excellent efficacy.

Pyrethroids

- **Bifenthrin (**Brigade and other brands) Efficacy is believed to be good, but little grower experience. Use for this purpose is increasing.

Biological control:

- None

Cultural control:

- Enhancing habitat for beneficials.

Raspberry Fruitworm (also known as Raspberry Beetle)

Byturus unicolor

Major driver of Diazinon use. Economic damage and infestations limited to the Northern Washington region. Adults emerging from the soil during April and May feed on fruit buds and unfolding leaves. Larvae feed within the blossom and in developing fruit.

Chemical control:

Organophosphate

- **Diazinon** Most effective and widely used control material. For many markets, there is a zero tolerance for this pest at harvest. Mite flare-ups are possible. Possible future loss or decreased rate of Diazinon could impact control of this pest. Efficacy is excellent.
- **Malathion** Growers who do not have a private applicators pesticide license use Malathion in place of Diazinon. Efficacy is fair.

Carbamate

- **Carbaryl** (Sevin) Limited use for this purpose. Efficacy is fair to good.

Other

- **Bifenthrin (**Brigade and other brands) Limitations on the amount of Bifenthrin that can be applied in one seasonal causes growers to reserve its use for other pests besides the raspberry beetle.
- **Spinetoram** (Delegate) Limited use. New Label. Expensive to use. Efficacy is unknown. Toxic to bees if not dried. Can be used at night if dried by morning.
- **Spinosad** (Success/ Entrust) Entrust is the organic formulation. Limited use. New label. Efficacy is unknown.

Biological control:

- None

Cultural control:

- Enhancing habitat for beneficials.
- May be beneficial to remove blackberries and thimbleberries from field borders.

Redberry Mite

Acalitus essigi

Redberry mite is a problem in blackberries only. Late-maturing cultivars, like Oregon Thornless Evergreen, are most susceptible, but mites also can economically infest other blackberries. The mites feed at the base of the berry drupelets in spring and summer, injecting a toxin, which prevents proper drupelet development, and causes drupelets to remain red and firm at harvest time. Some or all of the drupelets of a berry can be affected.

Chemical control:

Dormant spray

- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Industry standard. Good efficacy if multiple applications of lime sulfur and sulfur are used from delayed dormant through mid-bloom.
- **Elemental sulfur** (several types and brands). Organically acceptable. Usually used for later applications. Multiple applications per season are needed for good to excellent efficacy.

Biological control:

- None

Cultural control:

- None

Clay Colored Root Weevil

Otiorhynchus singularis

The early-emerging Clay Colored Weevil is found primarily in Northern Washington. It occurs but is rarely a caneberry pest in Oregon. They begin emerging very early in the season as buds break and new leaves are just forming. Though not widespread, in some years and in some fields, they can cause significant damage to developing shoots, impacting yield.

Other root weevils
Black Vine Weevil *(Otiorhynchus sulcatus)*
Strawberry Root Weevil *(O. ovatus)*
Rough Strawberry Root Weevil *(O. rugosostriatus)*
Obscure Root Weevil *(Sciopithes obscurus)*

Occasionally, the other weevil species overwinter as adults and, also, begin feeding in early spring. Their feeding can cause damage to emerging buds. If not detected and left uncontrolled, the adults will lay eggs that can cause problems later in the season (harvest contaminants) or enable populations to build and be problematic the following year.

Chemical control:
Organophosphate

- **Malathion** Poor efficacy. Not a restricted use material. It is not used very often for weevil management.

Pyrethroids

- **Bifenthrin** (Brigade and other brands) Major chemical for weevil control. Use can cause a mite flare-up. Can be used once pre-bloom and once post-bloom only. Efficacy is excellent.
- **Esfenvalerate** (Asana) Not efficacious. This chemical isn't a good fit for weevil management and is seldom used for it.
- **Zeta-cypermethrin** (Mustang) New registration. Efficacy is believed to be good, but little grower experience. This is not in widespread use yet, but could be a good fit because of restrictions on the number of Bifenthrin applications allowed.

Other

- **Azadirachtin** (Neem). Several brands. Poor efficacy. Organically approved.
- **Cryolite Bait** 24c registration. Not available (mfg. has discontinued production due to lack of demand).
- **Thiamethoxam** (Actara) Efficacious but not much field experience.

Biological control:

- ***Beauveria bassiana*** (Mycotrol) Not much grower experience. Organically approved. Has not been found to be reliably efficacious or economic.
- **Parasitic nematodes**. Available in various species but have not been found to be reliably efficacious or economic.

Cultural control:

- Adjacent area management
- Keep crates from damp soil/grass

Strawberry Crown Moth

Synanthedon bibionipennis

Larvae girdle the roots and lower crowns, and can tunnel in. Plants can be stunted and have poor vigor. An economic pest only in Southern Washington and Oregon.

Chemical control:

- **Bifenthrin** (Brigade and other brands) has received a label as a drench for Raspberry Crown Borer control. Strawberry Crown Moth is likely to also be controlled by this regimen). Applied as a crown drench in late March or before budbreak.

Organophosphate

- **Diazinon** As a result of EPA's review of organophosphates, only one application of Diazinon per season is allowed, which limits its use for strawberry crown moths if it is needed for raspberry beetle or raspberry crown borer control. Efficacy excellent.

Biological control:

- None

Cultural control:

- Enhancing habitat for beneficials.

Winter Moth

Operophthera spp.

Winter moth larvae are rare pests in caneberries and seldom require control measures. Larvae hatch in late winter/early spring and feed on buds. They can destroy fruit buds and, thus, reduce fruit yield.

Chemical control:

Organophosphate

- **Diazinon** As a result of EPA's review of organophosphates, only one application of Diazinon per season is allowed, which limits its use for winter moths if it is needed for raspberry beetle or raspberry crown borer control. Limit of 2 lb a.i./acre for an entire season, with the option of allocating the limited amount toward soil drench and/or foliar application. Efficacy is rated as good.
- **Malathion** (Malathion 8 Aquamul) Not as efficacious as others in cool temperatures. Very toxic to parasitic wasps. Efficacy is poor.

Carbamate

- **Carbaryl** (Sevin) Use can cause a mite flare-up. Works in warmer temperatures. Hard on beneficials and pollinators. Not restricted. Widespread use due to cost effectiveness.

Pyrethroids

- **Bifenthrin** (Brigade and other brands) Use can cause a mite flare-up. Can be used once pre-bloom and once post-bloom only. Widely used as clean up spray (pre-harvest). Toxic to parasitic wasps and some other beneficials. Efficacy is good to excellent.
- **Zeta-cypermethrin** (Mustang) (new product) Use comparable to Bifenthrin. Efficacy is

believed to be good, but little grower experience. This is not in widespread use yet, but could be a good fit because of restrictions on the number of Bifenthrin applications allowed. Toxic to parasitic wasps and some other beneficials.

Other

- **Tebufenozide** (Confirm) Effective in this early window.
- **Spinetoram** (Delegate) New label. Looks promising. Very similar to Spinosad. Limited experiences but will likely replace Spinosad. Toxic to bees if not dried. Can be used at night if dried by morning.
- **Spinosad** (Success) Entrust formulation is approved for organic production. Not effective on larger larvae. Efficacy is good to excellent.

Biological control:

- ***Bacillus thuringiensis*** (Bt) various labels have various rates. Poor efficacy. Approved for organic production.

Cultural control:

- Enhance habitat for beneficials.

<u>Critical Needs for Insect/Mite Management in Dormancy to Pre-bloom:</u>

Research:

- Cost effective alternatives for Diazinon and for the control of Raspberry Crown Borer and Strawberry Crown Moth.
- Research Malathion as soil drench for Raspberry Crown Borer.
- Develop economic thresholds for mites, root weevils, Strawberry Crown Moth, and Raspberry Crown Borer.
- Develop a resistance management program for leafrollers.
- Develop systems to encourage naturally occurring beneficial insects.
- Pheromone attractant for Raspberry Crown Borer.
- Alternative to Diazinon for raspberry beetle control.
- Research into trap and kill crops/hosts.
- Training and cane management for leafroller control.
- Develop economic threshold and determine life cycles of various weevil species.

Regulatory:

- Allow additional applications of Diazinon (more than one) per year.

Education:

- Educate growers on thresholds and monitoring.
- Need to gain experience and determine field efficacy for newer pesticides.
- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower

adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

DISEASES

About 80% of the caneberry acreage in Oregon and Washington is treated with a fungicide at least once but, more often, several times per season. Products such as calcium polysulfide and fixed copper are widely used on most blackberry acreage primarily for cane diseases. Leaf and Cane Spot (*Septoria rubi*), and Purple Blotch (*Septocyta ruborum*), are two diseases found in most blackberry fields. In every-year production fields, a rigorous fungicide regime is required to control these diseases, which can reduce plant vigor and yield. Alternate-year production, as is common on many farms, breaks the disease cycle, reducing or eliminating the number of fungicide applications needed to control these diseases. Primocane removal, either by mechanical means or with an herbicide, is a common practice in many caneberry fields during this crop growth stage. The removal of early flushes of primocanes not only makes machine harvesting more efficient, but alters the microclimate of the plant canopy, which can reduce the severity of several fungal diseases. The herbicide Dinoseb (Dinitro) was used in the past for early primocane removal; however, it is no longer registered for use in caneberries. Dinoseb (Dinitro) was known to be directly toxic to a number of pathogenic fungi, such as *Botrytis cinerea* (Fruit Rot), *Didymella applanta* (Spur Blight) and *Leptosphaeria coniothyrium* (Cane Blight), which occurs after harvest. The direct toxic effects of the newer herbicides that are used for primocane removal is unknown.

Anthracnose

Elsinoe veneta

A pest that can cause economic damage in black raspberries and very occasionally blackberries. Red raspberries and hybrid berries, such as 'Boysenberry' and 'Loganberry', are generally not infected. This fungus overwinters on infected canes. Excluding black raspberries, the disease, in this aspect, is generally viewed as not severe enough to warrant treatment. However, Anthracnose is a prime suspect as the causal agent of Dry Cell Syndrome although evidence is still not conclusive. If true, it should be considered a serious pest in years when we have warm, humid conditions during bloom and ripening.

In black raspberries Anthracnose can become particularly serious if rains continue late into spring, when spots on canes may be plentiful enough to retard sap flow, thus girdling the canes. Early-season infections are more severe than late-season infections. Given the high potential for weather conditions favorable for Anthracnose development in the PNW, most black raspberry growers treat preventatively to minimize risk.

Chemical control:

- Apply late dormant or delayed dormant and again when new canes are 6-12 inches high.

Delayed dormant application only:

- **Azoxystrobin** (Abound) Appears to be effective.
- **Boscalid + pyraclostrobin** (Pristine) PHI 0 days. Appears to be effective although serious outbreaks of this disease are rare.
- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Efficacy is good to excellent
- **Captan** In widespread use due to cost effectiveness and broad-spectrum control of other diseases. Global market restrictions limit its use. 12.5 lbs maximum allowed per year. Primocane application only. Fair to good control.
- **Copper sulfate + hydrated lime** (Bordeaux) Delayed dormant application and/or primocane applications. Fair control.
- **Fixed copper** (several brands). Many formulations are organically acceptable. Fair control.
- **Pyraclostrobin** (Cabrio EG) Appears to be effective although serious outbreaks of this disease are rare.

Biological control:

- None

Cultural control:

- Avoid overhead irrigation, or limit the time plants are wet from irrigation.
- Certified disease-free stock.
- Early primocane control.
- Eliminate weeds to provide good air movement.
- New over old training technique (Efficacy unknown; more research needed)
- Prune off old canes close to the ground as soon after harvest as possible, and destroy by burning. Best done before rains resume in the fall.
- Thin out weak canes.

Bacterial Blight

Pseudomonas syringae

Occasional problem in raspberries. Not seen in blackberries. Also called "blind bud". This is an ice nucleating bacteria. It can enter buds in the fall where it overwinters, causing damage by raising the temperature at which water freezes in the plant tissue. Affected buds fail to develop in the spring. Developing fruiting laterals below dead buds may also become infected. Symptoms are blackened stems and leaves and a shepherd's crook bending at the tip. Occurrence is usually quite erratic.

Chemical control:

Apply as a delayed dormant application.

- **Bordeaux** (copper sulfate + hydrated lime)
- **Fixed copper** (several brands). Many formulations are organically acceptable.

Biological control:

- None

Cultural control:

- Avoid overfertilization.

Black Raspberry Necrosis Virus (BRNV)

Very rarely treated for in dormancy to pre-bloom (treatment consists of controlling aphids which vectors this virus). Black raspberry is the only caneberry that displays symptoms from this virus and can be very severely impacted. Red raspberry and blackberry are symptomless when infected with BRNV by itself. Recent collection from the wild of black raspberry selections that display very good aphid resistance increases that potential of future cultivars that could incorporate this trait.

Chemical control:

- Possible benefits from control of the aphid vector. See aphid control options.

Biological control:

- None

Cultural control:

- None

Cane and Leaf Rust

Kuehneola uredinis

A pest only in blackberries, especially in Evergreen and Silvan cultivars. Hybrid cultivars are generally not affected by this disease. The fungus has several spore types that infect both floricane and primocane leaves. Wet conditions favor disease development. Canes become brittle and break easily. Premature defoliation can occur if disease pressure is severe.

Chemical control:

- **Bordeaux** (copper sulfate + hydrated lime). Efficacy is good.
- **Fixed copper** (several brands). Many formulations are organically acceptable.
- **Myclobutanil** (Rally 40 W) Efficacy is very good to excellent.
- **Pyraclostrobin** (Cabrio EG) New registration. Looks promising, but no field experience to date.

Biological control:

- None

Cultural control:

- An alternate-year fruiting program reduces disease pressure.

Cane and Leaf Spot (aka Septoria leaf spot)

Septoria rubi

This fungal disease is prevalent in most blackberry and hybrid berry fields but doesn't cause

economic losses in most circumstances. Minute, black, fruiting bodies (pycnidia) are formed within infected tissue, mature, and produce spores. Rain spreads the spores. During the wet early spring, more spores are produced, causing many new infections. Leaf spots vary from light to dark brown and are about 3mm in size. At first, they are purplish in color then later turn brown. In older leaf spots, centers are whitish with brown to red borders. Infections on canes are similar to those on leaves but are elongated and generally inconspicuous. At present the loss of benomyl in the last year has left growers without a previous primary control tool.

Chemical control:
Spray at budbreak

- **Boscalid + pyraclostrobin** (Pristine) Appears to be effective although serious outbreaks of this disease are rare.
- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). May burn leaves when shoots are greater than 0.75 inched long. Efficacy fair.
- **Fixed copper** (several brands). Many formulations are organically acceptable. Efficacy fair to good.
- **Pyraclostrobin** (Cabrio EG) Appears to be effective although serious outbreaks of this disease are rare.

Directed spray to young primocanes at 0 to 6 inches growth, 12- to 18-inch growth and 2- to 3-foot growth.

- **Azoxystrobin** (Abound) PHI 0 days. Efficacy is good to excellent.
- **Boscalid + pyraclostrobin** (Pristine) Appears to be effective.
- **Captan** 80WDG In widespread use due to cost effectiveness and broad-spectrum control of other diseases; Market restrictions limit its use. 12.5lbs Maximum allowed per year. Efficacy fair.
- **Cymoxanil + Famoxadone** (Tanos) PHI 0 days. New product. Although it is not labeled for cane and leaf spot management, research trials show good to excellent efficacy on *Septoria* spp.
- **Fixed copper** (several brands). Many formulations are organically acceptable.
- **Myclobutanil** (Rally 40 W) Appears to be effective although serious outbreaks of this disease are rare.
- **Pyraclostrobin** (Cabrio EG) Appears to be effective.

Other

- **Elemental sulfur** (several types and brands). Organically acceptable. Efficacy is good.

Biological control:

- None

Cultural control:

- Control weeds around base of canes because they can provide a natural moist chamber for infection and prevent effective spray coverage.
- The disease has rarely been a problem in alternate-year (AY) fields when canes are trained up as they grow.

<u>Downy Mildew</u>

Peronospora sparsa
This disease can be problematic mainly in Boysenberries and some blackberry cultivars. Raspberries and many blackberry cultivars are not affected. Climatic conditions play a major role in seemingly sudden outbreaks of disease symptoms, causing flare-ups of dry cell type symptoms on ripening fruit, reducing quality and marketability. The fungus overwinters primarily as a systemic infection of canes, crowns, roots, and buds. The disease cycle starts in spring with the production of infected shoots from infected root, crown, and cane buds. Diseased berries (with symptomatic "dry cell" damaged drupelets) then become an important source of inoculum for new cycles of berry infection. After harvest, infection of developing primocanes lying on the ground continues by internal mycelial growth and spore infection.

Chemical control:

- **Fosetyl-al** (Aliette WGD) PHI 60 days. Long PHI makes use prohibitive for some cultivars. Efficacy is good to excellent.
- **Phosphorous acid** (Fosphite) Efficacy is good to excellent.

Biological control:

- None

Cultural control:

- Early primocane control.
- Eliminate wild blackberries and roses close to fields.
- New over old training technique (efficacy unknown; needs more research).
- Practice good weed control.
- Reduce or eliminate overhead irrigation.

<u>Orange Rust</u>
Arthuriomyces peckianus and *Gymnoconia nitens*
Very rare but extremely serious economically. Last reported in 1997 on Kotata blackberries in the Willamette Valley. Fungi systemically infect the plants and, because of the infection, floricanes never produce flowers. Plants should be quickly removed and destroyed. Proper diagnosis is important. This disease can be confused with cane and leaf rust.

Chemical control:
None will cure existing infection. Herbicides can be used for spot treatment to kill infected plants.

- **Myclobutanil** (Rally 40 W) Good protectant, but not curative.

Biological control:

- None

Cultural control:

- Establish new planting from a clean source.
- Quickly destroy infected plants.

- Scout for disease during spring and summer months.

Powdery Mildew

Sphaerotheca macularis

Blackberries and raspberries are usually not affected by this fungal disease but 'Boysenberry' is susceptible. Warm, dry weather favors development. In spring, ascospores are the primary inoculum. Severe mildew retards, dwarfs, and distorts plant parts and makes fruit unsalable.

Chemical control:

- **Azoxystrobin** (Abound) PHI 0 days. Efficacy fair.
- **Boscalid + pyraclostrobin** (Pristine) Appears to be effective although serious outbreaks of this disease are rare.
- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Apply just before or when disease first appears. Efficacy is fair.
- **Elemental sulfur** (several types and brands). Organically acceptable. Fair control.
- **Fixed copper** (several brands). Many formulations are organically acceptable. Fair to good.
- **Horticultural oils (JMS Stylet Oil and other formulations)** Has good effectiveness against powdery mildew on other crops and may be useful on blackberries. Organically acceptable. Efficacy is fair to good.
- **Myclobutanil** (Rally 40 W) Efficacy is good to excellent.
- **Potassium bicarbonate** (Armicarb 100 or Kaligreen). Only a preventative treatment. Not effective once disease is found. Organically approved. Contact only. Efficacy is good.
- **Potassium salts of fatty acids** (M-Pede) Organically acceptable. Fair control.
- **Pyraclostrobin** (Cabrio EG) New registration. Looks promising but no field experience to date.

Biological control:

- ***Ampelomyces quisqualis*** (a fungal hyperparasite) Ineffective as a stand-alone treatment or if symptoms of disease are present.

Cultural control:

- Do not plant close to wooded areas that might shade the field.
- Remove wild blackberries from around the field.
- Remove any infected, late-forming suckers.

Purple Blotch

Septocyta ruborum

All blackberries and hybrid berries can be affected by this disease but Marionberries are particularly susceptible. The causal organism is a fungus similar to *Septoria rubi*. Spores are produced in spring on floricanes and then infect newly emerging primocanes. Symptoms don't develop until after chilling requirements are met. During winter and spring, lesions become purple with a red margin. Affected areas develop into cankers and girdle canes. Severely affected canes die in spring. The control strategy is to protect the primocanes from infection in the spring

or, in an alternate year cropping system, remove floricanes before they can infect the emerging primocanes.

Chemical control:
New primocanes
Spray at budbreak

- **Azoxystrobin** (Abound). Used for 1st spray. Efficacy good.
- **Boscalid + Pyraclostrobin** (Pristine) Used for canopy spray (final primocane spray) including botrytis control. Efficacy: good.
- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Industry standard. Directed spray to young primocanes at 0 to 6 inches growth, 12- to 18-inch growth and 2 to 3-foot growth. Efficacy: fair.
- **Captan** 50 WP Efficacy- fair. Other Captan formulations are available.
- **Cymoxanil + Famoxadone** (Tanos) PHI 0 days. Little grower experience. Efficacy research tests show it to be effective for Purple Blotch (*Septocyta ruborum*) and Cane and Leaf Spot (*Septoria rubi*).
- **Fixed copper** (several brands). Many formulations are organically acceptable. This is a typical grower practice in the fall but more effective on diseases other than Purple Blotch. Fair to good control.
- **Pyraclostrobin** (Cabrio EG) New registration. Looks promising. Directed spray to young primocanes at 0 to 6 inches growth, 12- to 18-inch growth and 2- to 3-foot growth.

Biological control:

- None

Cultural control:

- Control weeds around base of canes because they can provide a natural moist chamber for infection and prevent effective spray coverage.
- Cultivate an open canopy.
- In an every year cropping system, removing the first flush of primocane growth greatly aids in disease management.
- Manage overhead irrigation.
- The disease has rarely been a problem in alternate-year (AY) fields when canes are trained up as they grow. Remove old fruiting canes after harvest.

Root Rot
Phytophthora spp.
A major disease complex of red and black raspberries, and hybrid berries, in Oregon and Washington; occasionally found in blackberries. *Phytophthora fragariae* var. *rubi* causes a typical wet-soil Root Rot in raspberries throughout the region especially in the southern region, which has heavier soils; fine roots are lacking and root pith is brownish-red. No raspberry cultivar is very resistant. Plants may appear to recover, but new roots are often weak and lack lateral development. The new roots in turn become infected during cold, wet weather the next fall and winter so that the plant progressively declines. No single cultivar, chemical, or cultural practice used alone effectively controls this serious root disease. Control will depend on an

integrated program that combines several approaches.

Chemical control:

- **Fosetyl-Al** (Aliette WDG) PHI 60 days. Apply to foliage twice in spring. Efficacy is fair to good.
- **Mefenoxam** (Ridomil Gold) Some reduced efficacy has been observed in Western Washington. Registered for use in raspberries only.
- **Phosphorous acid** (Fosphite and various brands) Apply to foliage twice in spring. Multiple applications per season required. While some products are labeled only as plant nutrients other products carry a disease control label. The bewildering mix of formulations and pricing has led to much confusion over the potential efficacy differences between all these phosphorous products.

Biological control:

- None

Cultural control:

- Apply gypsum or other materials to achieve high calcium ion concentration. Research has shown it can inhibit disease spore movement.
- Best results occur when several cultural and chemical practices are integrated together.
- Do not over irrigate.
- Maintain raised beds.
- Subsoil between rows to promote drainage.

Spur Blight

Didymella applanata

While the predominant cultivars used are resistant/tolerant of Spur Blight, some of the potential new releases appear more susceptible to this disease. It could become a more important economic factor in the near future. It is primarily a problem in red raspberries.

Chemical control:

Apply late dormant or delayed dormant.

- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Efficacy is very good.

Biological control:

- None

Cultural control:

- Control early primocane growth. Efficacy is unknown. More research needed.
- Keep plant rows narrow.
- Planting resistant cultivars may be an option in some situations. Efficacy is considered fair to good.
- Practice good weed control. Efficacy is poor by itself.

Tomato Ringspot Virus (ToRSV)

This virus is vectored by nematodes (*Xiphinema americanum*) and spread within a field is often slow. Nematodes can be moved on any equipment that moves soil including wheels of harvesters, sprayers, tractors etc. Even though the virus moves slowly through a field it can have a devastating impact on production. Plants grow very poorly producing few short canes with small crumbly fruit.

Chemical control:

- None

Biological control:

- None

Cultural control:

- Control broadleaf weeds, which are alternate hosts for the virus: dandelions, plantains, and sow thistle.
- Restrict soil movement to reduce chance of moving viruliferous nematodes.
- Work healthiest fields with little or no virus symptoms first, then move to weaker fields to reduce chance of moving viruliferous nematodes (nematodes carrying virus) into new locations.

Yellow Rust

Phragmidium rubi-idaei

Widespread in most raspberry fields, particularly in years when spring rains continue late. Historically has not been a problem in the 'Canby', 'Willamette', 'Newburgh', 'Puyallup', 'Sumner', or 'Meeker' raspberry cultivars. However, new races are in the Pacific Northwest that will infect cultivars previously resistant, such as 'Meeker' and 'Willamette'. The fungus overwinters as teliospores on leaves. Fruit often dies on the canes before maturing if leaves on fruiting laterals are attacked early in the summer. By harvest, black overwintering spores (teliospores) appear in the yellow uredinia on the lower leaf surface. Infected canes often are brittle and may break off when old fruiting canes are pruned out. Not found in blackberries.

Chemical control:

Make a delayed dormant application (when buds have about 0.75 inches new growth):

- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Efficacy is fair to good.
- **Copper sulfate + hydrated lime** (Bordeaux). Efficacy is fair to good.

Make application when new growth is 3 to 4 inches long, and again just before flowers open:

- **Boscalid + pyraclostrobin** (Pristine) PHI 0 days. Good efficacy. Often used for rotation with Rally and for its effectiveness on a wide spectrum of fungal diseases. Efficacy is fair to good.
- **Myclobutanil** (Rally 40 W) at 0 day PHI. Has become the industry standard. Efficacy is good to excellent.
- **Propiconazole** (Orbit). PHI 30 days. Although not labeled for this disease, efficacy very good. However it retards plant growth for a period after application. Long PHI also limits

its use.
- **Pyraclostrobin** (Cabrio EG) PHI 0 days. Not as effective as Rally, Pristine or Orbit.

Biological control:
- None

Cultural control:
- Cultivate in early spring to cover fallen leaves, old cane stubs, and refuse before new leaves appear, thus eliminating inoculum sources.
- Planting resistant cultivars may help but Yellow Rust resistance will not be the reason for choosing which cultivar to grow.

Critical Needs for Disease Management in Dormancy to Pre-bloom:

Research:
- Determine the feasibility of Aliette as a root soak for Root Rot disease.
- Identify effective management options for *Pseudomonas syringae* (Bacterial blight).
- Identify resistance management strategies for diseases, esp. *Phytophthora* Root Rot.
- Cane management techniques for reducing diseases.
- Determine effectiveness of cane suppression herbicides for control of fungal pathogens, such as Botrytis Fruit Rot, Spur Blight, and Cane Blight.
- Modeling and forecasting for diseases.
- Vole monitoring, thresholds and management program.

Regulatory:
- Expedite registration of benomyl (Benlate) replacement (e.g. thiophanate/Topsin-M).

Education:
- Educating growers on proper identification of diseases. Educate growers on differences between pathogens: Septoria, Anthracnose, Dryberry Mite damage and Dry Cell Syndrome, sunburn vs. Redberry Mite.
- Developing disease resistance management programs for growers.
- Continue to develop information delivery system to growers.
- Educate growers about restricted use products.
- Way to encourage growers to obtain private pesticide applicator licenses.
- Educate growers on how to use new chemistries and resistance management.

WEEDS

There are numerous winter annual weeds. Effective control of most winter annuals is possible with a well-planned, integrated management system that includes proper use of pre- and post-emergence herbicides, in combination with timely field row management practices. Quackgrass is a primary perennial weed that can be treated effectively during dormancy. Various species of weeds can contaminate fruit, harbor insects and rodents, and compete with the caneberry plants for water and nutrients. In addition, weeds can interfere with harvesting efficiency and reduce air movement, thus increasing the likelihood of cane, fruit, and foliar diseases. Growers rely on a combination of chemical and cultural practices to manage weeds in their fields. Weeds within the rows are usually managed with banded herbicide applications, either pre- or postemergence. To create a vegetation-free zone in the plant row prior to the application of a pre-emergence herbicide in early spring, currently growing weeds are removed by hand hoeing or treatment with a contact herbicide, such as paraquat (Gramoxone) or pelargonic acid (Scythe). Weeds between the rows are managed primarily by frequent, shallow cultivation during the growing season. Caneberries respond positively to a non-disturbed, competition-free strip in the planted row. This is achieved through the application of directed, banded herbicides as well as primocane suppression materials (cane suppression) usually applied once in the early spring. It is recommended that growers diligently take note of shifts in predominant weed species, which indicates development of resistance and the need to select alternative weed management strategies or materials. Primocane suppression or "cane burning" is a common practice in caneberry production. When primocanes are 4 to 8 inches tall, they are sprayed with a contact herbicide, such as carfentrazone (Aim), oxyfluorfen (Goal), or pelargonic acid (Scythe) once or twice per season. The spray is directed to the primocanes and lower 18 inches of the floricane. Cane suppression has been shown to reduce incidence of fungal diseases and increase yields. It is also necessary to help facilitate mechanical harvesting.

Chemical control:

- **Dichlobenil** (Casoron) 30 day PHI. Preemergence. Useful as a spot application in mid-winter to control perennial weeds (field Horsetail, Quackgrass, Yellow Nutsedge and Canada Thistle). May reduce plant vigor if used repeatedly or at the high rate.
- **Diuron** (Karmex, Diuron 80 or Diuron 4L) Preemergence. Late spring or fall use recommended. Efficacy ranges from poor to good.
- **Glyphosate** (numerous names) Non-selective, postemergence. 14 day PHI. Herbicide damage from Glyphosate drift or misuse is fairly common in caneberries. Very effective and useful but requires supervision and training to prevent damage especially in raspberries.
- **Napropamide** (Devrinol) Pre-emergence. Effectiveness is limited if not incorporated by irrigation or rainfall either while applying or very soon after application. Performance is also reduced by excessive plant residue on soil surface. Primarily a grass herbicide. Used in spring and/or fall. Efficacy is poor to good.
- **Norflurazon** (Solicam) 60 day PHI. Preemergence. It is primarily used where annual grass control is a problem but also has activity against several common broadleaved weeds. It can cause discoloration in primocane foliage and fruit spurs. It should be used with caution on black raspberries. Cannot use on newly established plantings. Efficacy is

fair to good.
- **Oryzalin** (Surflan) Pre-emergence herbicide. Widespread use in spring and/or fall.
- **Paraquat** (Gramoxone Extra or Gramoxone Max). Non-selective, postemergence, contact herbicide. Usually used before new shoot emergence in spring.
- **Pronamide** (Kerb) December through March only. Not on frozen soil. Provides decent control of Quackgrass, if applied when grass is truly dormant. Expensive. Can delay emergence of primocanes in raspberries. Efficacy is poor to good.
- **Sethoxydim** (Poast) PHI 45 days. Postemergence. Controls grasses only. Long PHI limits use even though it's the only grass specific herbicide that can be used in established caneberry plantings. Resistant grasses include annual bluegrass and all fine fescues, but Quackgrass can be suppressed. Fair- good, if label application directions are followed closely.
- **Simazine** (Simazine 90 WDG or 90DF, Princep Caliber90, Simazine 4L) Inexpensive. Pre-emergence. Fair to Good control. In widespread use.
- **Terbacil** (Sinbar) PHI 70 days. Preemergence. 70 day PHI. Solubility relatively high; use with caution on tender/weakened plantings.

Primocane suppression:
- **Carfentrazone-ethyl** (Aim 40W) Broadcast. PHI 15 days. Fair to good cane management.
- **Oxyfluorfen** (Goal 2XL) Broadcast for blackberries; broadcast for raspberries and blackberries. PHI for raspberries is 50 days and 15 days for blackberries. 24c registration. Efficacy ranges from poor to good.
- **Pelargonic acid** (Scythe) For cane management and annual weeds. Poor efficacy.

Biological control:
- None

Cultural control:
- Hand hoeing.
- Flaming for weed control.
- Weed eater.

Critical Needs for Weed Management in Dormancy to Pre-bloom:

Research:
- Cover crops, and mowing and blowing into row for primocane suppression.
- More screening for additional herbicides.
- Mulching for weed control.

Regulatory:
- Clarify the regulatory status as an organic herbicide.
- Register organic acids for weed control.

Education:

- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

NEMATODES

Root-Lesion Nematode *(Pratylenchus spp)*
Dagger Nematode *(Xiphinema americanum)*

Chemical control:

- No nematicides are currently registered for use in caneberries.

Biological control:

- Biological control products are available in the marketplace, but have not been effective in research studies on caneberries.

Cultural control:

- Grass sod in the alleys helps prevent the spread of ToRSV (vectored by *X. americanum*).

Critical Needs for Nematode Management in Dormancy to Pre-bloom:

Research:

- Evaluate efficacy of biological nematicides.
- Expedite testing of fenamiphos (Nemacur) replacements.
- Timing of nematicide treatments in relationship to growers' activities.

Regulatory:

- Expedite registration of fenamiphos (Nemacur) replacements.

Education:

- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

RODENTS

Rodents, especially voles/field mice and voles, often cause major damage when they burrow through the root systems and feed on the roots of the plants, sometimes causing death. Baiting with Zinc Phosphide pellets can be implemented only post harvest through dormancy and until budbreak in the spring. Options for control are very limited.

Chemical control:

- **Zinc Phosphide Pellets (bait)** Broadcast to soil surface during dormancy and before leaf emergence in the spring. The target rodent must be on the label.

Biological control:

- Encourage raptor roosting and feeding can help reduce population but cannot be viewed as having an economic impact on them. The prey species just multiplies much too quickly.

Cultural control:

- Reduction of vole habitat within the field primarily by eliminating any existing between row cover crops and/or weed stands within the crop rows.

III. BLOOM to PRE-HARVEST

Early May to Mid-June
Raspberries –- Southwestern Washington
Mid-May to Early July
Raspberries -- Northwestern Washington
Raspberries, black raspberries and most blackberries—Oregon
Early-July to Mid August
Evergreens and other late-ripening blackberries – Oregon

FARMING ACTIVITIES

The following farming activities, many that are pertinent to AY production systems on a calendar basis, may take place during the bloom to pre-harvest period:

- Monitor for diseases, insects, and mites.
- Irrigation.
- Bring in bees at start of flowering.
- Fungicide applications.
- Continue primocane control, if needed.
- Continue foliar feeding as needed.
- Insecticide or miticide applications.
- Herbicide applications for weed control.
- Train new canes (in AY blackberry production).
- Peg primocanes out of the row middles (in EY blackberry production).
- Cultivation of row middles for weed control.
- Tuck raspberry primocanes under training wires; raise training wires, as needed.
- Take leaf samples for nutritional analysis.

INSECTS AND MITES

Aphids

Amphorophora agathonica
In the northern, cooler growing areas, it is a common practice to treat for aphids during this period to prevent an economic reduction plant vigor caused by their feeding as well as prevent their contaminating the crop when it is mechanically harvested. In the warmer, southern areas this practice is uncommon.

Chemical control:
Organophosphate

- **Diazinon** PHI 7 days. As a result of EPA's review of organophosphates, only one application of Diazinon per season is allowed, which limits its use for aphids if it is needed for raspberry beetle or raspberry crown borer control. PHI is too long if needed close to harvest.

- **Malathion** PHI 1 day. Efficacy is excellent.

Pyrethroids

- **Bifenthrin** (Brigade and other brands) PHI 3 days. Use can cause a mite flare-up. Toxic to pollinators.
- **Esfenvalerate** (Asana XL) PHI 7 days. PHI is limiting; cannot use sooner than 12 days prior to harvest. Can cause a mite flare-up. Cannot use during bloom because of bee toxicity. Essentially cannot be used for raspberries because of overlapping bloom to ripening berries.

Other

- **Imidacloprid-** (Admire-Pro) Applied with .25 inches irrigation or within 2 hours of rainfall. Applied as a soil drench. Or (Provado and other brands) PHI 3 days. Applied as a foliar spray.
- **Potassium salts of fatty acids** (M-Pede and other brands) PHI 0 days. Efficacy is very poor. Organically approved.
- **Spinosad** (Success) PHI 1 day. Bee toxicity until spray dries.
- **Thiamethoxam** (Actara) PHI 3 days. Cannot use during bloom because of bee toxicity.

Biological control:

- ***Beauveria bassiana*** (Mycotrol ES) PHI 0. New product, not much grower experience. Organically approved.
- Release of ladybird beetles.

Cultural control:

- Cover crops to encourage beneficials.

<u>Caterpillars and Loopers</u>

Various species

These caterpillars feed on leaves and many are usually nocturnal. They generally don't cause economic damage to the plants but can be a contaminant at harvest, especially in machine harvested fields. There is a zero tolerance for insects in the harvested commodity for most markets.

Chemical control:

Organophosphate (Cannot use if pollinators are present.)

- **Diazinon** 7 day PHI. Toxic to pollinators. An overall limit of 2 lb a.i./A for an entire season, with the option of allocating the limited amount toward soil drench and/or foliar application impacts this use of the material. Efficacy fair to excellent.
- **Malathion** PHI 1 day. Efficacy fair to good.

Carbamate

- **Carbaryl** (Sevin) PHI 7 days. Cannot use during bloom because of bee toxicity. Essentially cannot be used for raspberries because of overlapping bloom to ripening berries.

Other

- **Spinetoram** (Delegate) Similar to Spinosad. New product; limited grower experience but will probably replace Spinosad in market. Toxic to bees if not dried. Can be used at night

if dried by morning.
- **Spinosad** (Success) 1 day PHI. Entrust formulation is approved for organic production. Not effective on larger larvae but good to excellent on smaller ones. Toxic to bees if not dried. Can be used at night if dried by morning.

Pyrethroids
- **Bifenthrin** (Brigade and other brands) PHI 3 days. Shorter PHI than Asana. Only one pre-bloom and one post-bloom application allowed. Toxic to pollinators. Efficacy is excellent.
- **Esfenvalerate** (Asana XL) PHI 7 days. Specific application window of 12-7 days prior to harvest is limiting. Cannot use during bloom because of bee toxicity. Essentially cannot be used for raspberries because of overlapping bloom to ripening berries. Efficacy is good.

Biological control:
- ***Bacillus thuringiensis*** (Bt) various labels have various rates, PHI 0 days. Safe with pollinators. Efficacy good if caterpillars are small. Poor if they are large.

Cultural control:
- Enhance habitat for beneficials.

Earwigs

Forficula auricularia

A potentially serious pest at harvest (particularly if there is rain just prior to start of harvest or when the harvest conditions are wet) because it can be a contaminant in the harvested fruit. Since insecticides for leafrollers, weevils and other potential harvest contaminants are applied at the same time earwig control is needed, the materials listed for those insects also often control Earwigs.

Chemical control:
- **Bifenthrin** (Brigade and other brands) PHI 3 days. Use can cause a mite flare-up. Can be used once pre-bloom and once post-bloom only. Widely used as clean-up spray (Pre-harvest) in raspberries and some blackberries. Efficacy is fair.
- **Malathion** PHI 1 day. Short PHI makes it very useful. Thorough coverage is important. Short residual. Fair efficacy.

Biological control:
- None

Cultural control:
- Keep row clean of weeds.

Leafrollers

Obliquebanded Leafroller *(Choristoneura rosaceana)*
Orange Tortrix *(Argyrotaenia franciscana)*

Other species can also contribute to problem.
Leafrollers are a major reason for insecticide use, especially in Oregon and Southern Washington. Various species of leafroller larvae web and feed on caneberry foliage. This damage in itself is rarely economic, but larvae, if not controlled prior to harvest, can contaminate hand-picked and machine harvested fruit. Obliquebanded leafroller is the dominant species in Whatcom County, Washington; whereas Orange Tortrix dominates in Skagit, Clark, and Cowlitz counties of Washington, as well as Oregon's Willamette Valley.

Chemical control:
Evaluation of control efficacy is difficult, as egg hatch following treatment "masks" effectiveness.
Organophosphate (Cannot use if pollinators are present.)

- **Malathion** PHI 1 day. Not as efficacious as others under cooler temperatures. Toxic to pollinators and parasitic wasps.

Carbamate

- **Carbaryl** (Sevin) PHI 7 days. Use can cause a mite flare-up. Poor adulticide. Works in warmer temperatures. Hard on beneficials and pollinators. Widespread use due to cost effectiveness and availability to growers who don't have restricted use license. Efficacy is fair to good.

Pyrethrums and Pyrethroids

- **Bifenthrin** (Brigade and other brands) PHI 3 days. Use can cause a mite flare-up. Can be used once pre-bloom and once post-bloom only. Widely used as clean up spray (pre-harvest). May be extremely toxic to parasitic wasps. Efficacy is excellent.
- **Esfenvalerate** (Asana XL) 7 days**.** Specific application window of 7-12 days prior to harvest is limiting. Can cause a mite flare-up. Efficacy fair to good.
- **Pyrethrin** (Pyganic) PHI 0 days. Works for a quick knock down but very hard on beneficials. Efficacy is poor to fair. Can cause mite flair-up. Approved for organic production.
- **Zeta-cypermethrin** (Mustang) PHI 1 day. Use comparable to Bifenthrin. Efficacy is believed to be good, but little grower experience. This is not in widespread use yet, but could be a good fit because of restrictions on the number of Bifenthrin applications allowed.

Other

- ***Bacillus thuringiensis*** (Bt) PHI 0 days. Widely used but difficult to get control when pest pressure is high if relied upon exclusively due to caterpillars being in rolled leaves and product doesn't get to them. Most effective on early instars. Approved for organic production.
- **Parasitoid wasps –** not commercially available. Preservation of native populations is encouraged.
- **Spinetoram** (Delegate) PHI 1 day. Similar to Spinosad. New product; limited grower experience but will replace Spinosad product. Biological control: Some restrictions due to bee toxicity. Bee toxicity until spray dries.
- **Spinosad** (Success or Entrust) Entrust is the organic formulation. PHI 1 day. Effective. Commonly used. Some restrictions due to bee toxicity. Bee toxicity until spray dries. Also potentially toxic to some beneficials.
- **Tebufenozide** (Confirm) Insect growth regulator. Effective, but 14 day PHI limits

usefulness. (Safe with pollinators present)

Cultural control:

- Enhance habitat for beneficials.
- Keep crates from damp soil/grass Pheromone traps to monitor flight to evaluate populations and plan spray schedules.
- Pruning techniques (new over old)
- Sanitation
- Weed control

Mites

Twospotted Spider Mite *(Tetranychus urticae)* and others
Yellow Spider Mite *(Eotetranychus carpini borealis)* and others
Mites are not a problem in trailing blackberries, although they can be an occasional problem in erect and semi-erect blackberries. Both mite species are major economic pests in raspberries. Mite feeding reduces plant vigor and may cause leaves to be mottled, turn brown and drop prematurely. Use of pyrethroids can cause mite flair-ups.

Chemical control:

- **Bifenazate** (Acramite-50WS) PHI 1 Day. Allowed one application per year. Works well along with Savey.
- **Bifenthrin** (Brigade and other brands) PHI 3 days. Potential resistance because of heavy use. Cannot use if pollinators present. Efficacy is good to excellent.
- **Elemental sulfur** (several types and brands). Organically acceptable. Usually used for later applications. Multiple applications per season are needed for good to excellent efficacy. Not effective against Twospotted spider mites at this time.
- **Hexakis (50%) or Fenbutatin-oxide** (Vendex 50WP) PHI 3 days. Takes up to 10 days to work. Efficacy is good, though, not as effective in cool temperatures. Safe for beneficials. Registered for Raspberries only.
- **Hexythiozox** (Savey 50 WP) PHI 3 days. Does not control adults; just young motile forms and eggs. Safe for beneficials. Works well along with Acramite.
- **Horticultural oils** Excessive temperatures may cause phytotoxicity. Organically approved. Efficacious.
- **Potassium salts of fatty acids** (M-Pede) PHI 0 days. Efficacy is poor. Organically acceptable.

Biological control:

- **Anthocoris** Naturally occurring. Can purchase for inoculative releases but too expensive to be practical. Excellent naturally occurring control in many areas.
- **Predatory mites** (naturally occurring and can be purchased for release). Inundative releases of predatory mites are not practical. Naturally occurring predatory mite populations can be a major factor in mite management at this stage. Inoculative releases are occasionally used and have been researched but the long time for predatory mites to build up populations for good control limits efficacy.
- **Stethorus** Can be abundant in some regions and be a major factor in mite

management. While they can be available commercially, it isn't practical to do inoculative releases due to expense.

Cultural control:
- Avoid moisture stress.
- Conserve natural predators.
- Dust suppression.

Raspberry Fruitworm (also known as Raspberry Beetle)
Byturus bakeri
Larvae feed within the blossom and in developing fruit. They can also be a harvest contaminant. No controls are available at this stage because the larvae are mostly inside the fruit and difficult to treat. Treatment and control is targeted at the adults (beetles) during pre-bloom, when they begin feeding on unopened flower blossoms and new leaves.

Chemical control:
- None

Biological control:
- None

Cultural control:
- None

Root Weevil
Black Vine Weevil *(Otiorhynchus sulcatus)*
Strawberry Root Weevil *(O. ovatus)*
Rough Strawberry Root Weevil *(O. rugosostriatus)*
Obscure Root Weevil *(Sciopithes obscurus)*
Clay Colored Weevil *(O. sinularis)*

Adults root weevils can cause serious economic losses as a contaminant in harvested fruit. Adults appear after bloom, beginning in May and continuing through July. The Clay Colored Weevil is more common in Northern Washington. Directed basal sprays prior to harvest, rather than the entire canopy, give good results and preserve beneficial insects. However, just before harvest, full coverage is needed to prevent harvest contamination.

Chemical control (adults):
Organophosphate (Cannot use if pollinators are present)
- **Malathion** Poor efficacy. Not a restricted use material.

Pyrethroids (Cannot use if pollinators are present)
- **Bifenthrin** (Brigade and other brands) PHI 3 days. Use can cause a mite flare-up. Most commonly used chemical for weevil control. Efficacy is excellent.
- **Esfenvalerate** (Asana XL) PHI 7 days. Not efficacious. PHI too long. Effective on Black

Vine Weevil, but not on other types of weevil. The narrow application window is difficult.

- **Zeta-cypermethrin** (Mustang) New registration. Efficacy is believed to be good, but little grower experience. This is not in widespread use yet, but could be a good fit because of restrictions on the number of Bifenthrin applications allowed.

Other

- **Azadirachtin** (Neem). Several brands. Poor efficacy. Organically approved.
- **Cryolite Bait** 24c registration. Not available (mfg. has discontinued production due to lack of demand).
- **Thiamethoxam** (Actara) Efficacious but not much field experience.

Biological control:

- ***Beauveria bassiana*** (Mycotrol) New product, not much grower experience. Organically approved.
- **Parasitic nematodes** Available in various species but have not been found to be reliably efficacious or economic.

Cultural control:

- None

Sawfly

Monophadnoides geniculatus

A minor pest that is seldom economic but can be confused with leafrollers. In the late spring, larvae roll leaves and feed on undersides of leaf. Their feeding activity usually doesn't pose a problem but they can be a contaminant in mechanically harvested fields. Since insecticides for leafrollers, weevils and other potential harvest contaminants are applied at the same time Sawfly control would be needed, the materials listed for those insects also often control Sawfly.

Chemical control:

Organophosphate (Cannot use if pollinators are present.)

- **Diazinon** As a result of EPA's review of organophosphates, only one application of Diazinon per season is allowed, which limits its use for sawflies if it is needed for raspberry beetle or raspberry crown borer control Efficacy fair to good.
- **Malathion** PHI 1 day. Not as efficacious as others under cooler temperatures. Toxic to pollinators and parasitic wasps. Efficacy is fair.

Carbamate

- **Carbaryl** (Sevin) PHI 7 days. Use can cause a mite flare-up. Poor adulticide. Works in warmer temperatures. Hard on beneficials and pollinators. Widespread use due to cost effectiveness and availability to growers who don't have restricted use license. Efficacy is fair to good.

Pyrethrums and Pyrethroids

- **Bifenthrin** (Brigade and other brands) PHI 3 days. Use can cause a mite flare-up. Can be used once pre-bloom and once post-bloom only. Widely used as clean up spray (pre-harvest). May be extremely toxic to parasitic wasps. Efficacy is excellent.
- **Esfenvalerate** (Asana XL) PHI 7 days**.** Specific application window of 7-12 days prior to

harvest is limiting. Can cause a mite flare-up. Efficacy Excellent.

- **Pyrethrin** (Pyganic) PHI 0 days. Efficacy is good for quick knock down but very hard on beneficials. Can cause mite flair-up. Approved for organic production.
- **Zeta-cypermethrin** (Mustang) PHI1 day. Use comparable to Bifenthrin. Efficacy is believed to be good, but little grower experience. This is not in widespread use yet, but could be a good fit because of restrictions on the number of Bifenthrin applications allowed.

Other

- **Spinetoram** (Delegate) PHI 1 day. Similar to Spinosad. New product; limited grower experience but will replace Spinosad product.
- **Spinosad** (Success or Entrust) Entrust is the organic formulation. PHI 1 day. Effective. Commonly used. Some restrictions due to bee toxicity. Bee toxicity until spray dries. Also potentially toxic to some beneficials.
- **Tebufenozide** (Confirm) Insect growth regulator. Effective, but 14 day PHI limits usefulness. (Safe with pollinators present).

Biological control:

- ***Bacillus thuringiensis*** (Bt) various labels have various rates. PHI 0 days. Widely used but difficult to get control when pest pressure is high if relied upon exclusively due to caterpillars being in rolled leaves and product doesn't get to them. Most effective on early instars. Approved for organic production.

Cultural control:

- None

<u>Slugs</u>

Limax spp. *Arion* spp. *Deroceras* spp.

Slugs are occasional harvest contaminants particularly in cool, wet harvest weather when they may climb canes and move onto berries.

Chemical control:

- **Iron phosphate bait** (Sluggo) Organically approved. Efficacy: poor to fair.
- **Metaldehyde** baits (various brands) Application technique important to keep off basal foliage and fruit. Efficacy is excellent.

Biological control:

- None

Cultural control:

- Maintain vegetation free row middles and in rows. Efficacy is good.
- Slugs migrate into and under crates taken to the field before harvest, so keep crates and pallets away from damp soil and grass. Efficacy is good.

Snowy Tree Cricket

Oecanthus fultoni

Infestation by this species is very rare. Females drill small holes in canes to deposit eggs. Large numbers of punctures can girdle and kill canes above punctures, or weaken canes that can split or break under stress from wind or fruit load. Egg punctures can also be entry points for disease. Eggs hatch and young crickets emerge about May. Due to the life cycle of this pest, control is very difficult.

Chemical control:

- Insecticide applications are not made because by the time pest is noted, no chemical treatments would be successful.

Biological control:

- None

Cultural control:

- Remove and burn damaged primocanes to remove eggs.

Stinkbugs

Euschistus conspersus, and other species

Adults and egg masses on ripe fruit can cause quality issues and are a contaminant on harvested fruit. Since insecticides for leafrollers, weevils and other potential harvest contaminants are applied at the same time stinkbug control would be needed, the materials listed for those insects also often control Stinkbugs.

Chemical Control:

Organophosphate (Cannot use if pollinators are present.)

- **Malathion** PHI 1 day. Not as efficacious as others under cooler temperatures. Toxic to pollinators and parasitic wasps.

Carbamate

- **Carbaryl** (Sevin) PHI 7 days. Use can cause a mite flare-up. Poor adulticide. Works in warmer temperatures. Hard on beneficials and pollinators. Widespread use due to cost effectiveness and availability to growers who don't have restricted use license. Efficacy is poor.

Pyrethrums and Pyrethroids

- **Bifenthrin** (Brigade and other brands) PHI 3 days. Use can cause a mite flare-up. Can be used once pre-bloom and once post-bloom only. Widely used as clean up spray (pre-harvest). May be extremely toxic to parasitic wasps. Efficacy is excellent.
- **Esfenvalerate** (Asana XL) PHI 7 days**.** Specific application window of 7-12 days prior to harvest is limiting. Can cause a mite flare-up. Efficacy is fair.
- **Pyrethrin** (Pyganic) PHI 0 days. Efficacy is good for quick knock down but very hard on beneficials. Can cause mite flare-up. Approved for organic production.

- **Zeta-cypermethrin** (Mustang) PHI1 day. Use comparable to Bifenthrin. Efficacy is believed to be good, but little grower experience. This is not in widespread use yet, but could be a good fit because of restrictions on the number of Bifenthrin applications allowed.

Biological control:
- None

Cultural control:
- None

Thrips
Frankliniella spp.
Rarely a problem; control measures seldom used. Common flower feeders and, when abundant, have been reported to cause blossom blasting on occasion. They can also feed on fruit and be a contaminant on harvested fruit. Most likely to be a problem in specialty packs (e.g., kosher) with higher standards and/or restrictions.

Chemical control:
Organophosphate (cannot use when pollinators are present)
- **Diazinon** PHI 7 days. PHI is too long to be useful. As a result of EPA's review of organophosphates, only one application of Diazinon per season is allowed, which limits its use for thrips if it is needed for raspberry beetle or raspberry crown borer control. Limit of 2 lb a.i./acre for an entire season, with the option of allocating the limited amount toward soil drench and/or foliar application. Efficacy good.
- **Malathion** PHI 1 day. Short PHI makes it very useful. Thorough coverage is important. Short residual. Fair efficacy.

Pyrethrums and Pyrethroids (cannot use when pollinators are present)
- **Bifenthrin** (Brigade and other brands) Use can cause a mite flare-up. Can be used once pre-bloom and once post-bloom only. Widely used as clean-up spray (pre-harvest). Efficacy is excellent. May be extremely toxic to parasitic wasps.
- **Esfenvalerate** (Asana XL). Efficacy rated as good.
- **Pyrethrin** (Pyganic) PHI 0 days. Efficacy is good for quick knock down but very hard on beneficials. Can cause mite flair-up. Approved for organic production.
- **Zeta-cypermethrin (Mustang)** 1 day PHI. Use comparable to Bifenthrin. Efficacy is believed to be good; it is a new registration and there is yet little grower experience. This is not in widespread use yet, but could be a good fit because of restrictions on the number of Bifenthrin applications allowed.

Carbamate
- **Carbaryl** (Sevin) Efficacy is poor.

Other
- **Imidacloprid** (Admire Pro) PHI 7 days. Applied as a soil drench. Or (Provado and other brands) PHI 3 days. Applied as a foliar spray.
- **Spinetoram** (Delegate) Very similar to Spinosad. New product; limited experiences but will be replacement for Spinosad product. Bee toxicity until spray dries. Also potentially

toxic to beneficials.

- **Spinosad** (Success or Entrust) Success, PHI 1 day. New product, not much grower experience. Entrust is the organic formulation. PHI 1 day. Effective. Some restrictions due to bee toxicity. Bee toxicity until spray dries. Also potentially toxic to beneficials.

Biological control:

- None

Cultural control:

- None

<u>Critical Needs for Insect/Mite Management in Bloom to Pre harvest:</u>

Research:

- Conduct residue data work focused on shortening the PHI's of control materials that would allow for more effective pest management throughout the harvest period.
- Less toxic materials to pollinators and beneficials.
- Continue research on control of insect contaminants.
- Generate efficacy data on newer materials.
- Habitat management to conserve beneficials.
- Continue to develop IPM techniques.
- Resistance management.
- Develop economic thresholds and determine life cycles of various weevil species.

Regulatory:

- Shorter PHIs for several insecticides and miticides.

Education:

- Educate growers on IPM.
- Educate growers on pest identification and beneficials.
- Educate growers on habitat management for beneficials.
- Educate growers on resistance management, especially use of Bifenthrin.
- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

DISEASES

Black Raspberry Necrosis Virus (BRNV)

Black raspberry is the only caneberry that displays symptoms from this virus and can be very severely impacted. Red raspberry and blackberry are symptomless when infected with BRNV by itself. Recent collection from the wild of black raspberry selections that display very good aphid resistance increases that potential of future cultivars that could incorporate this trait.

Chemical control:

- Possible benefits from control of the aphid vector. See aphid control options.

Biological control:

- None

Cultural control:

- If possible, establish plantings that are isolated from infected fields.
- Use certified planting stock.

Fruit Rot (includes Cane Botrytis)

Botrytis cinerea

Fruit Rot, caused by *Botrytis cinerea,* is widespread in all the caneberry growing regions of Oregon and Washington. It causes lower quality fruit and/or reduced marketable yields. Initial infection of the fruit begins during early bloom when *Botrytis* spores are dispersed by wind and splashing water to infect developing flower parts. These early infections remain inactive (latent) until fruit develops and conditions are favorable for the fungus to further infect the fruit, causing gray mold on infected berries. This mold releases spores that cause additional fruit and cane infections. If conditions are favorable for disease development, several applications of a fungicide per season are required for adequate control. Tank mixing with, or rotation of, fungicides that have different modes of action are critical in a Fruit Rot control program to prevent likelihood of disease resistance.

Chemical control:

- **Boscalid + pyraclostrobin** (Pristine) PHI 0 days. Very effective on botrytis and broad spectrum.
- **Captan** 80WDG (50 WDG registered in Washington) at PHI 3 days. In widespread use due to cost effectiveness and broad-spectrum control of other diseases. However not as effective on botrytis as some other materials. Overseas market restrictions can limit its use. 12.5lbs Maximum allowed per year.
- **Captan + Elevate** (Captevate 68 WG) PHI 3 days. Labeled only for raspberries. Little used due to better materials and low rate of Captan.
- **Cyprodinil + Fludioxonil** (Switch 62.5 WG) PHI 0 days. Very effective on botrytis and moderately broad spectrum.
- **Fenhexamid** (Elevate), PHI 0 days. Narrow disease spectrum limits chemical usefulness. Very effective on botrytis.
- **Harpin Protein** (Messenger), PHI 0 days. Ineffective. Not used.
- **Hydrogen dioxide** (Oxidate) - Organic label; very limited effectiveness. Listed as a broad-spectrum fungicide and bactericide. OMRI approved. Foliar applications for Fruit

Rots, Downy and Powdery Mildews.

- **Iprodione** (Iprodione 4L AG, Rovral) PHI 0 days. Limited use; documented resistance. Good efficacy where resistance isn't a factor. Poor where it is a factor.
- **Ziram** (Ziram Granuflo). For late-ripening blackberries only; labeled for use only between mid-June and early July. Very little use due to availability of better materials with fewer restrictions.

Biological control:

- None

Cultural control:

- Cane vigor control and primocane suppression.
- Minimize or adjust irrigation so plants are not wet for long periods.
- North-South row orientation promotes even sun exposure and good air drainage.
- Planting resistant cultivars may be an option in some situations.
- Prune out more canes.
- Use drip/trickle irrigation.

Downy Mildew

Peronospora sparsa

This disease can be problematic in Boysenberries and some blackberry cultivars; raspberries and most blackberries are not affected. Climatic conditions play a major role in seemingly sudden outbreaks of disease symptoms, causing flare-ups of dry cell type symptoms on ripening fruit, reducing quality and marketability. Only effective treatment window in pre-bloom. See that entry for materials used.

The fungus overwinters primarily as a systemic infection of canes, crowns, roots, and buds. The disease cycle starts each spring with the production of infected shoots from infected root, crown, and cane buds. Diseased berries (with symptomatic "dry cell" damaged drupelets) then become an important source of inoculum for new cycles of berry infection. After harvest, infection of developing primocanes lying on the ground continues by internal mycelial growth and spore infection.

Chemical control:

- None are recommended for this development stage.

Biological control:

- None

Cultural control:

- None

Orange Rust

Arthuriomyces peckianus and *Gymnoconia nitens*

Rare, but extremely serious economically. Was last reported in 1997 on Kotata blackberries in the Willamette Valley. Fungi systemically infect the plants and, because of the infection, floricanes never produce flowers. Plants should be quickly removed and destroyed.

Chemical control:

(None will cure existing infection. Herbicides can be used for spot treatment to kill infected plants.)

- **Myclobutanil** (Rally 40 W) 0 PHI.

Biological control:

- None

Cultural control:

- Establish new planting from a clean source.
- Quickly destroy infected plants.
- Scout for disease during spring and summer months.

Powdery Mildew

Sphaerotheca macularis

Blackberries and raspberries are usually not affected by this fungal disease but 'Boysenberry' is very susceptible. Warm, dry weather favors development of this disease. In spring, ascospores are the primary inoculum. Severe mildew retards, dwarfs, and distorts plant parts and makes fruit unsalable.

Chemical control:

- **Azoxystrobin** (Abound) PHI 0 days. Efficacy very good.
- **Hydrogen dioxide** (Oxidate) Organic label; questionable effectiveness. Broad-spectrum fungicide and bactericide. OMRI approved. Foliar applications for Fruit Rots, Downy and Powdery Mildews.

Biological control:

- None

Cultural control:

- None

Raspberry Bushy Dwarf Virus (RBDV)

This is a major disease of many red and black raspberry cultivars and reduces the useful life of the plant by 50-75%. It is also found in Boysenberry, Loganberry and Marionberry. Fruit from infected plants are often crumbly or small and do not make IQF grade (the fruit is sold at a lower value and used for juice, jam or puree). RBDV is spread by pollen and vectored by pollinators. The virus is present in the root system, so removal must include destroying the root system so no suckers from the old root system remain. Very little virus is found in native *Rubus spp other than* Thimbleberry (*R. parviflorus*); the native *Rubus spp.* are probably not a major source of rapid

spread into commercial fields.

There are no controls for this virus. Even when present in native *Rubus spp*., pollination of commercial *Rubus spp*. with pollen from other species is likely a rare event.

Chemical control:
- None

Biological control:
- None

Cultural control:
- Adjacent area management.
- If possible, establish plantings that are isolated from infected fields.
- Planting resistant cultivars may be an option in some situations.
- Plant in large blocks to slow movement into new plants, especially if fields in the immediate area are infected.
- Use certified planting stock.

Root Rot

Phytophthora spp.

A major disease complex of red and black raspberries, and hybrid berries, in Oregon and Washington; occasionally found in blackberries. *Phytophthora fragariae* var. *rubi* causes a typical wet-soil Root Rot in raspberries throughout the region especially in the southern region, which has heavier soils; fine roots are lacking and root pith is brownish-red. No raspberry cultivar is very resistant. Plants may appear to recover, but new roots are often weak and lack lateral development. The new roots in turn become infected during cold, wet weather the next fall and winter so that the plant progressively declines. No single cultivar, chemical, or cultural practice used alone effectively controls this serious root disease. Control will depend on an integrated program that combines several approaches.

Chemical control:
- **Phosphorous acid** (Fosphite and other brands). Apply to foliage twice in spring. Multiple applications per season required. While some products are labeled only as plant nutrients other products carry a disease control label. The bewildering mix of formulations and pricing has led to much confusion over the potential efficacy differences between all these products.

Biological control:
- None

Cultural control:
- None

Spur Blight

Didymella applanata

Primocanes are commonly affected by this fungus that overwinters on infected canes produced the year before. Spores released from lesions on these canes can infect floricane and primocane foliage, usually appearing as a brown, wedge-shaped lesion. This is the symptom that may be seen at this time of the season. The fungus then moves through the leaf and petiole and is most apparent as a purplish/brown lesion around the bud on the lower portion of primocanes. This symptom on primocanes may not be seen until mid-harvest or thereabouts. This disease primarily affects red raspberries. Post harvest application of chemicals helps reduce inoculum.

Chemical control:

- **Azoxystrobin** (Abound) PHI 0 days. Efficacy very good.
- **Boscalid + pyraclostrobin** (Pristine) PHI 0 days. Very good efficacy.
- **Captan** 80WDG, PHI 3. In widespread use due to cost effectiveness and broad-spectrum control of other diseases. Market restrictions limit its use. 12.5lbs Maximum allowed per year. Efficacy is good.
- **Cyprodinil + Fludioxonil** (Switch 62.5 WG) PHI 0 days. Good to excellent efficacy.
- **Fenhexamid** (Elevate) PHI 0 days. Efficacy good when used with Captan.
- **Iprodione** (Rovral 50WP) PHI 0 days. Efficacy good when used with Captan.
- **Pyraclostrobin** (Cabrio EG) Very good efficacy.

Biological control:

- None

Cultural control:

- Control early primocane growth.
- Keep plant rows narrow.
- Practice good weed control.

Stamen Blight

Hapalosphaeria deformans

This fungal disease can be severe in some specific upright blackberry cultivars and Boysenberry. It does not affect raspberries or most blackberries. Severity varies markedly from year to year. Rain splashes spores from infected flowers to auxiliary buds of primocanes during bloom. If fruit develops, the receptacle is constricted, and a number of drupelets either fail to develop or do so unevenly. Ripening may be uneven, and fruit is hard and difficult to remove from the receptacle. Commonly, early blossoms are infected more severely than those opening during peak bloom period.

Chemical control:

- **Captan** 80WDG. PHI 3. In widespread use due to cost effectiveness and broad-spectrum control of diseases; market restrictions limit its use. 12.5lbs Maximum allowed per year. Efficacy is fair.

Biological control:

- None

Cultural control:

- The alternate-year fruiting system of growing blackberries controls the disease by removing the inoculum source from above the developing primocanes.

Yellow Rust

Phragmidium rubi-idaei

This disease is a major problem in raspberries throughout Oregon and Washington but does not affect blackberries. Fruit often dies on the canes before maturing if leaves on fruiting laterals are attacked early in the summer. By harvest, black overwintering spores (teliospores) appear in the yellow uredinia on the lower leaf surface. All succulent plant parts are subject to infection, but cane lesions rarely are observed.

Chemical control:

- **Boscalid + pyraclostrobin** (Pristine) PHI 0 days. Good efficacy. Often used for rotation with Rally and for its effectiveness on a wide spectrum of fungal diseases.
- **Myclobutanil** (Rally 40 W) 0 day PHI. Has become the industry standard. Good to Excellent control.
- **Propiconazole** (Orbit) PHI 30 days. Although not labeled for this disease, efficacy very good however it retards plant growth for a period after application. Long PHI also limits its use.
- **Pyraclostrobin** (Cabrio EG) PHI 0 days. Not as effective as Rally, Pristine or Orbit.

Biological control:

- None

Cultural control:

- None

Critical Needs for Disease Management in Dormancy to Pre-bloom:

Research:

- Black raspberry decline --Identification of the combination of viruses involved and better management techniques.
- Breeding and effective screening of new cultivars for virus and aphid resistance to Raspberry Bushy Dwarf Virus.
- Identify other fungal diseases that are affecting yield and quality.
- Modeling and disease forecasting for major insect pests and plant pathogens.
- New management strategies for Botrytis Fruit Rot control.

Regulatory:

- Allow multiple active ingredient Section 18s to allow a rotation of active ingredients for resistance management.

Education:

- Educate growers on how to use new chemistries and resistance management.
- The Extension Service provides a wide variety of research-based information and educational materials on many topics to growers; the continued support of their services is critical.

WEEDS

For AY production systems, weed control using products with "non-bearing" restrictions on the label can be used during this period.

Chemical control:

- **Carfentrazone-ethyl** (Aim 40W) broadcast, for primocane control. PHI 15 days.
- **Diuron** (Karmex, Diuron 80 or Diuron 4L) Preemergence. Use in row middles only. Efficacy ranges from poor to good.
- **Oxyfluorfen** (Goal 2XL) broadcast, for blackberries, PHI 15 days; cannot use in raspberries at this time because PHI for raspberries is 50 days. 24c registration. Efficacy ranges from poor to good.
- **Sethoxydim** (Poast) PHI 45 days. The 45 day. PHI limits usefulness. Postemergence herbicide. Controls grasses only. Resistant grasses include annual bluegrass and all fine fescues, but Quackgrass can be suppressed.

Biological control:

- None

Cultural control:

- Cultivating
- Flaming
- Hand hoeing
- Mowing

<u>Critical Needs for Weed Management in Dormancy to Pre-bloom:</u>

Research:

- Selective postemergence products.

Regulatory:

- Shorten PHI for Sethoxydim (Poast).

Education:

- Cover crop management.
- Educate growers on weed shifts and resistance (need for rotation of herbicides).
- Identification and biology of weeds.
- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the

defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

NEMATODES

Root-Lesion Nematode *(Pratylenchus spp)*
Dagger Nematode *(Xiphinema americanum)*

Chemical control:

- None

Biological control:

- None

Cultural control:

- None

<u>Critical Needs for Nematode Management in bloom to Preharvest:</u>

Research:

- None

Regulatory:

- None

Education:

- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

IV. HARVEST

Mid June to Mid August
Raspberries -- Southwest Washington
Late June to Mid August
Raspberries -- Northwest Washington
Raspberries, black raspberries and most blackberries -- Oregon
Mid-August to October
Evergreens and other late-ripening blackberries -- Oregon

HARVESTING METHOD

Mechanical harvesters are the predominant method of harvest for caneberries. The number of people needed for machine-harvesting depends on the type of harvester utilized. The driver/operator and from 1 to 4 people to work the sorting belt and maneuver filled crates are required per harvester. Depending on machine type and the hours of operation, a mechanical harvester can pick 8-10 acres per day. To complete harvest for the entire season, machine-picking requires 4-12 picks through the field; hand-picking takes 3 to 4 picks. The following data are estimates of the percentage of caneberries that are hand-picked (HP) or machine-picked (MP) during a typical berry season:

	HP	MP
Red raspberry	<5%	>95%
Black raspberry	<5%	>95%
Blackberry (all types)	25-35%	65-75%
Boysenberry	70-80%	20-30%
Loganberry	100%	0%

FARMING ACTIVITIES

The following farming activities, many that are pertinent to AY production systems on a calendar basis, may take place during the harvest period:

- Fruit Rot control, as necessary
- Fungicide sprays of canes in AY production
- Monitor for Root Rot
- Apply insecticides for control of harvest contaminants, as needed
- Monitor for mites
- Harvest
- Irrigation
- Scouting
- Train canes (in AY blackberry production)
- Peg primocanes out of row middles (in EY blackberry production)
- Fruit sorting

INSECTS AND MITES

Many insects are dislodged from caneberry foliage during the machine-harvesting process. These may include aphids, leafrollers, loopers, cutworms, small gnats, plant bugs, slugs, Earwigs, Box Elder Bugs, and several different species of weevils. Spiders and other beneficials can be contaminants in harvested fruit, as well. Many of these insects do not directly damage the plant but their mere presence in harvested fruit does pose a contamination problem, even if they are beneficial species. Even hand-harvested fruit may suffer from insect contaminants. The most serious contaminants are leafrollers in the south and weevils in the north. Most of these insects are partially controlled with a broad-spectrum insecticide application prior to the onset of harvest.

Insect contaminants

Many and various species which can include aphids, leafrollers, loopers, cutworms, small gnats, plant bugs, slugs, Earwigs, Box Elder Bugs, several species of weevils and spiders.

Chemical control:

Organophosphate

- **Malathion** PHI 1 day. Thorough coverage is important. Not as efficacious as others, but short PHI makes very useful.

Pyrethrums and Pyrethroids

- **Bifenthrin** (Brigade and other brands) PHI 3 days. The 3-day PHI is often too long for use in raspberries but is a good fit in blackberries that have a longer interval between picks.
- **Pyrethrin** (Pyganic) Organically approved.

Other

- **Spinetoram** (Delegate). PHI 1 day. Similar to Spinosad. New product; limited grower experience but will replace probably Spinosad in the market. Toxic to bees if not dried. Can be used at night if dried by morning.
- **Spinosad** (Success or Entrust) Entrust is the organic formulation. PHI 1 day. Effective.

Biological control:

- ***Bacillus thuringiensis*** (Bt) various labels have various rates. PHI 0 days. Too slow acting. Effective only on Lepidoptera larvae.

Cultural control:

- Add additional human sorters to harvesting machine.

- Correct adjustment of air-blast or vacuum-suction cleaner systems can lessen insect contamination of machine-harvested berries.

Critical Needs for Insect/Mite Management during Harvest:

Research:

- Insect collection systems on harvesting machines.
- Minimizing spread of insects through improved machine harvesting techniques.
- Alternative methods of removing insect contaminants from fruit.
- Develop less toxic materials or methods to workers.
- Life cycles of various weevil species.

Regulatory:

- Shorter PHIs/REIs.

Education:

- Identify insect contaminants so grower can better control.
- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

DISEASES

During the harvest period, *Botrytis cinerea* becomes active as the fruits mature and is the major fungal disease in caneberries. Symptoms include gray mold on the surface of berries (Fruit Rot) and pale brown lesions on the surface of canes (Cane Botrytis). Fruit Rot disease develops faster on overripe, mature berries. Control measures (fungicide applications) are initiated during bloom but may continue during harvest if disease pressure is severe. The harvest period is a critical period for Cane Blight because catcher plates on harvest machines, if not adjusted properly, can damage primocanes and open the door for infection. Cane Blight symptoms cannot be seen until later in the fall; control measures are taken after harvest. Spur Blight infection of new canes first appears as brown, wedge-shaped lesions usually on lower primocane leaves. The fungus progresses through the leaf and petiole, and into the primocane where it causes a chestnut-colored lesion on the surface around a bud. Although control of Spur Blight occurs in early spring and, again, after harvest, this cane lesion is the most obvious symptom of the disease during the harvest period. During harvest the most common above ground symptom of *Phytophthora* Root Rot is the collapse of fruiting laterals and wilting of primocanes. Treatment for Root Rot, however, occurs in the spring and in the fall.

Downy Mildew

Peronospora sparsa

This disease can be problematic in Boysenberries and some blackberry cultivars; raspberries and most blackberries are not affected. Climatic conditions play a major role in seemingly sudden outbreaks of disease symptoms, causing flare-ups of dry cell type symptoms on ripening fruit, reducing quality and marketability. Only effective treatment window is in pre-bloom. See that entry for materials used.

The fungus overwinters primarily as a systemic infection of canes, crowns, roots, and buds. The disease cycle starts each spring with the production of infected shoots from infected root, crown, and cane buds. Diseased berries (with symptomatic "dry cell" damaged drupelets) then become an important source of inoculum for new cycles of berry infection. After harvest, infection of developing primocanes lying on the ground continues by internal mycelial growth and spore infection.

Chemical control:

- None are recommended for this development stage.

Biological control:

- None

Cultural control:

- None

Fruit Rot (includes Cane Botrytis)

Botrytis cinerea

Under conditions favorable for disease development, Fruit Rot can be severe and can require control prior to and in between harvests to prevent major crop losses. The fungus enters the plant through the blossom and lies dormant until the fruit develops. Fruit becomes rotted, usually with tufts of gray fungus growing on the surface (Fruit Rot). The fungus may also infect leaves and, moving through the petiole, cause cane infections with lesions (Cane Botrytis). A fungicide with a short PHI is necessary during harvest.

Chemical control:

- **Boscalid + pyraclostrobin** (Pristine) PHI 0 days. Very effective on botrytis and broad spectrum.
- **Captan** 80WDG (50 WDG registered in Washington) PHI 3 days. In widespread use due to cost effectiveness and broad-spectrum control of other diseases; however not as effective on botrytis as other materials. Market restrictions limit its use. 12.5lbs Maximum allowed per year.
- **Captan + Elevate** (Captevate 68 WG) PHI 3 days. Labeled only for raspberries. Little used due to better materials and low rate of Captan.
- **Cyprodinil + Fludioxonil** (Switch 62.5 WG) PHI 0 days. Very effective on botrytis and moderately broad spectrum.
- **Fenhexamid** (Elevate) PHI 0 days. Narrow disease spectrum limits chemical usefulness.

Very effective on botrytis.
- **Harpin Protein** (Messenger) PHI 0 days. Ineffective. Not used.
- **Hydrogen dioxide** (Oxidate) Organic label; very limited effectiveness. Listed as a broad-spectrum fungicide and bactericide. OMRI approved. Foliar applications for fruit rots, Downy and Powdery Mildews.
- **Iprodione** (Iprodione 4L AG) PHI 0 days. Limited use; documented resistance.

Biological control:
- None

Cultural control:
- Cane vigor control and primocane suppression.
- Harvest fruit at correct stage of maturity; do not allow it to over-ripen.
- Minimize or adjust irrigation so plants are not wet for long periods. Use drip/trickle irrigation.
- Move harvested fruit to cold storage as soon as possible.
- North-South row orientation promotes even sun exposure and good air drainage.
- Planting resistant cultivars may be an option in some situations.
- Shorten harvest intervals, if possible. Don't let overripe fruit remain in the field.

Powdery Mildew

Sphaerotheca macularis

Blackberries and raspberries are usually not affected by this fungal disease but 'Boysenberry' is very susceptible. Warm, dry weather favors development of this disease. In spring, ascospores are the primary inoculum. Severe mildew retards, dwarfs, and distorts plant parts and makes fruit unsalable.

Chemical control:
- None are recommended for this development stage.

Biological control:
- None

Cultural control:
- None

Critical Needs for Disease Management in Harvest:

Research:
- Continue to evaluate new management strategies for Botrytis Fruit Rot.
- Develop spray timing based on models.
- Identify causal agents for Dry Cell Syndrome.
- Identify fungal diseases, in addition to Botrytis, that are affecting yield and quality.

Regulatory:

- Allow multiple active ingredient Section 18s for resistance management for pests that have a documented history of resistance.

Education:

- Educate growers on how to use new chemistries and resistance management.
- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

WEEDS

Weeds control is generally not practiced or needed during harvest.

Chemical control:

- None

Biological control:

- None

Cultural control:

- Some hand hoeing.

<u>Critical Needs for Weed Management in Harvest:</u>

Research:

- None

Regulatory:

- None

Education:

- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

NEMATODES

Root-Lesion Nematode *(Pratylenchus spp)*
Dagger Nematode *(Xiphinema americanum)*
There are usually no controls during this crop stage.

Chemical control:

- None

Biological control:

- None

Cultural control:

- None

Critical Needs for Nematode Management in Harvest:

Research:

- None

Regulatory:

- None

Education:

- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs

V. POST HARVEST

Early August to Mid October
Raspberries -- Southwest Washington Mid-August to Mid October
Raspberries -- Northwest Washington
Raspberries, black raspberries and most blackberries -- Oregon
Late September to Early November
Evergreens and other late-ripening blackberries -- Oregon

FARMING ACTIVITIES

The following farming activities, many that are pertinent to AY production systems on a calendar basis, may take place during the post harvest period:

- Irrigation.
- Take tissue samples for nutrient analysis.
- Take soil and nematode samples.
- Nematicide application, if needed.
- Monitor for diseases, such as, Root Rot, Cane Blight, Anthracnose, and rust.
- Fungicide application, if needed.
- Monitor for root weevil larvae in soil, mites on foliage.
- Insecticide/miticide application, if needed.
- Remove old fruiting canes.
- Tie up canes.
- Rebuild raised beds.
- Subsoil row middles before rain begins.
- Apply pre-emergence and postemergence herbicides.
- Establish cover crops.
- Rodent control.

INSECTS AND MITES

Aphids, mites and root weevils can be present on foliage after harvest.

Aphids

Amphorophora agathonica
In the northern, cooler growing areas, it is a common practice to treat for aphids to prevent an economic reduction plant vigor caused by their feeding. In the warmer, southern areas this practice is uncommon.

Chemical control:
Organophosphate

- **Diazinon** As a result of EPA's review of organophosphates, only one application of Diazinon per season is allowed, which limits its use for aphids if it is needed for raspberry beetle or raspberry crown borer control. Efficacy is good.
- **Malathion** Efficacy is excellent for quick knock down but no residual control.

Pyrethroids

- **Bifenthrin** (Brigade and other brands) Use can cause a mite flare-up.

Other

- **Imidacloprid** (Admire-Pro) Applied with .25 inches irrigation or within 2 hours of rainfall. (Provado and other brands) Foliar application. Efficacy is fair.
- **Potassium salts of fatty acids** (M-Pede and other brands) PHI 0 days. Efficacy is very poor. Organically approved.
- **Spinosad** (Success or Entrust) Entrust is the organic formulation. PHI 1 day. Poor efficacy.
- **Thiamethoxam** (Actara) Efficacious but not much field experience.

Biological control:

- Ladybird releases. Not economic.

Cultural control:

- Cover crops to encourage beneficials.

<u>Mites</u>

Twospotted Spider Mite *(Tetranychus urticae)* and others
Yellow Spider Mite *(Eotetranychus carpini borealis)* and others
Mites are not a problem in trailing blackberries, although they can be an occasional problem in erect and semi-erect blackberries. Both mite species are major economic pests in raspberries. Spider mite populations can increase rapidly after harvest through early September. Most of the mite population by this time has moved gradually from fruiting canes to primocane foliage. Defoliation in post harvest causes weak lateral buds next year. Recent research indicates the importance of maintaining healthy foliage late into the season in order to provide adequate carbohydrate reserves for the plant.

Chemical control:

- **Bifenazate** (Acramite-50WS) Allowed one application per year. Works well along with Savey.
- **Bifenthrin** (Brigade and other brands) Potential resistance because of heavy use for control of other pests. Efficacy is good.
- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Use at delayed dormant stage.
- **Hexakis (50%) or Fenbutatin-oxide** (Vendex 50WP**)** Takes up to 10 days to work. Effective, but less so in cool temperatures. Safe for beneficials. Registered for Raspberries only.
- **Hexythiozox** (Savey 50 WP) Very expensive. Ovicidal only. Good control of next generation. Safe to beneficials. Works well along with Acramite.
- **Horticultural oils** (particularly for early budbreak infestations). Efficacy is good.

- **Potassium salts of fatty acids** (M-Pede) Poor efficacy, short residual. Possibly better than doing nothing. Organically approved.

Biological control:

- **Anthocoris** Naturally occurring. Can purchase for inoculative releases but too expensive to be practical. Excellent naturally occurring control in many areas.
- **Predatory mites** (naturally occurring and can be purchased for release). Inundative releases of predatory mites are not practical. Naturally occurring predatory mite populations can be a major factor in mite management at this stage. Inoculative releases are occasionally used and have been researched but the long time for predatory mites to build up populations for good control limits efficacy.
- **Stethorus** Can be abundant in some regions and be a major factor in mite management. While they can be available commercially, it isn't practical to do inoculative releases due to expense.

Cultural control:

- Avoid moisture stress.
- Conserve natural predators.
- Dust suppression.

Root Weevils

Black Vine Weevil *(Otiorhynchus sulcatus)*
Strawberry Root Weevil *(O. ovatus)*
Rough Strawberry Root Weevil *(O. rugosostriatus)*
Obscure Root Weevil *(Sciopithes obscurus)*
Clay Colored Weevil *(O. sinularis)*
Adult root weevils can still be present after harvest but control measures of these adults is seldom economic since they've already laid the majority of eggs that lead to the population causing the damage the following season. Control applications in this crop window exclusively for weevil management are not recommended.

Chemical control: (adults)
Post harvest weevil treatment, while labeled, is not common or effective.
Organophosphate

- **Malathion** Poor efficacy. Not a restricted use material.

Pyrethroids

- **Bifenthrin** (Brigade and other brands) Use can cause a mite flare-up.
- **Esfenvalerate** (Asana XL) Not efficacious. PHI too long.
- **Zeta-cypermethrin** (Mustang) New registration. Efficacy is believed to be good, but little grower experience. This is not in widespread use yet, but could be a good fit because of restrictions on the number of Bifenthrin applications allowed.

Other

- **Azadirachtin** (Neem). Several brands. Poor efficacy. Organically approved.
- **Cryolite Bait** 24c registration. Not available (mfg. has discontinued production due to

lack of demand).
- **Thiamethoxam** (Actara). Efficacious but not much field experience.

Biological control:
- ***Beauveria bassiana*** (Mycotrol) New product, not much grower experience. Organically approved.
- **Parasitic nematodes** Available in various species but have not been found to be reliably efficacious or economic.

Cultural control:
- Adjacent area management.

Critical Needs for Insect/Mite Management in Post harvest:

Research:
- Develop economic threshold for root weevil larvae and determine life cycles of various weevil species.
- Predatory nematodes or biocontrol agents of root weevil larvae.
- Tools for control of root weevil larvae; identify best time for control.

Regulatory:
- Expedite registration of larvicides (e.g. soil-applied thiamethoxam) for root weevil larvae.

Education:
- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

DISEASES

Catcher plates on harvest machines, if not adjusted properly, can damage primocanes and create entry site for the fungus that causes Cane Blight. Cane Blight symptoms cannot be seen until later in the fall; control measures are taken after harvest. Cane Blight infection is likely to be more severe in years with heavy rainfall during the harvest period.

Black Raspberry Necrosis Virus BRNV

Black raspberry is the only caneberry that displays symptoms from this virus and can be very severely impacted. Red raspberry and blackberry are symptomless when infected with BRNV by itself. Recent collection from the wild of black raspberry selections that display very good aphid resistance increases that potential of future cultivars that could incorporate this trait.

Chemical control:

- Possible benefits from control of the aphid vector. See aphid control options.

Biological Control:

- None

Cultural Control:

- None

Bacterial Blight

Pseudomonas syringae

A rarely occurring problem in raspberries. Not seen in blackberries. Also called "blind bud". This is an ice nucleating bacteria. It enters buds in the fall where it overwinters, causing damage by raising the temperature at which water freezes in the plant tissue. Affected buds fail to develop in the spring. Developing fruiting laterals below dead buds may also become infected. Symptoms are blackened stems and leaves and a shepherd's crook bending at the tip. Occurrence is usually quite erratic.

Chemical control:

Apply before rains begin.

- **Bordeaux** (copper sulfate + hydrated lime) Efficacy is good.
- **Fixed copper** (several brands). Many formulations are organically acceptable. Efficacy is good.

Biological control:

- None

Cultural control:

- None

Cane Blight

Leptosphaeria coniothyrun

The immediate post harvest period is the critical time for Cane Blight preventative treatments because the catcher plates on harvest machines can scrape wounds on primocanes and open the door for infection. A fungicide application over these wounds can effectively limit disease severity. Symptoms cannot be seen until later in the fall or even the following spring.

Chemical control:

(Preliminary research has shown good efficacy with Pristine and Abound. Both are labeled for

other diseases but are used in this window of time for Cane Blight management as well as the other diseases)

- **Azoxystrobin** (Abound) PHI 0. Efficacy good.
- **Boscalid + pyraclostrobin** (Pristine) PHI 0 days. Very effective on botrytis and broad spectrum.
- **Captan** 80WDG. Not effective but the only fungicide labeled for Cane Blight. PHI 3 days.

Biological control:

- None

Cultural control:

- Irrigate in the early morning to minimize the period that plants remain wet.
- Prune black raspberries in dry weather to force lateral growth so wounds will dry.
- Prune close to the ground; the fungus overwinters on cane stubs.
- Minimize or adjust irrigation so plants are not wet for long periods Use drip/trickle irrigation instead of overhead irrigation.
- Remove infected canes.
- Use the alternative-year fruiting system for blackberries.

Cane Botrytis

Botrytis cinerea

This fungus which causes major Fruit Rot may also infect leaves and, moving through the petiole, cause cane infections with lesions (Cane Botrytis). Applications post harvest may be needed to limit cane infections.

Chemical control:

- **Boscalid + pyraclostrobin** (Pristine) Efficacy is excellent on botrytis and many other fungal diseases.
- **Captan** 80WDG (50 WDG registered in Washington) Not as effective on botrytis as other materials. Efficacy is good.
- **Captan + Elevate** (Captevate 68 WG) PHI 3 days. Labeled only for raspberries. Little used due to better materials and low rate of Captan.
- **Cyprodinil + Fludioxonil** (Switch 62.5 WG) Very effective on botrytis.
- **Fenhexamid** (Elevate) Narrow disease spectrum limits chemical usefulness. Very effective on botrytis.
- **Harpin Protein** (Messenger) Ineffective. Not used.
- **Hydrogen dioxide** (Oxidate) Organic label; very limited effectiveness. Listed as a broad-spectrum fungicide and bactericide. OMRI approved.
- **Iprodione** (Iprodione 4L AG) Limited use; documented resistance.

Biological control:

- None

Cultural control:

- None

Root Rot

Phytophthora spp.

A major disease complex of both red and black raspberry in the Oregon and Washington; occasionally found in blackberries. *Phytophthora fragariae* var. *rubi* causes a typical wet-soil Root Rot in red raspberries throughout the region especially in the southern region, which has heavier soils. No red raspberry cultivar is very resistant. Plants may appear to recover, but new roots are often weak and lack lateral development. The new roots in turn become infected during cold, wet weather the next fall and winter so that the plant progressively declines.

Chemical control:

- **Fosetyl-Al** (Aliette WDG). Applied to foliage twice in spring and repeated in fall. Efficacy rated as fair to good.
- **Mefenoxam** (Ridomil Gold). Applied just before fall rains when relatively warm soils can become saturated and provide perfect conditions for disease spread. Registered for use in raspberries only. Fair to excellent control.
- **Phosphorous acid** (Fosphite and other brands). Applied to foliage twice in spring and repeated in fall. Multiple applications per season required. While some products are labeled only as plant nutrients other products carry a disease control label. The bewildering mix of formulations and pricing has led to much confusion over the potential efficacy differences between all these products.

Biological control:

- None

Cultural control:

- Best results occur when several cultural and chemical practices are integrated together.
- Maintain raised beds.
- Refrain from overwatering in the fall.
- Subsoil between rows to promote drainage.

Leaf and Cane Spot (aka *Septoria* leaf spot)

Septoria rubi

Fall treatments are usually used for multiple disease control of which this is one. Inoculum on canes can be reduced by spraying after harvest and/or spraying in early October before heavy rains begin.

This fungal disease is prevalent in most blackberry and hybrid berry fields but doesn't cause economic losses in most circumstances. Minute, black, fruiting bodies (pycnidia) are formed within infected tissue, mature, and produce spores. Rain spreads the spores. During the wet early spring, more spores are produced, causing many new infections. Leaf spots vary from light to dark brown and are about 3mm in size. At first, they are purplish in color then later turn brown.

In older leaf spots, centers are whitish with brown to red borders. Infections on canes are similar to those on leaves but are elongated and generally inconspicuous.

Chemical control:
1. Spray after harvest.
    - **Fixed copper** (several brands). Many formulations are organically acceptable. Fair to good control.
2. Spray again in early October before heavy rains begin.
    - **Copper** (Bordeaux) Fair to good control.
    - **Fixed copper** (several brands). Many formulations are organically acceptable. Fair to good control.

Biological control:
- None

Cultural control:
- Alternate-year (AY) fruiting program. Cane and Leaf Spot is generally not a problem in AY-producing fields if canes are trained to the trellis as they grow. If canes are allowed to lie on the ground, Cane and Leaf Spot can be just as severe as in fields where berries are harvested annually.
- Control weeds because they can provide a natural "moist chamber" for infection and prevent effective spray coverage.
- Remove old fruiting canes after harvest.
- Trellis canes in August through early September or wait until late winter (February or March). Canes trained after early September may be more susceptible to winter injury.

Purple Blotch

Septocyta ruborum

Fall treatments are usually used for multiple disease control of which this is one. Inoculum on canes can be reduced by spraying after harvest and/or spraying in early October before heavy rains begin.

All blackberries and hybrid berries can be affected by this disease but Marionberries are particularly susceptible. The causal organism is a fungus similar to *Septoria rubi*. Spores are produced in spring on floricanes and then infect newly emerging primocanes. Symptoms don't develop until after chilling requirements are met. During winter and spring, lesions become purple with a red margin. Affected areas develop into cankers and girdle canes. Severely affected canes die in spring. The control strategy is to protect the primocanes from infection in the spring or, in an alternate year cropping system, remove floricanes before they can infect the emerging primocanes.

Chemical control:
- **Copper** (Bordeaux). Efficacy is poor to fair.
- **Fixed copper** (several brands). Many formulations are organically acceptable. This is a typical grower practice in the fall but more effective on diseases other than Purple Blotch.

Efficacy poor.

Biological control:

- None

Cultural control:

- Alternate-year (AY) fruiting program. Cane and Leaf Spot is generally not a problem in AY-producing fields if canes are trained to the trellis as they grow. If canes are allowed to lie on the ground, leaf and cane spot can be just as severe as in fields where berries are harvested annually.
- Controlling weeds since they can provide a natural moisture chamber for infection and prevent effective spray coverage.
- New over old training technique (efficacy unknown, needs more research) (is this the correct crop stage?)
- Remove old fruiting canes after harvest.
- Trellis canes in August through early September or wait until late winter (February or March). Canes trained after early September may be more susceptible to winter injury.

Spur Blight

Didymella applanata

Though chemicals are labeled for this stage, disease is not controlled during this time.

Chemical control:

- None are recommended and seldom used for this disease in this window.

Biological control:

- None

Cultural control:

- Keep plant rows narrow.
- Practice good weed control.

Stamen Blight

Hapalosphaeria deformans

Fall treatments are usually used for multiple disease control of which this is one. Inoculum on canes can be reduced by spraying after harvest and/or spraying in early October before heavy rains begin.

Primocanes are commonly affected by this fungus that overwinters on infected canes produced the year before. Spores released from lesions on these canes can infect floricane and primocane foliage, usually appearing as a brown, wedge-shaped lesion. This is the symptom that may be seen at this time of the season. The fungus then moves through the leaf and petiole and is most apparent as a purplish/brown lesion around the bud on the lower portion of primocanes. This symptom on primocanes may not be seen until mid-harvest or thereabouts. This disease

primarily affects red raspberries. Post harvest application of chemicals helps reduce inoculum.

Chemical control:

- Calcium polysulfide (Lime sulfur, Sulforix, and other brands). Late summer application on Boysenberries is reported by some growers to provide adequate disease suppression.

Biological control:

- None

Cultural control:

- Alternate-year fruiting system helps control the disease by removing inoculum source from the developing primocanes.

Yellow Rust

Phragmidium rubi-idaei

Rust is generally not treated at this time. However immediate post harvest applications are sometimes used if infection and subsequent defoliation of primocanes is severe.

Chemical control:

- **Boscalid + pyraclostrobin** (Pristine) Good efficacy. Often used in rotation with Rally and for its effectiveness on a wide spectrum of fungal diseases.
- **Myclobutanil** (Rally 40 W) Very effective. Rally has become the industry standard.
- **Propiconazole** (Orbit) Although not labeled for this disease, efficacy is very good; however it retards plant growth for a period after application so is used judiciously.
- **Pyraclostrobin** (Cabrio EG) Not as effective as Rally, Pristine or Orbit.

Biological control:

- None

Cultural control:

- Cultivate in late fall to cover fallen leaves, old cane stubs, and refuse to eliminate inoculum source.
- Postpone trellising primocanes until leaves drop off or strip leaves from primocanes before tying.
- Remove and burn old fruiting canes as soon after harvest as possible, cutting flush with the ground. Cultivate as soon as weather permits

Critical Needs for Disease Management in Post harvest:

Research:

- Fungicide timing for Spur Blight control.
- Herbicides that have better selectivity between the weeds and the crop plants for in-row weed management.
- Research post harvest fruit handling to minimize disease: Ozone or other options.

Regulatory:

- Register thiophanate (Topsin M) for Cane Blight control.

Education:

- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.
- Educate growers on how to use new chemistries and resistance management.

WEEDS

After canes are trained to the trellis wire in the late summer, a preemergence herbicide can be applied to the plant row. If grasses are present, the postemergence grass herbicide, Sethoxydim (Poast) can be applied. Glyphosate, for control of emerged weeds, must be used carefully and judiciously at this time, as it is non-selective and can be especially damaging to raspberries.

Chemical control:

- **Dichlobenil** (Casoron) Preemergence. Useful as a spot application in mid-winter to control perennial weeds (field Horsetail, Quackgrass, Yellow Nutsedge and Canada Thistle). May reduce plant vigor if used repeatedly or at the high rate. Efficacy is fair to good.
- **Diuron** (Karmex, Diuron 80 or Diuron 4L) Preemergence herbicide.
- **Glyphosate** (numerous brands) Non-selective, postemergence. Herbicide damage from Glyphosate drift or misuse is fairly common in caneberries. Very effective and useful but requires supervision and training to prevent damage especially in raspberries.
- **Napropamide** (Devrinol) Preemergence. Effectiveness is limited if not incorporated by irrigation or rainfall either while applying or very soon after application. Performance is also reduced by excessive plant residue on soil surface. Primarily a grass herbicide.
- **Norflurazon** (Solicam) Preemergence. It is primarily used where annual grass control is a problem but also has activity against several common broadleaved weeds. It can cause discoloration in primocane foliage and fruit spurs. It should be used with caution on black raspberries. Cannot use on newly established plantings. Efficacy is fair to good.
- **Oryzalin** (Surflan) Preemergence. Control ranges from poor to good.
- **Oxyfluorfen** (Goal 2XL) Broadcast, for non-bearing AY blackberries, 24c registration. Efficacy ranges from poor to good.
- **Paraquat** (Gramoxone Extra or Gramoxone Max). Non-selective, postemergence, contact herbicide.
- **Pronamide** (Kerb) Provides decent control of Quackgrass, if applied when grass is truly dormant. Expensive.
- **Sethoxydim** (Poast) Postemergence. Controls grasses only. The only grass specific

herbicide that can be used in established caneberry plantings. Resistant grasses include annual bluegrass and all fine fescues, but Quackgrass can be suppressed. Fair- good control if label application directions are followed closely.
- **Simazine** (Simazine 90 WDG or 90DF, Princep Caliber90, Simazine 4L) Preemergence.
- **Terbacil** (Sinbar) Preemergence. Solubility relatively high; use with caution on tender/weakened plantings.

Biological control:
- None

Cultural control:
- None

Critical Needs for Weed Management in Post harvest:

Research:
- Biological control.
- Clarify and enhance the role of beneficial of insects (i.e. carabid beetles).
- Controlling perennial weed seeds.
- Herbicides that have good selectivity on the weeds and cause little or no damage to caneberries.

Regulatory:
- None

Education:
- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

NEMATODES

Root-Lesion Nematode *(Pratylenchus spp)*
Dagger Nematode *(Xiphinema americanum)*

Chemical control:
- No nematicides are currently registered for use in caneberries.

Biological control:

- Biological control products are available in the marketplace, but have not been effective in research studies on caneberries.

Cultural control:

- Grass sod in the alleys helps prevent the spread of ToRSV (vectored by *X. americanum*).

Critical Needs for Nematode Management in Post harvest:

Research:

- Evaluate efficacy of biological nematicides.
- Continue testing alternatives as a replacement for fenamiphos (Nemacur).
- Timing of nematicide treatments in relationship to growers' activities.

Regulatory:

- Expedite registration of fenamiphos (Nemacur) replacements

Education:

- Since the original caneberry PMSP was created in 2003, we have seen acceleration in the defunding and dismantling of our Land Grant universities' extension and research support services for the caneberry industry. This piecemeal removal of the traditional foundations of IPM research and implementation continue to severely hamper grower adaptation of new or innovative pest management strategies. We have an increasingly critical need for either renewed investments in the traditional Land Grant university research and extension support or investments in alternative models to meet these research, education and information dispersal needs.

RODENTS

Rodents, especially voles/field mice and voles, can cause damage when they burrow through the root systems and feed on the roots of the plants, sometimes causing death. Baiting with zinc phosphide pellets can be implemented only during dormancy and prior to budbreak in the spring. Options for control are very limited.

Chemical control:

- **Zinc Phosphide Pellets** (bait) Broadcast to soil surface after last harvest and before leaf emergence in the spring. The target rodent must be on the label.

Biological control:

- None

Cultural control:

- None

Table 1: Efficacy ratings for various insect and mite pest management tools against caneberry pests.
Rating scale: E = excellent (90-100% control); G = good (80-90% control); F = fair (70-80% control); P = poor (<70% control); ? = efficacy unknown, more research needed; * = used but not a stand-alone management tool; blank space = not used for this pest.

MANAGEMENT TOOLS ~ INSECTS/MITES	Aphids	Armyworms/cutworms	Clay Colored Weevil	Dryberry Mite	Earwigs	Leafrollers	Misc. caterpillars	Mites	Raspberry Crown Borer	Raspberry Fruitworm (Beetle)	Redberry Mite	Root weevils	Sawfly	Slugs	Snowy tree Cricket	Stinkbugs	Strawberry Crown Moth	Thrips	Winter Moth	COMMENTS
Registered chemistries																				
1, 3-Dichloropropene (Telone II)		E										E								Pre-plant
1, 3-Dichloropropene+Chloropicrin (Telone C-17, C35)												E								Larvae only
Azadirachtin (Neemix, Azatin, Azatrol)			P									P								
Bifenazate (Acramite)								G												Non-bearing only; little grower experience; good control with "Savey"
Bifenthrin (Brigade and other brands)	E		E		F	E	E	G-E	G	G		E	E			E		E	G-E	RCB- little grower experience; limited window; potential resistance; possible mite flare-up
Calcium polysulfide (Lime sulfur) (Sulforix , others)				G-E				F-G			G									Timing important
Carbaryl (Sevin and other brands)	P	F				F-G	F-G						F-G			P		P	G	Can cause mite flare-up
Cryolite Bait			P									F-P								No longer available
Dazomet (Basamid)		P-G										P-G								Pre-plant
Diazinon	G-E	F-G		P		G-E	F-E		E	E			F-G				E	G	G	
Esfenvalerate (Asana)	F-P	F-G	P			F-G	G					P	E			F		G		Aphids-PHI is limiting; possible mite flare-up
Hexakis (Vendex)								E-G												
Hexythiozox (Savey)								G-E												
Horticultural oils (e.g. stylet oil)								G												
Imidacloprid (Provado, Admire, others	E																	F		
Iron phosphate														F-P						
Malathion	E	F	P		F	F	F-G			F		P	F			F		F	P	
Metaldehyde														E						
Methyl Bromide/ Chloropicrin		E										E								Pre-plant
Oxydemeton-methyl (MSR)	E																			WA use only
Pyrethrin (pyganic,others)	F	P-F	F			P-F	P-F					P	G			G		G	?	Can cause mite flare-up
Potassium salts of fatty acides (M-Pede)	P-F							P												
Sodium Methyldithiocarbamate (Vapam)		P-G										P-G								Pre-plant
Spinosad (Success)	P	G-E				G	G-E			?			F					G	G-E	Not effective on lrg armyworm larvae
Spinetoram (Delegate)		G				?	G-E			?			?					?	G-F	limited grower experience
Sulfur (Thiolux, Wettable sulfur)				G				G-E			G-E									
Tebufenozide (Confirm)		G				G							F						G-F	14 day PHI limits usefulness
Thiamethoxam (Actara, Platinum)	E		F-G									G								limited grower experience
Zeta-cypermethrin (Mustang)			G			G						G	G			G		G	G	not much grower experience
Unregistered/potential chemistries																				
Abamectin (Agrimek, Avid, Zephyr) Clinch)								G												
Flonicamid	E																			
Indoxacarb (Avaunt)		E				E				E									G-E	
Pymetrozine (Fulfill)	E																			

Table 1: Efficacy ratings for various insect and mite pest management tools against caneberry pests. Continued. Rating scale: E = excellent (90-100% control); G = good (80-90% control); F = fair (70-80% control); P = poor (<70% control); ? = efficacy unknown, more research needed; * = used but not a stand-alone management tool; blank space = not used for this pest.

MANAGEMENT TOOLS INSECTS/MITES	Aphids	Armyworms/cutworms	Clay Colored Weevil	Dryberry Mite	Earwigs	Leafrollers	Misc. caterpillars	Mites	Raspberry Crown Borer	Raspberry Fruitworm (Beetle)	Redberry Mite	Root weevils	Sawfly	Slugs	Snowy tree cricket	Stinkbugs	Strawberry Crown Moth	Thrips	Winter Moth	COMMENTS
Biological																				
Bacillus thuringiensis (Bt)		G				G	G						F						P	Timing critical
Beauveria Bassiana	?		?									?								Little Grower experience
Ladybird beetles	?																			
Parasitic nematodes			?									?								
Parasitoid wasps						?	?													Conservation of naturally occurring populations very important. Not commercially available.
Predatory mites *								*												
Stethorus & anthocorus beetles *								?												
Cultural non-chemical																				
Additional human sorters to harvesting machine		*	*		*	*	*							*		*				
Adjacent area management		*	*							*	F*	*								
Adjust air-blast or vacuum suction cleaner systems	*	*	*		*	*	*							*		*		*		
Avoid moisture stress								F												
Conserve Natural predators such as carabids	F	*						F												
Cover crops																				
Dust Management								*												
Enhancing habitat for beneficials	*					*	*		*	*							*		*	
Keep crates from damp soil/grass		*	*			*								G						
Pheromone traps to monitor flight to evaluate populations and plan spray schedules						*														
Pre-plant disking		*	*									*								
Pruning techniques (e.g. new over old)						*														
Remove & burn damaged primocanes															F					
Resistant cultivars																				
Sanitation						*								G						
Weed control					*	*								G						

Table 2: Efficacy ratings for various disease pest management tools against caneberry pests.

Rating scale: E = excellent (90-100% control); G = good (80-90% control); F = fair (70-80% control); P = poor (<70% control); ? = efficacy unknown, more research needed; blank space = not used for this pest; * = used but not a stand-alone management tool. ***= Aphids vector Black Raspberry Necrosis Virus; see Aphid controls.

MANAGEMENT TOOLS DISEASES	Anthracnose	Armillaria Root Rot	Black Raspberry Necrosis ***	Cane Blight	Crown & Cane Gall	Downy Mildew	Fruit Rot	Powdery Mildew	Purple Blotch	Rasp. Bushy Dwarf virus	Root Rot	Septoria Cane & Leaf	Spur Blight	Stamen Blight	Tomato Ringspot Virus	Verticillium Wilt	Yellow Rust	COMMENTS
Registered Chemistries																		
Azoxystrobin (Heritage, Quadris, Abound)	G			G				F	G			G-E	G-E					
Boscalid + Pyraclostrobin (Pristine)	F-G			G			E	G	G			G	G-E				F-G	
1, 3-Dichloropropene (Telone II)					P						G				E			
1, 3-Dichloropropene+Chloropicrin (Telone C-17, C35)					F-G						F							
Calcium polysulfide (Lime sulfur-Sulforix, others)	G-E							F	F			F	G-E	P			P-G	
Captan	F-G			P			G-F		F			F	G	F				
Captan + Elevate (Captevate)							P											Limited use; low Captan rate
Copper (Bordeaux)	F								P-F			F-G					P-G	
Cyprodinil + Fludioxonil (Switch)							E						G-E					
Famoxadone+cymoxanil (Tanos)									G			G-F						New label; little grower experience
Fenhexamid (Elevate)							E						*G					*when used with Captan
Fixed Copper (Nordox, Copper-Count, others)	F							F-G	P-G			F-G						
Fosetyl-al (Aliette)						G-E					F-G							
Gallex					F													
Harpin Protein (Messenger)							P											
Horticultural Oils (JMS, Supreme, others)								F G										
Hydrogen dioxide (Oxidate)							P	p										Very limited effectiveness
Iprodione (Rovral)							G *						G					*Resistance;*with Captan
Mefenoxam (Ridomil)											+F-E							+ Some reduced efficacy has been noted in W. Wash.
Metamsodium (and other brands)																F		

Table 2 continued: Efficacy ratings for various disease pest management tools against caneberry pests.
Rating scale: E = excellent (90-100% control); G = good (80-90% control); F = fair (70-80% control); P = poor (<70% control); ? = efficacy unknown, more research needed; blank space = not used for this pest; * = used but not a stand-alone management tool. ***= Aphids vector Black Raspberry Necrosis Virus; see Aphid controls.

MANAGEMENT TOOLS DISEASES	Anthracnose	Armillaria Root Rot	Black Raspberry Necrosis ***	Cane Blight	Crown & Cane Gall	Downy Mildew	Fruit Rot	Powdery Mildew	Purple Blotch	Rasp. Bushy Dwarf virus	Root Rot	Septoria Cane & Leaf	Spur Blight	Stamen Blight	Tomato Ringspot Virus	Verticillium Wilt	Yellow Rust	COMMENTS
Registered Chemistries Continued																		
Methyl Bromide		G									F				E	F		Resistance?
Methyl Bromide/Chloropicrin		G									E				E	F-G		Delays disease 3-4 years
Myclobutanil (Rally)								G-E				G					G-E	
Phosphorous acid (Fosphite)						G-E					?							
Potassium salts of fatty acids (M-Pede)								F										
Potassium bicarbonate (Kaligreen,Milstop)								G										
Propiconazole (Orbit)																	[+]G-E	[+]not labeled for this disease
Pyraclostrobin (Cabrio)	F-G							[+]?	G-E			G	G-E				P-F	+New registration; little grower experience
Sodium methyldithiocarbamate (Vapam)											P-F				F-P			
Sulfur (Thiolux, Wettable Sulfur)								F				G						
Ziram							F-P											
Unregistered/potential chemistries																		
Thiophanate-methyl (Topsin-M)				F-G														[1]Resistance
Biological																		
Agrobacterium radiobacter K84 or K1026 (Galltrol-A, Nogall).					F-E													
Ampelomyces quisqualis								?										

Table 2 continued: Efficacy ratings for various disease pest management tools against caneberry pests.
Rating scale: E = excellent (90-100% control); G = good (80-90% control); F = fair (70-80% control); P = poor (<70% control); ? = efficacy unknown, more research needed; blank space = not used for this pest; * = used but not a stand-alone management tool. ***= Aphids vector Black Raspberry Necrosis Virus; see Aphid controls.

MANAGEMENT TOOLS DISEASES	Anthracnose	Armillaria Root Rot	Black Raspberry Necrosis ***	Cane Blight	Crown & Cane Gall	Downy Mildew	Fruit Rot	Powdery Mildew	Purple Blotch	Rasp. Bushy Dwarf virus	Root Rot	Septoria Cane & Leaf	Spur Blight	Stamen Blight	Tomato Ringspot Virus	Verticillium Wilt	Yellow Rust	COMMENTS
Cultural non-chemical																		
Adjacent area management										F					?			
Alternate-year fruiting system	F			G-E(1)					F-G			F-G		F				(1) Effective, but not economically practical in red raspberries.
Avoid planting black raspberries where verticillium susceptible crops were grown.																F-G		
Certified nursery stock/tissue culture plants	F		G		F-E	G-E	F			G-E	G-E					G		
Cultivate an open canopy	F							P-F	F			F						
Isolation from other *Rubus* or infected fields			G			F				G								
Maintain/enhance drainage											F-G							
Manage overhead irrigation	F					F		P-F	F			F						
Minimize periods in which the plants stay wet				F														
New over old training technique	?					?	?	?	?			?				?		
Primocane suppression	F			F		F		?	F			?	?					
Proper amounts of nitrogen (not over fertilization)						?		?				?	?					
Prune off old canes close to ground postharvest, before rain. Destroy by	G																	
Raised beds							F				F-G							
Resistant/tolerant cultivars	F				F		P	?		G-E	F-G	?	F-G			?	F	
Rotations using non-susceptible grasses and cereals.																?-F		
Sanitation	P																F	
Solarize							G-F				F-G(1)							(1) 2+ year delay of disease
Tie up after leaf fall																	G	
Use drip or trickle irrigation				F			G											
Weed control	F					F		?	P			P	P		?			

Table 2 continued: Efficacy ratings for various disease pest management tools against caneberry pests.

MANAGEMENT TOOLS DISEASES	Anthracnose	Armillaria Root Rot	Black Raspberry Necrosis	Cane Blight	Crown & Cane Gall	Downy Mildew	Fruit Rot	Powdery Mildew	Purple Blotch	Rasp. Bushy Dwarf virus	Root Rot	Septoria Cane & Leaf	Spur Blight	Stamen Blight	Tomato Ringspot Virus	Verticillium Wilt	Yellow Rust	COMMENTS
Cultural non-chemical continued																		
Avoid sawdust mulch		G																
Avoid soil movement to reduce spread of disease		G																
Destroy and remove infected plants and native vegetation		G																
Do not harvest overripe fruit							G											
Keep plant rows narrow													F					
Move harvested fruit to cold storage as soon as possible							G											
North-South row orientation promotes even sun exposure and good air drainage							F											
Plant in large block to slow disease movement into new plants										G								
Raise concentration of calcium							F				G							
Refrain from overwatering in fall							F											
Remove old fruiting canes after harvest									G			G						
Subsoil between rows to promote drainage							F				G							
Trellis canes before mid-September to avid cold injury									G			G						

Table 3: Efficacy ratings for various weed pest management tools against caneberry pests.
Rating scale: E = excellent (90-100% control); G = good (80-90% control); F = fair (70-80% control); P = poor (<70% control); S = seeding control only, A = control of above-ground vegetation only, ? = efficacy unknown, more research needed; blank space = not used for this pest; * = used but not a stand-alone management tool.
Note: Plant size or stage of growth is an important consideration when applying most post-emergence herbicides.

WEEDS MANAGEMENT TOOLS	Cane Burning Material	Common Mallow	Common Chickweed	Dog Fennel	Goosefoot	Groundsel	Henbit	Horseweed	Knotweed, Prostrate	Lambsquarters	Miners Lettuce	Mustard	Nightshade	Pigweed	Pineapple Weed	Prickly Lettuce	Purslane	Sheppard's Purse	Smatweed, Ladysthumb	Sow thistle	Speedwell	Wild Radish	COMMENTS
Registered chemistries																							
Bentazon (Basagran)										F		G					F	F	G				Non-bearing, Post-emergent, apply at or before planting only.
Carfentrazone-ethyl (Aim)										F-G			F-G	F-G					F				Postemergence
Dichlobenil (Casoron)		F	G		G	G	G		G	G	G	G	G	G			G	G	G		G	G	Preemergence
Diuron (Karmex, Diuron 80) 40)		P	G	G	F	F	G	F	F	G	G	G	G	G	G	G	G	G	F	F	P	G	Preemergence
Glyphosate (Roundup; others)		F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	Postemergence
Isoxaben (Gallery)		G	G	F		G	G	G	G	G		G	G	G	G	G	G	G	G	G	G	G	Non-bearing only; preemergence
Napropamide (Devrinol)		G	G		P	G	P	F	F	G	G	G	P	G	G	G	P	P	P	G		G	Preemergence
Norflurazon (Solicam)		F					G		G	G	F	G	G				G	G	F			G	Preemergence
Oryzalin (Surflan)		P	G	P	P	P	F	P	G	G	G	G	P	G	P	P		P	F	P		G	Preemergence
Oxyfluorfen (Goal) Galigan)		P	P	F	G	G	G	P	F	F	G	F	G	G	F	G	G	P	F			F	Preemergence
Paraquat (Gramoxone)			G	S	F	G	G	A	A	F	G	G	G	G	S	G	G	G	G		G	G	Postemergence
Pelargonic acid (Scythe)		?	?	?	?	F	?	?	?	F	?	F	?	F	?	?	?	?	?	?	?	P-F	Postemergence
Pronamide(Kerb)		P	G	P	F	P	F	P	F	F	F	F	F	P	P	P		F		P	P	F	Preemergence
Simazine (Princep)		F	G			F	G		G	G	G	G	G	G			G	G	F			G	Preemergence
Terbacil (Sinbar)		G	G	G	G		F	P	G	G	G	G	G	F	G	G	G	G	G	G	F	G	Preemergence
Unregistered/potential chemistries																							
S-metolachlor (Dual Magnum)													F-G	G									Preemergence
Thiazopyr (Visor)		G	G			G				G		G											
Biological																							
None																							
Cultural non-chemical																							
Disking		G	G	G	G	G	G	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	
Flaming		F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
Hand hoeing/weed eater		F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
Mowing		P	P	P	F	P	P	F	P	G	P	F	F	G	P	F	F	F	F	F	F	F	
Mulching		F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	

Annual Broadleaves

Annual Grasses, Perennial Grasses, Perennial Broadleaves, Perennial Sedges and Rushes

	Annual Grasses						Perennial Grass	Perennial Broadleaves								Perennial Sedges and Rushes		
WEEDS MANAGEMENT TOOLS	**Annual Blue Grass**	**Barnyard Grass**	**Crabgrass**	**Rye Grass**	**Fescues**	**Wild Oats**	**Quackgrass**	**Blackberry**	**Buckhorn Plantain**	**Canada Thistle**	**Clovers**	**Curly Dock**	**Dandelion**	**Field Bindweed**	**Red Sorrel**	**Field Horsetail**	**Yellow Nutsedge**	**COMMENTS**
Registered chemistries																		
Bentazon (Basagran)										P-F							P-F	Non-bearing; postemergence
Clethodim (Prism, Select)	G	G	G	G	F	G	F-G											Non-bearing; postemergence
Dichlobenil (Casoron)	G	G	G	G		F	G		G	G			G	P-F	G		G	Preemergence
Diuron (Karmex, Diuron 80 or 40)	G	G	F-G	G		P	P	P	P	P			P	P	GS		P	
Fluazifop (Fusilade)	P	G	G	F-G	P	G	F	P	P	P		P	P	P	P		P	Non-bearing; postemergence
Flumioxazin (Chateau)																		Preemergence; non-bearing; new label
Glyphosate (Roundup, others)	G	G	G	G	G	G	G	G	G	G			G	F-G	G		F	postemergence
Isoxaben (Gallery)									G		F-G	P-F	P-F	P-F				Non-bearing, Preemergence
Napropamide (Devrinol)	G	F-G		G		G	P	P		P			S	P			P	Preemergence
Norflurazon (Solicam)	G	G	F			G	P										F	
Oryzalin (Surflan)	G	G	G	G		P	P	P		P			P	P			P	Preemergence
Oxyfluorfen (Goal)	FS	P		G		G	P	P	F			F	G	A	G		P	
Paraquat (Gramoxone)	G	G	G	G		G	F	A	G	A			A	A	A		F	
Pelargonic acid (Scythe)																		
Pronamide (Kerb)	G	P	P	G	G	G	G	P	P	P		F	P	P	F		P	
Sethoxydim (Poast)	P	G	G	G	P	G	P	P	P	P		P	P	P	P		P	Postemergence; controls grasses
Simazine (Simazine, Princep)	G	F	P-F	G		F	P	P	G				S	P			P	Preemergence
Terbacil (Sinbar)	G	F	G	G		G	F	F	G	P			F	P	G		P	
Unregistered/potential																		
S-metolachlor (Dual Magnum)		G	G														G	
Thiazopyr (Visor)	G	G	G														F-G	
Biological																		
None																		
Cultural non-chemical																		
Disking	G	G	G	G	F	G	P	F	G	P			F	P	G		P	
Flaming	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	
Hand hoeing/weed eater	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	
Mowing	F	F	F	F	P	G	F	F	P	P			P	P	P		P	
Mulching	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	

Table 4: Efficacy ratings for various nematode pest management tools against caneberry pests.
Rating scale: E = excellent (90-100% control); G = good (80-90% control); F = fair (70-80% control); P = poor (<70% control); ? = efficacy unknown, more research needed; blank space = not used for this pest; * = used but not a stand-alone management tool.

NEMATODES (pre & post plant)					
	Root Lesion		Dagger		
MANAGEMENT TOOLS	Preplant	Postplant	Preplant	Postplant	COMMENTS
Registered chemistries					
Chloropicrin	E		E		Best in combo w/ Dichloropropene or Methyl Bromide
1, 3-Dichloropropene (Telone II)	E		E		Relied upon heavily; concern about
Sodium Methyldithiocarbamate (Vapam)	F-G		F-P		
Methyl Bromide/Chloropicrin	E		E		
Unregistered/potential chemistries					
Iodomethane (Midas)	E		E		
Biological					
Cultural non-chemical					
Cover crops	P		F		
Fallow 2 or more years	F		F		Weed free
Solarization	P		P		
Test for *Xiphinema* spp.			E		
Test for *P. penetrans*	E				
Use certified planting stock	E		E		

Activity Table 1: ~ Northwestern Washington Red Raspberries

Cultural Activities Profile												
Activity	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Bring in bees												
Cane suppression												
Drain tile installation												
Establish cover crop												
Fertilization												
Hand hoeing												
Harvest												
Install irrigation												
Irrigation												
Liming												
Maintain raised beds												
Mowing/cultivating row middles												
Planting												
Pre-plant soil fumigation												
Pruning & tying canes												
Raise training wires												
Removal of annual cover crop												
Remove old fruiting canes												
Replanting (if necessary)												
Soil testing												
Subsoil row middles												
Take leaf samples												
Take nematode samples												
Train new canes												
Pest Management Activities												
Activity	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Check leafroller trap count												
Fumigation												
Fungicide application												
Herbicide application												
Insecticide application												
Miticide application												
Nematicide application												
Scout for diseases												
Scout for insects												
Scout for mites												
Scout for mouse/vole damage												
Scout for weeds												
Take samples for nematode testing												
Seasonal Pest Occurrence												
Insects & Mites	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Aphids												
Armyworms & climbing cutworms												
Clay Colored Weevils												
Leafrollers												
McDaniel mites												

Activity Table 1: ~ Northwestern Washington Red Raspberries – Continued

Seasonal Pest Occurrence												
Insects and Mites- Continued	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Miscellaneous caterpillars & loopers												
Miscellaneous harvest contaminants												
Raspberry crown borer												
Raspberry fruitworm (raspberry beetle)												
Root weevil adults												
Sawflies												
Slugs												
Spider mites												
Stinkbugs												
Thrips												
Diseases	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Anthracnose												
Armillaria Root Rot												
Crown & cane gall												
Fruit Rot												
Pseudomonas blight												
Raspberry Bushy Dwarf Virus												
Root Rot												
Spur blight												
Yellow Rust												
Weeds	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Annual Grasses												
Annual blue grass												
Barnyard grass												
Crabgrass												
Fescues												
Annual Broadleaves												
Common chickweed												
Dog fennel, Pineapple weed												
Groundsel												
Knotweed, prostrate												
Lambs quarters												
Mustard												
Nightshade												
Pigweed												
Prickly lettuce												
Sheppard’s purse												
Smartweed												
Sow thistle												
Wild radish												
Perennial Grasses												
Quackgrass												
Rye grass												

Activity Table 1: ~ Northwestern Washington Raspberries – Continued

Weeds	J	F	M	A	M	J	J	A	S	O	N	D
Perennial Broadleaves												
Blackberry												
Buckhorn Plantain												
Canada Thistle												
Clovers												
Curly Dock												
Dandelion												
Field Bindweed												
Red Sorrel												
Perennial Sedges & Rushes												
Field Horsetail												
Yellow Nutsedge												
Nematodes	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Dagger												
Root-lesion												
Vertebrates												
Deer												
Gophers												
Mice/voles												

Activity Table 2 ~ Southwestern Washington and Oregon Red Raspberries

Cultural Activities Profile												
Activity	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Bring in bees												
Cane suppression												
Drain tile installation												
Establish cover crop												
Fertilization												
Hand hoeing												
Harvest												
Irrigation												
Liming												
Maintain raised beds												
Mowing/cultivating row middles												
Planting												
Pre-plant soil fumigation												
Pruning & tying canes												
Raise training wires												
Removal of annual cover crop												
Remove old fruiting canes												
Replanting (if necessary)												
Soil testing												
Subsoil row middles												
Take leaf samples												
Take nematode samples												
Train new canes												
Pest Management Activities												
Activity	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Check leafroller trap count												
Fumigation												
Fungicide application												
Herbicide application												
Insecticide application												
Miticide application												
Nematicide application												
Scout for diseases												
Scout for insects												
Scout for mites												
Scout for mouse/vole damage												
Scout for weeds												
Take samples for nematode testing												
Seasonal Pest Occurrence												
Insects & Mites	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Armyworms & climbing cutworms												
Leafrollers												
McDaniel mites												
Miscellaneous caterpillars & loopers												
Miscellaneous harvest contaminants												

Activity Table 2 ~ Southwestern Washington and Oregon Red Raspberries – Continued

Seasonal Pest Occurrence												
Insects and Mites- Continued	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Raspberry crown borer			■							■		
Root weevil adults					■	■	■					
Sawflies						■	■					
Slugs					■	■	■					
Snowy tree crickets									■	■		
Spider mites							■	■	■			
Stinkbugs						■	■					
Strawberry crown moth			■							■		
Thrips						■	■					
Winter moth		■	■	■								
Diseases	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Anthracnose				■	■	■	■					
Armillaria Root Rot						■	■	■				
Crown & cane gall						■	■	■				
Fruit Rot						■	■					
Pseudomonas blight			■	■	■							
Raspberry Bushy Dwarf Virus						■	■					
Root Rot						■	■	■				
Spur Blight					■	■	■	■				
Yellow Rust				■	■	■	■	■				
Weeds	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Annual Grasses												
Annual blue grass	■	■	■	■	■	■	■	■	■	■	■	■
Barnyard grass						■	■	■				
Crabgrass						■	■	■				
Fescues	■	■	■	■	■	■	■	■	■	■	■	■
Annual Broadleaves	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Common chickweed	■	■	■	■						■	■	■
Dog fennel, Pineapple weed			■	■	■	■	■	■				
Groundsel	■	■	■	■	■	■	■	■	■	■	■	■
Knotweed, prostrate				■	■	■	■	■	■	■		
Lambsquarters				■	■	■	■	■	■	■	■	
Mustard	■	■	■	■	■	■	■	■	■	■	■	■
Nightshade						■	■	■				
Pigweed				■	■	■	■	■	■	■	■	
Prickly lettuce				■	■	■	■	■	■	■		
Shepard's purse	■	■	■	■	■	■	■	■	■	■	■	■
Smartweed				■	■	■	■	■	■			
Sowthistle				■	■	■	■	■	■	■	■	
Wild radish	■	■	■								■	■
Perennial Grasses	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Quackgrass	■	■	■	■	■	■	■	■	■	■	■	■
Rye grass	■	■	■	■	■	■	■	■	■	■	■	■

Activity Table 2 ~ Southwestern Washington and Oregon Red Raspberries – Continued

Perennial Broadleaves	J	F	M	A	M	J	J	A	S	O	N	D
Blackberry												
Buckhorn Plantain												
Canada Thistle												
Clovers												
Curly Dock												
Dandelion												
Field Bindweed												
Red sorrel												
Perennial Sedges & Rushes												
Field Horsetail												
Yellow Nutsedge												
Nematodes												**D**
Dagger												
Root-lesion												
Vertebrates												
Deer												
Gophers												
Mice/voles												

Activity Table 3 ~ Fall Bearing Raspberries (all regions)

Cultural Activities Profile												
Activity	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Bring in bees												
Drain tile installation												
Establish cover crop												
Fertilization												
Hand hoeing												
Harvest												
Irrigation												
Liming												
Maintain raised beds												
Mowing/cultivating row middles												
Planting												
Pre-plant soil fumigation												
Raise training wires												
Remove old fruiting canes												
Replanting (if necessary)												
Soil testing												
Subsoil row middles												
Take leaf samples												
Take nematode samples												
Pest Management Activities												
Activity	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Check leafroller trap count												
Fertilization												
Fumigation												
Fungicide application												
Herbicide application												
Insecticide application												
Nematicide application												
Scout for diseases												
Scout for insects												
Scout for mites												
Scout for mouse/vole damage												
Scout for weeds												
Take samples for nematode testing												
Seasonal Pest Occurrence												
Insects & Mites	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Aphids												
Leafrollers												
McDaniel mites												
Misc. harvest contaminants												
Raspberry crown borer												
Root weevils												
Spider mites												
Stinkbugs												
Strawberry crown moth												

Activity Table 3: ~ Fall Bearing Raspberries (all regions) **-Continued**

Diseases	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Anthracnose												
Crown & cane gall												
Fruit Rot												
Pseudomonas blight												
Root Rot												
Yellow Rust												
Weeds- Annual Grasses	J	F	M	A	M	J	J	A	S	O	N	D
Annual blue grass												
Barnyard grass												
Crabgrass												
Fescues												
Annual Broadleaves												
Common chickweed												
Dog fennel, Pineapple weed												
Groundsel												
Knotweed, prostrate												
Lambsquarters												
Mustard												
Nightshade												
Pigweed												
Prickly lettuce												
Sheppard's purse												
Smartweed												
Sowthistle												
Wild radish												
Perennial Grasses												
Quackgrass												
Rye grass												
Perennial Broadleaves												
Blackberry												
Buckhorn Plantain												
Canada Thistle												
Clovers												
Curly Dock												
Dandelion												
Field Bindweed												
Red Sorrel												
Perennial Sedges & Rushes												
Field Horsetail												
Yellow Nutsedge												
Nematodes	J	F	M	A	M	J	J	A	S	O	N	D
Dagger												
Root-lesion												
Vertebrates												
Deer												
Gophers												
Mice/voles												

Activity Table 4: ~ EY (Cropping every year) Blackberries, Oregon

Cultural Activities Profile												
Activity	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Bring in bees												
Cane suppression												
Drain tile installation												
Establish annual cover crop												
Fertilization												
Hand hoeing												
Harvest												
Irrigation												
Liming												
Mowing/cultivating row middles												
Peg primocanes out of row middles												
Planting												
Removal of cover crop												
Replanting (if necessary)												
Soil testing												
Subsoil row middles												
Take leaf samples												
Train new canes & remove old												
Pest Management Activities												
Activity	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Check leafroller trap count												
Fumigation												
Fungicide applications												
Herbicide applications												
Insecticide applications												
Scout for diseases												
Scout for insects												
Scout for weeds												
Scout for mouse/vole damage												
Take samples for nematode testing												
Seasonal Pest Occurrence												
Insects & Mites	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Armyworms & climbing cutworms												
Dryberry Mites												
Leafrollers												
Miscellaneous harvest contaminants												
Raspberry crown borer												
Redberry mites												
Root weevils												
Strawberry crown moth												
Thrips												
Diseases	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Anthracnose												
Armillaria Root Rot												
Cane & Leaf Rust												

Activity Table 4: ~ EY (Cropping every year) Blackberries, Oregon - Continued

Seasonal Pest Occurrence												
Diseases - Continued	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Downy mildew												
Fruit Rot												
Orange Rust												
Powdery mildew												
Purple Blotch												
Root Rot												
Septoria leaf spot												
Stamen blight												
Verticillium Wilt												
Weeds –Annual Grasses	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Annual blue grass												
Barnyard grass												
Crabgrass												
Fescues												
Annual Broadleaves												
Common chickweed												
Dog fennel, Pineapple weed												
Groundsel												
Knotweed, prostrate												
Lambsquarters												
Mustards												
Nightshade												
Pigweed												
Prickly lettuce												
Shepard's purse												
Smartweed												
Sowthistle												
Perennial Grasses												
Quackgrass												
Rye grass												
Perennial Broadleaves												
Blackberry												
Buckhorn Plantain												
Canada Thistle												
Clovers												
Curly Dock												
Dandelion												
Field Bindweed												
Red sorrel												
Perennial Sedges & Rushes												
Field Horsetail												
Yellow Nutsedge												
Nematodes	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Dagger												
Root-lesion												

Seasonal Pest Occurrence	J	F	M	A	M	J	J	A	S	O	N	D
Deer												
Gophers-lesion												
Mice/voles												

Activity Table 5: ~ AY (non-cropping years) Blackberries, Oregon

Many blackberries are cropped every second year (the AY system). The activity table below reflects activities in the non-cropping year.

Cultural Activities Profile												
Activity	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Cane suppression												
Drain tile installation												
Establish annual cover crop												
Fertilization												
Hand hoeing												
Harvest												
Irrigation												
Liming												
Mowing/cultivating row middles												
Train primocanes												
Planting												
Replanting (if necessary)												
Soil testing												
Subsoil row middles												
Take leaf samples												
Pest Management Activities												
Activity	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Fumigation												
Fungicide applications												
Herbicide applications												
Scout for diseases												
Scout for weeds												
Scout for mouse/vole damage												
Take samples for nematode testing												
Seasonal Pest Occurrence												
Insects & Mites	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Raspberry crown borer												
Strawberry crown moth												
Diseases	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Anthracnose												
Armillaria Root Rot												
Cane & leaf rust												
Downy mildew												
Orange Rust												
Powery mildew												
Root Rot												
Verticillium wilt												
Weeds	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Annual Grasses												
Annual blue grass												
Barnyard grass												
Crabgrass												
Fescues												

Activity Table 5: ~ AY (non-cropping years) Blackberries, Oregon - Continued

Many blackberries are cropped every second year (the AY system). The activity table below reflects activities in the non-cropping year.

Annual Broadleaves	J	F	M	A	M	J	J	A	S	O	N	D
Common chickweed	■	■	■	■						■	■	■
Dog fennel, Pineapple weed				■	■	■	■	■				
Groundsel	■	■	■	■	■	■	■	■	■	■	■	■
Knotweed, prostrate				■	■	■	■	■	■	■		
Lambsquarters				■	■	■	■	■	■	■	■	
Mustards	■	■	■	■	■	■	■	■	■	■	■	■
Nightshade							■	■				
Pigweed				■	■	■	■	■	■	■		
Prickly lettuce					■	■	■	■	■			
Shepard's purse	■	■	■	■	■	■	■	■	■	■	■	■
Smartweed					■	■	■	■	■			
Sowthistle					■	■	■	■	■	■	■	
Perennial Grasses												
Quackgrass	■	■	■	■	■	■	■	■	■	■	■	■
Rye grass	■	■	■	■	■	■	■	■	■	■	■	■
Perennial Broadleaves												
Blackberry	■	■	■	■	■	■	■	■	■	■	■	■
Buckhorn Plantain				■	■	■	■	■	■	■	■	
Canada Thistle				■	■	■	■	■	■	■	■	
Clovers	■	■	■	■	■	■	■	■	■	■	■	■
Curly Dock				■	■	■	■	■	■	■	■	
Dandelion				■	■	■	■	■	■	■	■	
Field Bindweed				■	■	■	■	■	■	■	■	
Red sorrel				■	■	■	■	■	■	■	■	
Perennial Sedges & Rushes												
Field Horsetail	■	■	■	■	■	■	■	■	■	■	■	■
Yellow Nutsedge				■	■	■	■	■	■	■		
Seasonal Pest Occurrence												
Nematodes	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Dagger	■	■	■	■	■	■	■	■	■	■	■	■
Root-lesion	■	■	■	■	■	■	■	■	■	■	■	■
Vertebrates												
Deer				■	■	■	■	■	■	■		
Gophers	■	■	■	■	■	■	■	■	■	■	■	■
Mice/voles	■	■	■	■	■	■	■	■	■	■	■	■

References

1. *Pacific Northwest Weed Management Handbook, 2008.* Oregon State University, Washington State University, and the University of Idaho.

2. *Pacific Northwest Plant Disease Management Handbook, 2008.* Oregon State University, Washington State University, and the University of Idaho.

3. *Pacific Northwest Insect Control Management Handbook, 2008.* Oregon State University, Washington State University, and the University of Idaho.

4. *2001-2002 Oregon Agriculture & Fisheries Statistics,* Oregon Agricultural Statistics Service, U.S. Department of Agriculture, Salem, OR, December 2002.

5. *Blackberry Production in Oregon,* B. Strik, Oregon State University. http://berrygrape.oregonstate.edu/fruitgrowing/berrycrops/orblack.htm website verified on May 26, 2003.

6. *Crop Profile for Blackberries in Oregon,* revised September 1999. http://pestdata.ncsu.edu/cropprofiles/docs/orblackberries.html, website verified on May 26, 2003.

7. *Crop Profile for Blackberry in Oregon,* August 2002, J. DeFrancesco, W. Parrott, J. Jenkins, Oregon State University. http://www.ipmcenters.org/CropProfiles/docs/ORblackberries.pdf, website verified on May 24, 2009.

8. *Crop Profile for Raspberries (Red) in Washington,* January 1999, G.W.Menzies, Washington State University. http://www.ipmcenters.org/CropProfiles/docs/waraspberries-red.pdf, website verified on May 24, 2009.

9. National Agricultural Statistics Service, U. S. Agriculture Department, 2008 http://usda.mannlib.cornell.edu/usda/current/NoncFruiNu/NoncFruiNu-01-23-2009_revision.pdf, website verified on May 24, 2009.

10. Interregional Research Project #4, http://ir4.rutgers.edu, website verified on May 24, 2009.

11. *Integrated Pest Management for Raspberries,* Washington State University Cooperative Extension, Whatcom County G.W. Menzies & C.B. MacConnell, June, 1998, http://whatcom.wsu.edu/ag/comhort/nooksack/ipmweb/Toc.htm