Pest Management Strategic Plan
Caneberry Production in Washington and Oregon

Prepared for the
Pacific Northwest Caneberry Industry,
United States Department of Agriculture,
and the
Environmental Protection Agency

By the
Caneberry Workshop Attendees

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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 (OP), 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, Extension service personnel, industry representative, 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.

Currently, the caneberry industry is faced with losing a number of essential chemicals critical for pest management in caneberry production. At the same time, a number of unproven, newer, low-risk chemistries are becoming available. 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 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 control.
- Develop strategies, which may include resistant cultivars, for control of raspberry bushy dwarf virus.
  Bushy dwarf virus is the direct 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 pollinating bees, making control very difficult.
- Identify replacements for diazinon, fenamiphos (Nemacur), methyl bromide, and azinphos-methyl (Guthion).
  After EPA completes its review of these compounds, they may no longer be available for use in caneberries or have a limited use pattern.
- Need insecticides with shorter PHIs and REIs for use as a clean up spray to control insect contaminants just prior to or during harvest
- Develop strategies, which may include resistant cultivars, for control of *Phytophthora* (root rot).
  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 technologies.
  In order to remain economically viable in a global marketplace, it will be necessary to develop practical and realistic long-range goals that include innovative technologies to reduce cost, improve quality and increase yields.

REGULATORY

- Approve the Critical Use Exemption (CUE) for nursery use of methyl bromide for production of caneberry plant material.
- Need more consistency between REIs and PHIs to allow better use of products.
  For some products, the REI is longer than the PHI, which limits its use.
- Streamline the process for registration of pesticides for use on minor crops.
  The obstacles involved in gaining registration for minor crop uses poses major difficulties 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.
- Allow multiple Section 18s for products that are not only efficacious but also needed for resistance management.
- Retain diazinon use pattern.
  Proposed restrictions to diazinon use threatens the economic viability of growers using it to control raspberry fruit worm and raspberry crown borer.

EDUCATION

- Need fully funded Extension and Research programs at Land-Grant universities.
  Recent budgetary cutbacks and personnel layoffs threaten the viability of IPM implementation and research. Methods of dispersal of information between publicly funded agencies and the caneberry industry are slowly disappearing.
- Need full support of IR-4 to assist caneberry producers in obtaining minor crop tolerances.
- Educate growers on thresholds, pest identification and IPM techniques.
- Continue to educate on resistance management for all pesticides.
  The rapid introduction of newer pest control/pest management materials has not been accompanied by adequate resistant management strategies to insure their longer term viability.
- Support and strengthen IPM programs at colleges and universities.
- Keep the USDA/ARS Northwest Center for Small Fruits Research in Corvallis, Oregon, fully funded.

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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 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 74 million pounds of raspberries on 9,500 acres with a value of $37 million in 2002.
- Washington raspberry production accounts for 65% 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 77% of the state total, followed by Skagit County (10%) and Clark and Cowlitz counties combined (11%).

Western Oregon

- Oregon harvested 11.7 million pounds of raspberries on 2,500 acres with a value of $8.4million in 2002. (Rufus: harvested 7.5 million pounds with a value of $4 million)
- Oregon raspberry production accounts for 10% 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 of the nation's processed black raspberries (approximately 2.8 million pounds produced on 1,100 acres in 2002).

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 fruitworms, 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. There is an on-line IPM guide for key raspberry pests occurring in Northwest Washington (http://whatcom.wsu.edu/ag/comhort/nooksack/ipmweb/Toc.htm).

Blackberries

- In 2002, Oregon growers produced 46.7 million pounds of blackberries on 5,980 acres, with a farm-gate value of about $19.7 million.
- Oregon leads the nation in blackberry production, accounting for over 90% of the production.
- Boysenberries and Loganberries have a growth habit similar to the cultivated blackberry and are commonly included in the blackberry category. In 2002, Oregon produced more than 3 million pounds of Boysenberries on 1,380 acres, with a farm-gate value of nearly $1.8 million.
- Most notable blackberry cultivars in order of poundage are: Marion, Oregon Thornless Evergreen (commonly referred to as Evergreen), and Boysen.
- Marionberries account for approximately two-thirds of the total blackberry crop.
- Blackberries, at present, are not a large 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 hand picked 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 the 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 are 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 funds become 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, 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 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 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, Extension service personnel, crop consultants, and researchers.

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 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 is 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 often used in combination with chloropicrin to increase its activity on additional fungal pathogens. The use of methyl bromide in the USA is to be banned by 2005. 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 cutworms, 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:

- **1,3-dichloropropene** (Telone II) or **1,3-dichloropropene + chloropicrin** (Telone C17, C35) at 20 – 30 gal/acre. Pre-plant soil fumigation. Excellent control.
- **Sodium methyldithiocarbamate** (Vapam) at 50 to 100 gal/A. Poor – Good. Pre-plant soil fumigation. Efficacy dependent on soil type, moisture, application method.

- **Dazomet** (Basamid) **at** 400 lb/acre. Poor – Good. Used little. Same issues as sodium methyldithiocarbamate (Vapam).
- **Methyl bromide/Chloropicrin** at 300 – 400 lbs/acre. Pre-plant soil fumigation. Due to be phased out by 2005. Excellent control.

Biological control:
- None

Cultural control:
- Disking can kill the majority of in-field populations of weevils and cutworms insects.

List for insect/mite management needs in newly established plantings:

Research:
- Cover crops research (i.e. brassica)
- Preplant insecticide incorporation
- Methyl bromide alternatives
- Develop economic thresholds

Regulatory:
- None

Education:
- Provide information to growers about pre-plant scouting, insect identification and thresholds (when developed).
- 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.

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: it 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 one or two canes.

Chemical control:

- **Methyl bromide/Chloropicrin** at 300 – 400 lb/acre. Pre-plant soil fumigation. Fumigate when soil is warm, preferably the summer prior to spring planting. Excellent control

Biological control:

- None

Cultural control:

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

Crown and Cane Gall

*Agrobacterium tumefacien*s and *A. rubi*

All caneberries are susceptible to crown and cane gall but blackberries (in particular Boysens and Evergreens) 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:

- None

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/roothairs treated by the dip. As root development occurs, the disease can infect new tissue, if it is present in the soil.

Cultural control:

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

Root Rot

Phytophthora spp.

Most caneberries can get root rot but red and black raspberries are especially susceptible. Root rot is a major disease problem, 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:

- **1,3-dichloropropene** (Telone II) or **1,3-dichloropropene + chloropicrin** (Telone C17, C35) at 20 – 30 gal/acre. C17 and C35. Pre-plant soil fumigation. Fair.
- **Methyl bromide/Chloropicrin** at 300 –400 lb/acre. Pre-plant soil fumigation. Used under tarp for best control. (Generic to all references of this chemical).
- **Mefenoxam** (Ridomil Gold) at 0.25 pint/ 1,000 ft. of row. Fair – Excellent. Resistance is suspected. Applied at planting. Registered for use in raspberries only.

Biological control:
- None

Cultural
- Plant on raised beds (incorporation of gypsum has added benefits)
- Planting resistant cultivars may be an option in some situations.
- Certified planting stock in soil that has not grown small fruit for several years.
- Solarize soil before planting. New method for commercial use. Organic option. Delays the onset of the disease for two years.
- Improve drainage and/or avoid poorly drained fields.

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:
- **Methyl bromide/Chloropicrin** at 300 –400 lb/acre. Pre-plant soil fumigation. Fair to Good

Biological control:
- None

Cultural Aids
- Rotations using non-susceptible grasses and cereals
- Avoid planting caneberries in soil where other Verticillium-susceptible crops (e.g tomatoes, hops, potatoes) were grown.
- Use certified planting stock
- Select well-drained soils

List for disease management needs in newly established plantings:

Research:

- Develop better sampling diagnostic tools for Verticillium and Phytophthora (Root rot)
- Effectiveness of Agrobacterium radiobacter K84 or K1026 (Galltrol and Nogall)
- Develop more affective controls for Phytophthora (Root rot)
- Evaluate commercial feasibility of solarization.
- Evaluate cover crops for control of Verticillium.
- Develop Phytophthora (root rot) tolerant cultivars

Regulatory:

- Expedite Methyl Bromide alternatives.

Education:

- 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.
- Revise and update the Guide for Commercial Raspberry Production in the Northwest.

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 preemergence 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 preemergence 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:

- **Napropamide** (Devrinol) at 4.0 lb. ai/A. Preemergence herbicide. Effectiveness is limited if not incorporated by irrigation or rainfall within hours after application. Performance is also reduced by excessive plant residue on soil surface. Primarily a grass herbicide. Poor – Good.
- **Oryzalin** (Surflan) at 2.0 to 6.0 lb ai/A. Preemergence herbicide. Expensive. Excellent control and safe for small plants.
- **Isoxaben** (Gallery 75 DF) at 0.5 to 1 lb ai/A. Preemergence herbicide. Non-bearing only. Controls several broadleaf weeds; will not control grasses.

Partially suppresses field bindweed and curly dock at the 1 lb ai/A rate. Requires sprinkler irrigation or rain (0.5 inch or more) for activation. Excellent control.

- **Simazine** (Simazine 90 WDG or 90DF, Princep Caliber90, Simazine 4L) at 1 to 1.6 lb ai/A. Inexpensive. Preemergence herbicide. Fair to Good control. Should be used only when soil around roots has settled and new planting has been established for several weeks, due to phytotoxicity.
- **Bentazon** (Basagran) at 0.75 to 1 lb ai/A. Temperatures below 55°F, drought, or rain within 8 hours will reduce activity. Postemergence herbicide. Non-bearing only. Not used because it can't be sprayed over the top of new plants.
- **Sethoxydim** (Poast) at 0.28 to 0.47 lb ai/A – 1.5 to 2.5 pints, PHI 45. Postemergence herbicide. Controls grasses only. Resistant grasses include annual bluegrass and all fine fescues, but quackgrass can be suppressed. Good, if label application directions are followed closely.
- **Clethodim** (Prism or Select) at 0.094 to 0.125 lb ai/A – (13 to 17 fl. oz. Prism/A or 5 to 8 fl. oz. Select/A). Postemergence herbicide. Controls grasses only. Fair – Good. Control of quack and annual bluegrass.
- **Fluazifop** (Fusilade DX) at 16-24 oz/A. Postemergence herbicide. Controls grasses only. Non-bearing only. Annual bluegrass and all fine fescues resist treatment. Similar to Poast
- **Glyphosate** (numerous names, rates vary according to crop,). Non-selective, postemergence herbicide.
- **Paraquat:** (Gramoxone Extra or Gramoxone Max) at 2-3 pints/A. Non-selective, postemergence, contact herbicide.

Biological control:

- None

Cultural control:

- Cultivation
- Hand hoeing
- Flaming

<u>List for weed management needs 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:

No new herbicides being registered on caneberries because manufacturers consider caneberries a relatively small market.

Education:

- 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.

NEMATODES

There are two types of 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. Such root damage can also exacerbate *Phytophthora spp* infections in susceptible soils. The dagger nematode (*X. americanum*) causes little or no direct root damage but is capable of transmitting the tomato ringspot virus which, even at low population levels, can reduce raspberry growth and cause crumbly fruit. X 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 (TRsV).

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) at 20 – 30 gal/acre. Very Good.
- **Sodium methyldithiocarbamate** (Vapam) at 50 to 100 gal/A. May apply through an irrigation system. Fair to Poor. The chemical does not penetrate deep enough into the soil to be effective.
- **Methyl bromide/Chloropicrin** at 300 –400 lb/acre. Excellent. To be discontinued in 2005.

Biological control:

- None

Cultural control:

- Use certified planting stock.
- Fallow two or more years (if practical).
- Plant in soil that has been tested and found free of dagger nematodes.

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.

- **Fenamiphos** (Nemacur) – Banded application immediately after planting. Excellent – Good. To be removed from the market in 2007. Can be phytotoxic. Registered for raspberries only.
- **1,3-dichloropropene** (Telone II) at 52 to 106 fl oz/1,000 ft of row using a single chisel per row on mineral soils.
- **Sodium methyldithiocarbamate** (Vapam)at 50 to 100 gal/A. Immediately roll the soil and follow up with tarps or a light watering. Vapam is more affective on Root-lesion than Dagger. Fair to good. The chemical does not penetrate deep enough into the soil to be effective.
- **Methyl bromide/Chloropicrin** at 300 –400 lb/acre. To be discontinued in 2005**.**

Biological control:

- None

Cultural control:

- Used certified planting stock.
- Plant cover crops, like wheeler rye, Sudan grass, or marigolds.
- Plant in soil that has been tested and found free of nematodes.

List for nematode management needs in newly established plantings:

Research:

- Evaluate use of cover crops for nematode control
- Screen for resistant and tolerant cultivars
- Fenamiphos (Nemacur) replacement
- Alternate for methyl bromide.
- Preplant nematicide that is not a soil fumigant.
- Detection of virus in nematodes

Regulatory:

- Expedite registration of fenamiphos (Nemacur) replacement
- No new nematicides being registered on caneberries because manufacturers consider caneberries a relatively small market

Education:

- Continue to educate growers on sampling, monitoring and thresholds.
- 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.

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 bud break 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)

INSECT AND MITE PESTS

<u>Armyworms and climbing cutworms</u>
Many species
Larvae may be present as buds begin to swell and open. They are active at night, feeding on primary buds and new growth. Infestations are usually spotty within a field. Early season cutworms are rarely a problem, but if present, their feeding can significantly reduce yield.

Chemical control:
OP

- **Diazinon** at 1lb ai/A. Not as effective as azinphos-methyl.
- **Azinphos-methyl** (Guthion) at 0.5 lb ai/A or (Azinphos-methyl 50W Soluble) at 1.25 lb ai/A. EPA is proposing to eliminate foliar application in caneberries.

Carbamate

- **Carbaryl** (Sevin) at 2 lb ai/A. Toxic to bees.

Other

- **Spinosad** (Success) at 4 to 6 fl oz product/A. Newer product, not a lot of grower experience with this material. More expensive than older products.

Biological control:

- ***Bacillus thuringiensis*** *(Bt)* various labels have various rates. Works better on early instars.

Cultural control:

- Conserve natural predators such as carabids.

Dryberry mite

Phyllocoptes gracilis

Dryberry mite is a 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 at delayed dormant.

Chemical control:

OP

- **Diazinon** at 1 to 2 lb ai/A. Not effective.

Other

- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Rates vary.
- **Elemental sulfur** (several types and brands). Rates vary. Organically acceptable.

Biological Control:

- None.

Cultural control:

- None.

Leafrollers

Obliquebanded leafroller (*Choristoneura rosaceana*)
Orange tortrix (*Argyrotaenia franciscana*) Others

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 (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 difficult, as egg hatch following treatment "masks" effectiveness.

OP

- **Azinphos-methyl** at 0.25 lb ai/A. EPA is proposing to eliminate foliar application in caneberries. Relatively soft on beneficials, effective in cool temperatures, works well on adults.
- **Malathion** at 1.5 to 2 lb ai/A. Not as efficacious as others under cooler temperatures.
- **Diazinon** at 1 lb ai/A. EPA proposes to allow only one application per season of diazinon.

Carbamate

- **Carbaryl** (Sevin) at 2 lb ai/A. Use can cause a mite flare-up. Poor adulticide. Works better in warmer temperatures.

Pyrethroid

- **Bifenthrin** (Brigade or Capture) at 0.05 to 0.1 lb ai/A. Use can cause a mite flare-up. More expensive than others. Can be used once pre-bloom and once post-bloom only.

Other

- **Tebufenozide** (Confirm 2 F) at 0.25 lb ai/A. Newer product, not a lot of grower experience with this material.
- **Spinosad** (Success) at 4 to 6 fl oz product/A. Newer product, not a lot of grower experience with this material. More expensive than older products.
-

Biological control:

- ***Bacillus thuringiensis*** (Bt) various labels have various rates. Difficult to get control because of coverage to where instars are in rolled leaves.

Cultural control:

- None

Mites

Twospotted spider mite (*Tetranychus urticae*)
Yellow spider mite (*Eotetranychus carpini borealis)*
Others
Mite feeding reduces plant vigor and may cause leaves to be mottled, turn brown, and drop prematurely. They are an occasional pest in caneberries at this stage.

Chemical control:

- **Potassium salts of fatty acids** (M-Pede) 1-to 2% v/v solution. Poor efficacy, short residual. Possibly better than doing nothing. Organically approved.
- **Hexythiozox** (Savey 50 WP) 0.25 to 0.375 lb ai/A. Very expensive. Ovicidal only. Good control of next generation. Safe to beneficials.
- **Hexakis** (Vendex) at 1 lb ai/A. Takes up to 10 days to work. Not as effective in cool temperatures. Safe to beneficials.
- **Bifenthrin** (Brigade or Capture) at 0.1 lb ai/A. PHI 3. Potential resistance because of heavy use for control of other pests.
- **Summer Oils** (particularly for early bud break infestations).
- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Rates vary. Use at delayed dormant stage.

Biological Control:

- **Predatory mites** (naturally occurring and can be purchased for release). Very little inundative releases of predatory mites. Naturally occurring predatory mite populations generally control mites at this stage. Inoculative releases work best. Takes a long time for predatory mites to build up populations for good control.
- **Stethorus** (abundant in nature, expensive to buy), **Anthocoris** (naturally occurring, can purchase) releases. Good at low population densities of mites.

Cultural control:

- Conserve natural predators.

<u>Raspberry crown borer</u>

Pennisetia marginata

OPs 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 OPs 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:

OP

- **Azinphos-methyl** at 2 lb ai/A. EPA proposes to allow this soil/lower cane application for the next four years but at a rate of 0.5 lb ai/A; however, 2.0 lb ai/A is needed to control this pest.
- **Diazinon** at 1-2 lb ai/A. Need to drench the soil for efficacy.

Biological control:

- None.

Cultural control:

- None.

Raspberry fruitworm

Byturus unicolor

Major driver of Diazinon use; 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:

OP

- **Diazinon** at 1 lb ai/A. EPA proposes to allow only one application per season of diazinon. For control of this pest, diazinon is the only option. For most markets, there is a zero tolerance for this pest at harvest and this is the only time to treat.

Biological control:

- None.

Cultural control:

- None.

Redberry mite

Acalitus essigi

Redberry mite is a problem in blackberries only. Late-maturing cultivars, like Oregon Thornless Evergreen, are most susceptible but mites infest other blackberries, also. 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). Rates vary.
- **Elemental sulfur** (several types and brands). Rates vary. Organically acceptable.

Biological control:

- None.

Cultural control:

- None.

Rodents

Rodents, especially field mice and voles, can cause damage when they chew on the roots of the caneberry plant, sometimes causing cane death. Trapping is method of control that

can be implemented any time of the year. Baiting with Zinc Phosphide Pellets can be implemented only during dormancy and prior to bud break in the spring.

Chemical control:

- **Zinc Phosphide Pellets (bait)** at 6 to 10 lb product/A. Broadcast to soil surface during dormancy and before leaf emergence in the spring.

Biological control:

- None.

Cultural control:

- Traps. Time consuming and not highly efficient.

Root weevils

Black vine weevil (*Otiorhynchus sulcatus*)
Strawberry root weevil *(O. ovatus*)
Rough strawberry root weevil (*O. rugosostriatus*)
Clay colored weevil (*O. singularis*)
Obscure root weevil (*Sciopithes obscurus)*

The clay colored weevil is found primarily in northern Washington and is rare 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. 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:

OP

- **Azinphos-methyl** (Guthion) at 0.5 lb ai/A EPA is proposing to eliminate foliar application in caneberries.
- **Malathion** at 1.75 lb ai/A. Poor efficacy. Not a restricted use material.

Pyrethroid

- **Bifenthrin** (Brigade or Capture) at 0.05 to 0.1 lb ai/A. Major chemical for weevil control. Use can cause a mite flare-up. More expensive than others. Can be used once pre-bloom and once post-bloom only.

- **Esfenvalerate** (Asana XL) at 0.05 lb ai/A. Not efficacious.

Other

- **Azadirachtin** (Neem). Several brands. Rates vary. Poor efficacy. Organically approved.

- **Cryolite Bait** at 4 to 8 lb ai/A. 24c registration. Expensive, may not be available (mfg. may not continue making due to lack of demand).

Biological control:

- ***Beauveria bassiana*** (Mycotrol ES) at 1 to 3 quarts of product/A. New product, not much grower experience. Organically approved.

Cultural control:

- None.

Strawberry crown moth

Synanthedon bibionipennis

Larvae girdle the roots and lower crowns, and can tunnel in. Plants can be stunted and have poor vigor. Primarily a pest in southern Washington and Oregon.

Chemical control: (applied as a crown drench in late March or before bud break.)

OP

- **Azinphos-methyl** (Azinphos-methyl 50W Soluble) at 2 lb ai/A. EPA proposes to allow soil/lower cane application for the next four years but strawberry crown moth won't be included on the label. A rate of 0.5 lb ai/A will be on the new label; however, 2.0 lb ai/A is needed to control this pest.
- **Diazinon** at 2 lb ai/A. EPA proposes to allow only one application per season of diazinon.

Biological control:

- None.

Cultural control:

- None.

Winter moth

Operophthera spp.

Larvae hatch in late winter/early spring and feed on buds. They can destroy fruit buds and, thus, reduce fruit yield. The winter moth larvae are occasional pests in caneberries.

Chemical control:

OP

- **Diazinon** at 0.5 to 1 lb ai/A. EPA proposes to allow only one application of diazinon per season. Foliar application.
- **Azinphos-methyl** at 0.25 lb ai/A. EPA proposes to eliminate foliar applications of azinphos-methyl in caneberries.

Other

- **Spinosad** (Success) at 4 to 6 fl oz product/A. Newly registered, not much grower experience
- **Tebufenozide** (Confirm 2 F) at 0.25 lb ai/A. Limited grower experience.

Biological control:

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

Cultural control:

- None.

List for insect/mite management needs in dormancy to prebloom season:

Research:

- Cost effective alternatives for diazinon and azinphos-methyl (Guthion).
- Research malathion as soil drench for raspberry crown borer.
- Develop economic thresholds for mites, root weevils, and raspberry crown borer.
- Develop a resistance management program for leafrollers.
- Encourage naturally occurring beneficial insects.
- Pheromones for raspberry crown borer.
- Parasitoid wasps for control of leafrollers.
- Alternative to diazinon for raspberry fruitworm control.
- Research into trap and kill crops/hosts.
- Cane management for leafroller control

Regulatory:

- .
- Allow additional applications of diazinon. (more than one)

Education:

- Educate growers on thresholds and monitoring.
- Need to gain experience and determine field efficacy for newer pesticides, such as spinosad (Success) and tebufenozide (Confirm).
- 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.

DISEASE PESTS

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 seriously affects black raspberries and 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 is not always severe enough to warrant the cost of spraying. This disease 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, growers treat preventatively to minimize risk.

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

- **Fixed copper** (several brands). Rates vary. Many formulations are organically acceptable.
- **Bordeaux** (copper sulfate + hydrated lime)
- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands) Rates vary.
- **Captan 50 WP** at 4 lb/A,, 24c registration.
- **Ferbam Granuflo** at 1.5-3 lb/A, 24c registration. Not used. No efficacy data.
- **Pyraclostrobin** (Cabrio EG) at 14 oz/A. New registration. Efficacy looks promising but no field experience to date.

Biological control:

- None.

Cultural control:

- Certified disease-free stock.
- 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.
- Early primocane control.
- Thin out weak canes. Eliminate weeds to provide good air movement.
- Avoid overhead irrigation, or limit the time plants are wet from irrigation.

Bacterial blight
Pseudomonas syringae
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 as a delayed dormant application.
- **Fixed copper** (several brands). Rates vary. Many formulations are organically acceptable.
- **Bordeaux** (copper sulfate + hydrated lime)

Biological control:
- None

Cultural control:
- Avoid overfertilization.

Cane and Leaf Rust
Kuehneola uredinis
A pest in blackberries, especially in the Oregon Thornless Evergreen and Silvan blackberry cultivars; hybrid berries are generally not affected by this disease. This fungus has several spore types that infect both floricane and primocane leaves. The fungus is not systemic in the plant. Wet conditions favor disease development. Canes become brittle and break easily. Premature defoliation can occur if disease pressure is severe.

Chemical control:
- **Fixed copper** (several brands). Rates vary. Many formulations are organically acceptable.
- **Bordeaux** (copper sulfate + hydrated lime).
- **Myclobutanil** (Rally 40 W) at 1.25 to 2.5 oz/A.
- **Pyraclostrobin** (Cabrio EG) at 14 oz/A. New registration. Looks promising but no field experience to date.

Biological control:
- None.

Cultural control:
- An alternate-year fruiting program reduces disease pressure. However, production is dramatically reduced for many growers.

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

This fungal disease is prevalent in most blackberry and hybrid berry fields. 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 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 their primary control tool.

Chemical control:

1. Spray at budbreak.
    - **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Rates vary. May burn leaves when shoots are greater than 0.75 inched long
    - **Fixed copper** (several brands). Rates vary. Many formulations are organically acceptable.
    - **Pyraclostrobin** (Cabrio EG) at 14 oz/A. New registration. Looks promising but no field experience to date.
2. Directed spray to young primocanes at 0 to 6 inches growth, 12- to 18-inch growth and 2- to 3-foot growth.
    - **Ferbam Granuflo** at 1.5 to 3 lb/A. 24c registration. Not used. No efficacy data.
    - **Fixed copper** (several brands). Rates vary. Many formulations are organically acceptable.
    - **Captan 50 WP** at 4 lb/A. 24c registration.
    - **Pyraclostrobin** (Cabrio EG) at 14 oz/A. New registration. Looks promising but no field experience to date.

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 is especially problematic in Boysenberries and some blackberry cultivars; raspberries are not affected. This 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. Climatic conditions play a major role in seemingly sudden "outbreaks" of this

disease, causing flareups of "dry cell" on ripening fruit, reducing quality and marketability.

Chemical control:

- **Fosetyl-al** (Aliette WGD) at 5 lb/A, PHI 60. Long PHI makes use prohibitive for some cultivars.
- **Phosphorous acid** (Fosphite) at 1 to 2 quarts/A.

Biological control:

- None.

Cultural control:

- Early primocane control.
- Reduce or eliminate overhead irrigation.
- Practice good weed control.
- Eliminate wild blackberries and roses close to fields.

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. 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) at 1.25 to 2.5 oz/A. Protectant, not curative.

Biological control:

- None

Cultural control:

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

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:
Dormant sprays

- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Rates vary.
- **Potassium bicarbonate** Armicarb 100 at 2.5-5 lb/A or Kaligreen at 2.5-3 lb/A. Not preventative, use once disease is found. Organically approved. Apply whenever see disease. Contact only.
- **JMS Stylet Oil** at 3-6 qt/100 gal water. . Has good effectiveness against powdery mildew on other crops and may be useful on blackberries. Organically acceptable.
- **Elemental sulfur** (several types and brands). Rates vary. Organically acceptable.
- **Potassium salts of fatty acids** (M-Pede) at 2 gal/100 gal water. Organically acceptable.
- **Myclobutanil** (Rally 40 W) at 1.25-2.5 oz/A. No more than 10 oz/A/season.
- **Pyraclostrobin** (Cabrio EG) at 14 oz/A. New registration. Looks promising but no field experience to date.

Biological control:

- ***Ampelomyces quisqualis*** (a fungal hyperparasite) AQ10 at 0.5-1 oz/A. Ineffective as a stand-alone treatment or if symptoms of powdery mildew are present.

Cultural control:

- Do not plant close to wooded areas that might shade the field.
- Remove wild blackberries from around the field.
- Planting resistant cultivars may be an option in some situations.
- Remove any infected, late-forming suckers.

<u>Purple Blotch</u>
Septocyta ruborum
All blackberries and hybrid berries are affected by this disease. The causal organism is a fungus similar to *Septoria rubi*. Spores are produced in spring on floricanes and infect only primocanes. Symptoms will not develop unless a chilling requirement is 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. At present the loss of growers' primary chemical control, benomyl, could impact the economic losses attributed to purple blotch.

Chemical control on new primocanes:
1. Spray at budbreak:

- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Rates vary.
- **Fixed copper** (several brands). Rates vary. Many formulations are organically acceptable.
- **Pyraclostrobin** (Cabrio EG) at 14 oz/A. New registration. Looks promising but no field experience to date.

2. Directed spray to young primocanes at 0 to 6 inches growth, 12- to 18-inch growth and 2- to 3-foot growth:
   - **Captan** 50 WP at 4 lb/A. 24c registration.
   - **Fixed copper.** Several brands. Rates vary. Many formulations are organically acceptable.
   - **Ferbam Granuflo** at 1.5 to 3 lb/A, 24c registration. Not used. No efficacy data.
   - **Pyraclostrobin** (Cabrio EG) at 14 oz/A. New registration. Looks promising but no field experience to date.

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. 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:

Rotate applications between these materials to help prevent building up resistant populations.
- **Mefenoxam** (Ridomil Gold) at 0.25 pint/1,000 feet, PHI 45. Some reduced efficacy has been observed in western Washington. Registered for use in raspberries only.
- **Fosetyl-Al** (Aliette WDG) at 5 lb/A, PHI 60. Apply to foliage twice in spring.
- **Phosphorous acid** (Fosphite) at 1 to 2 quarts/A, Apply to foliage twice in spring.

Biological control:
- None.

Cultural control: Best results occur when several cultural and chemical practices are integrated together.

- Maintain raised beds.
- Subsoil in alleyways to promote drainage.
- Do not over irrigate.

Spur Blight
Didymella applanata
Primarily a pest of red raspberries. 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.

Chemical control:
Apply late dormant or delayed dormant

- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Rates vary. Questionable efficacy, may reduce inoculum, may not reduce disease severity.

Biological control:

- None.

Cultural control:

- Keep plant rows narrow
- Practice good weed control
- Control early primocane growth
- Planting resistant cultivars may be an option in some situations.
- Scout during previous year for severity.

Yellow Rust
Phragmidium rubi-idaei
Widespread in most raspberry fields, particularly in years when spring rains continue late. Historically has not 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.

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

- **Bordeaux** (copper sulfate + hydrated lime)
- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Rates vary.

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

- **Ferbam Granuflo** at 1.5 to 3 lb/A. 24c registration. Do not use more than 15 lb/A per season or within 40 days of harvest. Effectiveness is doubtful. Has limited activity against this disease.
- **Myclobutanil** (Rally 40 W) at 5 oz/A.
- **Pyraclostrobin** (Cabrio EG) at 14 oz/A. New registration. Looks promising but no field experience at to date.

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 be an option in some situations.

List for disease management needs in dormancy to prebloom season:

Research:
- Determine efficacy of pyraclostrobin (Cabrio) and boscalid (Pristine/BAS 516) for various diseases.
- Controls for *Pseudomonas syringae* (bacterial blight)
- Resistance management for diseases, esp. *Phytophthora* root rot
- Cane management techniques for reducing diseases.
- Determine toxicity of cane suppression herbicides to fungal pathogens, such as Botrytis fruit rot, spur blight, and cane blight.
- Modeling and forecasting for diseases.

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

Education:
- Diagnosis of diseases.
- Developing resistance programs for growers.
- Where to get information (develop a web site and other sources.)
- 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.

WEED PESTS
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 post-emergent. To create a vegetation-free zone in the plant row prior to the application of a preemergence 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 "caneburning" 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 acie (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.

- **Diuron** (Karmex, Diuron 80 or Diuron 4L) at 1.6 to 2.4 lb ai/A. Preemergence herbicide. Cannot use on newly established plantings.
- **Norflurazon** (Solicam) at 2.5 to 5 lb ai/A. It is primarily used where annual grass control is a problem but also has activity against several common broadleaved weeds. Preemergence herbicide. 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.
- **Dichlobenil** (Casoron) at 2-4 lb ai/A – 50-100 lb/A granular, 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.
- **Terbacil** (Sinbar) at 0.8 to 1.6 lb ai/A, PHI 70. Preemergence herbicide. Solubility relatively high; use with caution on tender/weakened plantings.
- **Oryzalin** (Surflan) at 2 to 6 lb ai/A. Preemergence herbicide.
- **Paraquat** (Gramoxone Extra or Gramoxone Max). Non-selective, postemergence, contact herbicide.
- **Napropamide** (Devrinol) at 4 lb ai/A. Preemergence herbicide.

- **Simazine** (Simazine 90 WDG or 90DF, Princep Caliber90, Simazine 4L) at 2.2 to 4.0 lb ai/A. Preemergence herbicide.
- **Glyphosate** (numerous names) Non-selective, postemergence herbicide. Some species show poor response.
- **Sethoxydim** (Poast) at 0.28 to 0.47 lb ai/A – 1.5 to 2.5 pints Poast/A, PHI 45. Postemergence herbicide. Controls grasses only.
- **Pronamide** (Kerb) at 1-2 lb ai/A for annual grass; 2-4 lb ai/A for perennial grass. 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 black raspberries.

Primocane suppression:

- **Oxyfluorfen** (Goal 2XL or Galigan 2XL) at 0.4 to 0.8 lb ai/A, broadcast for blackberries; 0.2 to 0.75 lb ai/A broadcast for raspberries. PHI for raspberries is 50 days (15 days for blackberries) 24c registration.
- **Oxyfluorfen** (Goal 2XL) at 0.5 to 1.0 lb ai/A broadcast, for non-bearing AY blackberries, 24c registration.
- **Carfentrazone-ethyl** (Aim 40W) at 0.05 to 0.1 lb ai/A broadcast. New product.
- **Pelargonic acid** (Scythe) at 5 to 7% solution in 75 to 100 gal/A water – for annual weeds use 3 to 5% solution.

Biological control:

- None.

Cultural control:

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

<u>List for weed management needs in dormancy to prebloom season:</u>

Research:

- Mulching for weed control.
- Cover crops, and mowing and blowing into row for primocane suppression.
- More research on Carfentrazone-ethyl (Aim) efficacy for primocane suppression.
- Phytotoxicity of Carfentrazone-ethyl (Aim) in raspberries.
- More screening for additional herbicides.
- Determine if cane suppressing herbicides impact fungal diseases.

Regulatory:

- Register organic acids for weed control.

Education:

- 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.

NEMATODES
Root-lesion nematode *(Pratylenchus spp)*
Dagger nematode *(Xiphinema americanum)*

Chemical control:
- **Fenamiphos** (Nemacur). Excellent – Good. May be removed from the market in 2007. Can be phytotoxic. Registered for raspberries only. Dec. 31st is cut off date for use in established plantings.

Biological control:
- None.

Cultural control:
- None.

List for nematode management needs in dormancy to prebloom season:

Research:
- Biological nematicides
- Replacement for fenamiphos (Nemacur) by 2007.

Regulatory:
- None

Education:
- 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.

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.

INSECT AND MITE PESTS

Aphids

Larger Raspberry Aphid *(Amphorophora agathonica)* and other species
Aphid feeding causes the leaves to curl downward and become deformed.

Chemical control:

OP

- **Azinphos-methyl** (Guthion) 0.5 lb ai/A, PHI 14. PHI too long if needed close to harvest. EPA proposes to eliminate foliar applications of azinphos-methyl in caneberries.
- **Malathion** at1.5 to 2 lb ai/A, PHI 1.
- **Diazinon** at1 lb ai/A, PHI 7. EPA proposes to allow only one application of diazinon per season. PHI is too long if needed close to harvest.

Pyrethroid

- **Bifenthrin** (Brigade or Capture) at 0.05 to 0.1 lb ai/A. PHI 3. Use can cause a mite flare-up. Potential resistance because of heavy use for control of other pests. Toxic to bees.
- **Esfenvalerate** (Asana XL) at 0.025 to 0.05 lb ai/A. PHI 7**.** PHI is limiting; can not 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

- **Potassium** salts of fatty acids (M-Pede) at 1-2% v/v solution. PHI 0. Efficacy is very poor. Organically approved.
- **Spinosad** (Success) at 4 to 6 fl oz product/A, PHI 1. Bee toxicity until spray dries.

Biological control:

- ***Beauveria bassiana*** (Mycotrol ES) 1-3 qt of product/A, 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>:
Miscellaneous 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:

OP (Cannot use if bees are present.)
- **Diazinon** at 1 lb ai/A, PHI 7.

Carbamate
- **Carbaryl** (Sevin) at 2 lb ai/A, PHI 7. Latex-based formulations of carbaryl, such as Sevin XLR Plus. Cannot use during bloom because of bee toxicity. Essentially cannot be used for raspberries because of overlapping bloom to ripening berries.

Other
- **Spinosad** (Success) at 4 to 6 fl oz product/A, PHI 1. Bee toxicity until spray dries.
- **Esfenvalerate** (Asana XL) at 0.025 to 0.05 lb ai/A. PHI 7. 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.
- **Bifenthrin** (Brigade or Capture) 0.05 to 0.1 lb ai/A. Shorter PHI than Asana. One pre-bloom and one post-bloom application allowed. Toxic to bees.

Biological control:
- ***Bacillus thuringiensis*** (Bt) various labels have various rates, PHI 0. Safe with bees.

Cultural control:
- None.

<u>Earwigs</u>
European (common) earwig (*Forficula auricularia*)
A 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.

Chemical control:

- **Bifenthrin** (Brigade or Capture) at 0.05 to 0.1 lb ai/A, PHI 3. REI discrepancy between hand and mechanical harvesting.
- **Malathion** at 1.75 to 2 lb ai/A, PHI 1. Short PHI makes it very useful. Thorough coverage is important. Short residual. Fair efficacy.

Biological control:
- None

Cultural control:
- Keep row clean of weeds.

<u>Leafrollers</u>:
Obliquebanded Leafroller (*Choristoneura rosaceana*)
Orange Tortrix (*Argyrotaenia franciscana*)
Other species.
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 difficult, as egg hatch following treatment "masks" effectiveness.

OP (Cannot use if bees are present.)
- **Azinphos-methyl** at 0.25 lb ai/A, PHI 14. PHI too long if needed close to harvest. EPA proposes to eliminate foliar applications of azinphos-methyl in caneberries.
- **Malathion** at 1.5 to 2 lb ai/A, PHI 1. Not as efficacious as other materials. Short residual. Is a useful material because of short PHI.
- **Diazinon** at 1 lb ai/A, PHI 7. Cannot use if bees are present.

Carbamate (Cannot use if bees are present.)
- **Carbaryl** (Sevin) at 2 lb ai/A, PHI 7. Cannot use during bloom because of bee toxicity. Essentially cannot be used for raspberries because of overlapping bloom to ripening berries. Use can cause a mite flare-up.

Pyrethroid (Cannot use if bees are present.)
- **Bifenthrin** (Brigade or Capture) at 0.05 to 0.1 lb ai/A, PHI 3. Use can cause a mite flare-up. Major use product for these pests. Potential resistance because of heavy use.
- **Esfenvalerate** (Asana XL) at 0.025 to 0.05 lb ai/A, PHI 7**.** Specific application window of 12-7 days prior to harvest is limiting. Can cause a mite flare-up.

Other

- **Tebufenozide** (Confirm 2 F) at 0.25 lb ai/A, PHI 14. Use limited because of PHI. Limited grower experience.
- **Spinosad** (Success) at 4 to 6 fl oz product/A, PHI 1. Bee toxicity until spray dries.
- **Pyrethrin** (Pyganic, Py-Rin 60-6 EC) PHI 0. Rates vary. Organically acceptable.

Biological control:

- ***Bacillus thuringiensis*** (Bt) various labels have various rates, PHI 0. Safe with bees. Second to bifenthrin in use.
- **Parasitoid wasps –** not commercially available. Encourage natural populations.

Cultural control:

- Enhance habitat for beneficials.
- Pheromone traps to monitor flight to evaluate populations and plan spray schedules.

Mites

Twospotted spider mite *(Tetranychus urticae)* and others

Mite feeding reduces plant vigor and may cause leaves to be mottled, turn brown and drop prematurely. Use of pyrethroids as a cleanup spray for insect contaminants can cause mite problems. Usually, by mid-August, female mites begin to enter their "overwintering" stage, with additional feeding damage to foliage minimized. Red raspberries are fairly tolerant to relatively high pre-harvest mite populations. It is often best to wait out infestations, allowing mid-late summer predators to provide adequate population suppression.

Chemical control:

- **Potassium salts of fatty acids** (M-Pede) at 1-2% v/v solution, PHI 0. Organically acceptable.
- **Hexythiozox** (Savey 50 WP) at 0.25 to 0.375 lb ai/A, PHI 3. Does not control adults; just young motile forms and eggs. Safe to beneficials.
- **Hexakis** (Vendex) at 1 lb ai/A, PHI 3. Works better in warmer temperatures. Safe to beneficials.
- **Bifenthrin** (Brigade or Capture) at 0.1 lb ai/A, PHI 3. Potential resistance because of heavy use. Cannot use if bees present.
- **Elemental sulfur** (several types and brands). Rates vary. Not used at this stage of crop development because of poor performance. Not effective against twospotted spider mites at this time. Organically acceptable.
- **Summer oils –** Excessive temperatures may cause phytotoxicity. Organically approved.

Biological Control:

- **Predatory mites** (naturally occurring and can be purchased for release). Very little inundative releases of predatory mites. Naturally occurring predatory mite

populations generally control mites at this stage. Inoculative releases work best. Takes a long time for predatory mites to build up populations for good control.
- ***Stethorus*** beetles (abundant in nature, expensive to buy), **Anthocoris** (naturally occurring, can purchase) releases. Good at low population densities of mites.

Cultural control:
- Dust suppression.
- Avoid moisture stress.

Raspberry fruitworm
Byturus bakeri
Larvae feed within the blossom and in developing fruit. They are 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.

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 (*Otiorhynchus 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 Washington. Directed basal sprays, rather than the entire canopy, give good results prior to harvest and preserve beneficial insects.

Chemical control (adults):

OP (Cannot use if bees are present)
- **Azinphos-methyl** (Guthion) at 0.5 lb ai/A, PHI 14. EPA is proposing to eliminate foliar application in caneberries.
- **Malathion** at 1.75 lb ai/A. Poor efficacy. Not a restricted use material.

Pyrethroid (Cannot use if bees are present)
- **Bifenthrin** (Brigade or Capture) at 0.05 to 0.1 lb ai/A, PHI 3. Use can cause a mite flare-up. Potential resistance because of heavy use. Most commonly used chemical for weevil control.
- **Esfenvalerate** (Asana XL) at 0.05 lb ai/A, PHI 7. Not efficacious. PHI too long.

Other
- **Azadirachtin** (Neem). Several brands. Rates vary. PHI 0. Poor efficacy. Organically approved.

Cryolite Bait at 4 to 8 lb ai/A, PHI 3, 24c registration. Expensive, may not be available (mfg. may not continue making due to lack of demand).**Biological control (larvae):**

- ***Beauveria bassiana*** (Mycotrol ES) at 1 to 3 quarts of product/A. New product, not much grower experience. Organically approved.

Cultural control:
- None.

Sawfly.
Monophadnoides geniculatus
A minor pest that is often 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.

Chemical control:

OP (Cannot use if bees are present)
- **Diazinon** at 1 lb ai/A, PHI 7. Not effective
- **Malathion** at 1.75 lb ai/A. Poor efficacy. Not a restricted use material.

Other
- **Spinosad** (Success) at 4 to 6 fl oz product/A, PHI 1. Unknown efficacy. Toxic to bees until spray has dried.

Biological control:
- None.

Cultural control:
- None.

Slugs
Limax spp*., Arion* spp*., Deroceras* spp.
Slugs may climb canes and move onto berries, on which they become contaminants. They are most likely to be a problem in cool, wet summers.

Chemical control:
- **Metaldehyde** baits (various brands) at 0.5 to 2.4 lb ai/A. Application technique important to keep off basal foliage and fruit.
- **Iron phosphate** bait (Sluggo) at 2.4 to 4.4 lb ai/A. Organically approved. Questionable efficacy.

Biological control:
- Geese

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

Snowy tree cricket
Oecanthus fultoni
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. Infestation by this species is very rare. 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.

Chemical control:

Pyrethroid
- **Esfenvalerate** (Asana XL) at 0.05 lb ai/A, PHI 7. When applied for leafroller control before harvest may provide some control of stinkbugs. Poor efficacy.
- **Bifenthrin** (Brigade or Capture) at 0.05 to 0.1 lb ai/A, PHI 3. Best chemical for stinkbugs.
- **Malathion** at 1.75 lb ai/A, PHI 1. Not efficacious.

Other
- **Pyrethrin** (Pyganic, Py-Rin 60-6 EC). Rates vary. PHI 0. Organically approved.

Biological control:
- None.

Cultural control:
- None.

Thrips
Frankliniella spp.

Common flower feeders and, when abundant, have been reported to cause blossom blasting. They can also feed on fruit and be a contaminant on harvested fruit. Usually not a major problem; control measures seldom used. Can be a problem in specialty packs (e.g., kosher).

Chemical control:

OP (cannot use when bees are present)

- **Diazinon** at 1 lb ai/A, PHI 7. PHI is too long to be useful.
- **Malathion** at 1 to 2 lb ai/A. PHI 1. Acceptable control.

Pyrethroid (cannot use when bees are present)

- **Bifenthrin** (Brigade or Capture) 0.05 to 0.1 lb ai/A, PHI 3.

Other

- **Spinosad** (Success) at 4 to 6 fl oz of product/A, PHI 1. Limited experience, but should be efficacious. Toxic to bees until spray has dried.

Biological control:

- None.

Cultural control:

- None.

<u>List for insect/mite management needs in bloom to preharvest season:</u>

Research:

- Generate data to shorten PHIs.
- Chemical and non-chemical alternatives to current controls.
- Less toxic materials to bees.
- Continue research on control of insect contaminants
- Generate efficacy data on newer materials.
- Habitat management to conserve beneficials.
- Continuing to develop IPM techniques.
- Resistance management.

Regulatory:

- Shorter PHIs for several insecticides and miticides.
- Resolve different REIs for bifenthrin (Brigade or Capture) for hand vs. mechanical harvesting.

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 (Brigade or Capture).
- 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.

DISEASE PESTS

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.

Fruit Rot (includes Cane Botrytis)

Botrytis cinerea

This fungal disease can cause major economic 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 in the surface (Fruit rot). The fungus may also infect leaves and, moving through the petiole, cause cane infections with lesions (Cane botrytis). Small, black, overwintering structures (sclerotia) may develop on any infected plant part.

Chemical control:

- **Captan** 50 WP at 4 lb/A, PHI 3. 24c registration.
- **Fenhexamid** (Elevate) at 1.5 lb/A, PHI 0.
- **Cyprodinil + Fludioxonil** (Switch 62.5 WG) at 14oz/A, PHI 0.
- **Harpin Protein** (Messenger) at 2.3 to 13.4 oz/A, PHI 0. Not known to be effective.
- **Iprodione** (Rovral 50WP) at 1 to 2 lb/A, PHI 0. Known resistance.
- **Ziram** (Ziram Granuflo) at 3 lb/100 gal water or (OR-Cal Ziram 400) at 4.5 pints/A. For late-ripening blackberries only; use only between mid-June and early July.

Biological control:

- None.

Cultural control:

- Minimize or adjust irrigation so plants are not wet for long periods. Use drip/trickle irrigation.

- Cane vigor control and primocane suppression.
- North-South row orientation promotes even sun exposure and good air drainage.
- Planting resistant cultivars may be an option in some situations.

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) at 1.25-2.5 oz/A, 0 PHI.

Biological control

- None

Cultural control:

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

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 'Marion' blackberries. 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 bees. 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

Chemical control:

- None

Biological control:

- None

Cultural control:

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

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:

- **Captan** 50 WP at 4 lb/A. 3 day PHI. 24c registration.
- **Cyprodinil + Fludioxonil** (Switch 62.5 WG) at 14oz/A, PHI 0.
- **Fenhexamid** (Elevate) at 1.5 lb/A, PHI 0.
- **Ferbam Granuflo** at 1.5 to 3.0 lb/A, PHI 40, 24c registration.
- **Iprodione** (Rovral 50WP) at 1 to 2 lb/A, PHI 0.
- **Pyraclostrobin** (Cabrio EG) at 14 oz/A. PHI 0. New registration. Looks promising but no field experience at to date.

Biological control:

- None

Cultural control:

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

Stamen Blight

Hapalosphaeria deformans

This fungal disease is severe in some plantings and affects blackberries and hybrid berries, particularly Boysenberry. Severity varies markedly from year to year. Rain splashes spores from infected flowers to axillary 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** 50 WP at 4 lb/A, PHI 3, 24c registration.

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
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. Infected canes often are brittle and may break off when old fruiting canes are pruned out. Especially problematic in raspberries throughout Oregon and Washington.

Chemical control:
- **Myclobutanil** (Rally 40 W) at 5 oz/A, PHI 0. Applications may be made up to the day of harvest. Do not apply more than 40 oz/A/season.
- **Pyraclostrobin** (Cabrio EG) at 14 oz/A. PHI 0. New registration. Looks promising but no field experience to date.
- **Ferbam Granuflo** at 1.5 to 3 lb/A. 24c registration. 40 day PHI limits usefulness. Effectiveness is doubtful; has limited activity against this disease.

Biological control:
- None.

Cultural control:
- None

List for disease management needs in bloom to preharvest season:

Research:
- Identify other molds that are affecting yield and quality.
- Effective screening of new cultivars for resistance to RBDV.
- Genetically engineered and/or conventional bred resistance for RBDV and tomato ringspot virus.
- Identification and management of black raspberry decline virus.
- Modeling and disease forecasting for *Botrytis*.
- Continue to evaluate new management strategies for Botrytis fruit rot control.

Regulatory:
- Allow multiple active ingredient Section 18s for resistance management for pests that have a documented history of resistance.
- Expedite registration of boscalid (Pristine/BAS 516) for caneberries.

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.

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

Chemical control:
- **Sethoxydim** (Poast) at 0.28 to 0.47 lb ai/A (1.5 to 2.5 pints/A), PHI 45. The 45 PHI limits usefulness. Postemergence herbicide. Controls grasses only. Resistant grasses include annual bluegrass and all fine fescues, but quackgrass can be suppressed.
- **Diuron** (Karmex, Diuron 80 or Diuron 4L) at 1.6 to 2.4 lb ai/A. Use in row middles only.
- **Carfentrazone-ethyl** (Aim 40W) at 0.05 to 0.1 lb ai/A broadcast, for primocane control.
- **Oxyfluorfen** (Goal 2XL or Galigan 2XL) at 0.4 to 0.8 lb ai/A broadcast, for blackberries, PHI 15; cannot use in raspberries at this time because PHI for raspberries is 50 days. 24c registration.
- **Oxyfluorfen** (Goal 2XL) at 0.5 to 1.0 lb ai/A broadcast, for non-bearing AY blackberries, 24c registration.

Biological control:
- None.

Cultural control:
- Mowing
- Cultivating
- Hand hoeing
- Flaming
- Irrigation technique

<u>List for weed management needs in bloom to preharvest season:</u>

Research:
- Additional primocane suppression materials.
- Products with a shorter PHI.
- Selective post-emergent products.

Regulatory:
- Expedite registration of shorter PHI materials.
- Shorten PHI for Sethoxydim (Poast).

Education:
- Identification and biology of weeds.
- 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.
- Weed shifts and resistance (need for rotation of herbicides).
- Cover crop management.

NEMATODE PESTS
Root-lesion nematode *(Pratylenchus spp*)
Dagger nematode (*Xiphinema americanum)*

Chemical control:
- None

Biological control:
- None

Cultural control:
- None

<u>List for nematode management needs in bloom to preharvest season:</u>

Research:
- None

Regulatory:
- None

Education:
- 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.

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

INSECT AND MITE PESTS

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, boxelder 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

Chemical control:

OP

- **Malathion** at 1.75 to 2 lb ai/A, PHI 1. Thorough coverage is important. Not as efficacious as others, but short PHI makes very useful.

Pyrethroid

- **Bifenthrin** (Brigade or Capture) 0.05 to 0.1 lb ai/A, PHI 3. The 3-day PHI is too long. REI discrepancy between hand and mechanical harvesting.

Other

- **Pyrethrin** (Pyganic, Py-Rin 60-6 EC) Rates vary. PHI 0. Organically approved.
- **Spinosad** (Success) at 4 to 6 fl oz product/A, PHI 1. New product, not much grower experience.

Biological control:

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

Cultural control:

- Correct adjustment of air-blast or vacuum-suction cleaner systems can lessen insect contamination of machine-harvested berries.
- Add additional human sorters to harvesting machine.

List for insect/mite management needs in the harvest season:

Research:

- Insect collection systems on harvesting machines.
- Alternate methods of removing insect contaminants from fruit.
- Develop less toxic materials or methods to workers.

Regulatory:

- Expedite registration of the organically approved formulation of spinosad (Entrust) for organic growers.
- Shorter PHIs/REIs.

Education:

- Identify insect contaminants so grower can better control.
- 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.

DISEASE PESTS

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.

Fruit Rot (includes Cane Botrytis)

Botrytis cinerea

Under conditions favorable for disease development, fruit rot is rampant and must be controlled prior to and in between harvests. 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:

- **Captan** 50 WP at 4 lb/A, PHI 3, 24c registration. Not a viable option during harvest in raspberries because of 3 day PHI and 4 day REI.
- **Fenhexamid** (Elevate) at 1.5 lb/A, PHI 0.
- **Cyprodinil + Fludioxonil** (Switch 62.5 WG) at 14oz/A, PHI 0
- **Iprodione** (Rovral) at 1 to 2 lb/A, PHI 0. Known resistance.

Biological control:

- None

Cultural controls:

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

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) at 1.25 to 2.5 oz/A, PHI 0.

Biological control

- None

Cultural control:

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

List for disease management needs in the harvest season:

Research:

- Develop spray timing based on models.
- Identify other molds that are affecting yield and quality.
- Continue to evaluate new management strategies for Botrytis fruit rot.

Regulatory:

- Change PHI and REI on Captan to 0 days
- Allow multiple active ingredient Section 18s for resistance management for pests that have a documented history of resistance.
- Expedite registration of boscalid (Pristine/BAS 516) for caneberries.

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.

WEED PESTS
Weeds control is generally not practiced or needed during harvest.

Chemical control:
- None.

Biological control:
- None.

Cultural control:
- Some hand hoeing.

List for weed management needs in the harvest season:

Research:
- None

Regulatory:
- None

Education:
- 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.

NEMATODE PESTS
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

List for nematode management needs in the harvest season:

Research:

- None

Regulatory:
- None

Education:
- 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.

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 preemergence and post-emergent herbicides.
- Establish cover crops.
- Rodent control.

INSECT AND MITE PESTS
Aphids, mites and root weevils can be present on foliage after harvest.

<u>Aphids</u>
Larger Raspberry Aphid *(Amphorophora agathonica)* and other species
Aphid feeding can cause the leaves to curl downward and become deformed.

Chemical control:

OP

- **Azinphos-methyl** (Guthion) at 0.5 lb ai/A. EPA proposes to eliminate foliar applications of azinphos-methyl in caneberries.
- **Malathion** at1.5 to 2 lb ai/A.
- **Diazinon** at1 lb ai/A. EPA proposes to allow only one application of diazinon per season.

Other

- **Potassium** salts of fatty acids (M-Pede) at 1-2% v/v solution. Efficacy is very poor. Organically approved.
- **Spinosad** (Success) at 4 to 6 fl oz product/A. New product, not much grower experience.

Biological control:

- ***Beauveria bassiana*** (Mycotrol ES) 1-3 qt of product/A. New product, not much grower experience. Organically approved
- Release of ladybird beetles.

Cultural control:

- Cover crops to encourage beneficials.

Mites

Twospotted spider mite *(Tetranychus urticae)* and others

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. There is no clear correlation between mite population density and economic injury to raspberry fields. They are a pest in raspberries and an occasional pest in blackberries. 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:

- **Potassium salts** of fatty acids (M-Pede) at 1-2% v/v solution. Organically acceptable.
- **Hexythiozox** (Savey 50 WP) at 0.25 to 0.375 lb ai/A. Controls eggs and young motile stages. Does not control adult mites. Cannot make more than one application per crop season. Safe to beneficials.
- **Hexakis** (Vendex) at 1 lb ai/A. Registered for use in raspberries, only. Safe to beneficials. Works better in warmer temperatures.

Biological Control:

- **Predatory mites** (naturally occurring and can be purchased for release). Very little inundative releases of predatory mites. Naturally occurring predatory mite populations generally control mites at this stage. Inoculative releases work best. Takes a long time for predatory mites to build up populations for good control.

- **Stethorus** (abundant in nature, expensive to buy), **Anthocoris** (naturally occurring, can purchase) releases. Good at low population densities of mites.

Cultural control:
- Dust control
- Avoid plant stress.

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 (*Otiorhynchus sinularis)*

Adult root weevils can still be present after harvest; control measures of these adults should be taken prior to egg-laying. Eggs that were laid in the soil prior to or during harvest will hatch into young larvae that begin feeding on roots.

Chemical control (adults):

OP
- **Azinphos-methyl** (Guthion) at 0.5 lb ai/A, EPA is proposing to eliminate foliar application in caneberries.
- **Malathion** at 1.75 lb ai/A. Thorough coverage is important. Not as efficacious as others. Rarely used.

Other
- **Azadirachtin** (Neem). Several brands. Rates vary. Poor efficacy. Organically approved
- **Cryolite Bait** at 4 to 8 lb ai/A. 24c registration. Expensive, may not be available (mfg. may not continue making due to lack of demand).

Biological control (larvae):
- **Parasitic nematodes**. Expensive. Dependent on soil temperature and moisture. Difficult to obtain consistent results.
- ***Beauveria bassiana*** (Mycotrol ES) at 1 to 3 quarts of product/A. New product, not much grower experience. Organically approved

Cultural control:
- None

Rodents
Rodents, especially field mice and voles, can cause damage when they chew on the roots of the caneberry plant, sometimes causing cane death. Trapping is method of control that can be implemented any time of the year. Baiting with Zinc Phosphide Pellets can be implemented after last harvest and prior to bud break in the spring.

Chemical control:

- **Zinc Phosphide Pellets** (bait) at 6 to 10 lb product/A. Broadcast to soil surface after last harvest and before leaf emergence in the spring.

Biological control:

- None.

Cultural control:

- Traps. Time consuming and not highly efficient.

List for insect/mite management needs in the postharvest season:

Research:

- Weed management for weevil control.
- Tools for control of root weevil larvae; identify best time for control.
- Predatory nematodes control of root weevil larvae.
- Life cycles of various weevil species.

Regulatory:

- Expedite registration of larvicides (e.g. thiamethoxam) for root weevil larvae

Education:

- 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.

DISEASE PESTS

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

Bacterial blight

Pseudomonas syringae

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.

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

Biological control:
- None

Cultural control:
- None.

Cane blight
Leptosphaeria coniothyrun

Chemical control:
With the loss of Benlate, there are no effective chemical controls.
- **Captan** 50WP at 4 lb/A, 24c registration. Not effective

Biological control:
- None.

Cultural control:
- Remove infected canes.
- 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.
- Irrigate in the early morning to minimize the period that plants remain wet.
- Use the alternative-year fruiting system for blackberries.

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:
Rotate applications between these materials to help prevent building up resistant populations.
- **Mefenoxam** (Ridomil Gold) at 0.25 pint/1,000 feet. Some reduced efficacy has been observed in western Washington. Registered for use in raspberries only.
- **Fosetyl-Al** (Aliette WDG) at 5 lb/A. Apply to foliage twice in fall.
- **Phosphorous acid** (Fosphite) at 1 to 2 quarts/A.

Biological control:
- None.

Cultural control:
Best results occur when several cultural and chemical practices are integrated together.
- Maintain raised beds.
- Subsoil in alleyways to promote drainage.

Leaf and Cane Spot (aka *Septoria* leaf spot)
Septoria rubi
Not found in raspberries but is common in blackberries and hybrid berries.

Chemical control:
1. Spray after harvest.
    - **Fixed copper** (several brands). Rates vary. Many formulations are organically acceptable.
2. Spray again in early October before heavy rains begin.
    - **Bordeaux** 8-8-100.
    - **Fixed copper** (several brands). Rates vary. Many formulations are organically acceptable.

Biological control:
- None.

Cultural control:
- Alternate-year (AY) fruiting program. Cane and lead 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.
- 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.
- Control weeds because they can provide a natural "moist chamber" for infection and prevent effective spray coverage.

Purple Blotch
Septocyta ruborum
A disease similar to cane and leaf spot, occurring in blackberries and hybrid berries.

Chemical control:
1. Spray after harvest.
    - **Fixed copper** (several brands). Rates vary. Many formulations are organically acceptable.
2. Spray again in early October before heavy rains begin.
    - **Bordeaux** 8-8-100.
    - **Fixed copper** (several brands). Rates vary. Many formulations are organically acceptable.

Biological control:

- None.

Cultural control:

- Alternate-year (AY) fruiting program. Cane and lead 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.
- 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.
- Control weeds because they can provide a natural "moist chamber" for infection and prevent effective spray coverage.

Spur Blight

Didymella applanata

Chemical control:

- **Captan** 50 WP at 4 lb/A. 24c registration.
- **Iprodione** (Rovral 50 WP) at 1 to 2 lb/A. Expensive.
- **Cyprodinil + Fludioxonil** (Switch 62.5 WG) at 14oz/A
- **Fenhexamid** (Elevate) at 1.5 lb/A
- **Ferbam Granuflo** at 1.5 to 3.0 lb/A, 24c registration.
- **Pyraclostrobin** (Cabrio EG) at 14 oz/A. New registration. Looks promising but no field experience at to date.

Biological control:

- None.

Cultural control:

- Keep plant rows narrow
- Practice good weed control

Stamen Blight

Hapalosphaeria deformans

Primarily affects blackberries and the hydrid berries. Post harvest chemical applications help reduce inoculum.

Chemical control:

- **Calcium polysulfide** (Lime sulfur, Sulforix, and other brands). Rates vary. Late summer application on Boysenberries can provide adequate suppression.

Biological control:

- None

Cultural control:

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

Tomato ringspot virus (TRsV)

The 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:

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 survive at a low level.

- **Fenamiphos** liquid (Nemacur 3) at 1 to 2 gal in 10 to 20 gal/A water, Six-month PHI. Registered for use in raspberries only. Apply between October 1 and December 31. Nemacur has very limited efficacy against this vector.

Biological control:

- None

Cultural control:

- Fallow period of over one year.
- Keep field weed free since the virus and nematodes have a broad host range.
- Use cover crops to reduce soil movement on wheels of equipment.
- Work on the healthiest fields first, finishing up in any fields with tomato ringspot.
- Wash equipment between fields to minimize soil movement.

Yellow Rust

Phragmidium rubi-idaei

Disease symptoms appear in spring but may also be evident on leaves after harvest (black teliospores appear in the yellow uredinia on lower leaf surfaces). Infected canes often are brittle and may break off when old fruiting canes are pruned out.

Chemical control:

- **Ferbam Granuflo** at 1.5 to 3 lb/A. 24c registration. Do not use more than 15 lb/A per season. Effectiveness is doubtful. Has limited activity against this disease.
- **Myclobutanil** (Rally 40 W) at 5 oz/A. Limit use to avoid resistance.
- **Pyraclostrobin** (Cabrio EG) at 14 oz/A. New registration. Looks promising but no field experience to date.

Biological control:

- None.

Cultural control:

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

List for disease management needs in the postharvest season:

Research:

- Cover crops to suppress virus vectors.
- Fungicide timing for spur blight control.
- Alternative to benomyl (benlate) for cane blight control.
- Research post harvest fruit handling.

Regulatory:

- Register thiophanate (Topsin –M) for cane blight control.

Education:

- 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.

WEED PESTS

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, a postemergence grass herbicide, like sethoxydim (Poast) can be applied. Glyphosate (RoundUp and other brands), 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.

- **Diuron** (Karmex, Diuron 80 or Diuron 4L) at 1.6 to 2.4 lb ai/A. Preemergence herbicide. Cannot use on newly established plantings.
- **Norflurazon** (Solicam) at 2.5 to 5 lb ai/A. It is primarily used where annual grass control is a problem but also has activity against several common broadleaved weeds. Preemergence herbicide. 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.
- **Dichlobenil** (Casoron) at 2-4 lb ai/A (50-100 lb product/A). 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.
- **Terbacil** (Sinbar) at 0.8 to 1.6 lb ai/A,. Preemergence herbicide. Solubility relatively high; use with caution on tender/weakened plantings.
- **Oryzalin** (Surflan) at 2 to 6 lb ai/A. Preemergence herbicide.
- **Paraquat** (Gramoxone Extra or Gramoxone Max). Non-selective, postemergence, contact herbicide.
- **Napropamide** (Devrinol) at 4 lb ai/A. Preemergence herbicide.
- **Simazine** (Simazine 90 WDG or 90DF, Princep Caliber90, Simazine 4L) at 2.2 to 4.0 lb ai/A. Preemergence herbicide.
- **Glyphosate** (numerous brands) Non-selective, postemergence herbicide. Some species show poor response.
- **Sethoxydim** (Poast) at 0.28 to 0.47 lb ai/A – 1.5 to 2.5 pints Poast/A,. Postemergence herbicide. Controls grasses only.
- **Pronamide: (Kerb)** at 1-2 lb ai/A for annual grass; 2-4 lb ai/A for perennial grass. Not on frozen soil. Provides decent control of quackgrass, if applied when grass is truly dormant. Expensive.

Biological control:
- None

Cultural control:
- None

<u>List for weed management needs in the postharvest season:</u>

Research:
- None

Regulatory:
- None

Education:
- 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.

NEMATODE PESTS
Root-lesion nematode (*Pratylenchus spp)*
Dagger nematode (*Xiphinema americanum*)

Chemical control
- **Fenamiphos** liquid (Nemacur 3) at 1 to 2 gal in 10 to 20 gal/A water, Six-month PHI. Registered for use in raspberries only. Controls only the root-lesion nematode *(Pratylenchus penetrans)*. Apply between October 1 and December 31. This control will only be available until 2007. A replacement is needed.

Biological control:

- None

Cultural control:

- None

List for nematode management needs in the postharvest season:

Research:

- Research on low rates of drip applied fumigants.
- Research on low rates of banded applied fumigants.
- Replacement for fenamiphos (Nemacur).

Regulatory:

- None

Education:

- 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.

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	Leafrollers	Misc. caterpillars	Mites	Raspberry crown borer	Raspberry fruitworm	Redberry mite	Root weevils	Slugs	Stinkbugs	Strawberry crown moth	Sawfly	Snowy tree cricket	Thrips	Winter moth	COMMENTS
Registered chemistries																			
1,3-Dichloropropene (Telone II)			P								P	G							
Azadirachtin (Neemix, Azatin, Azatrol)	?	P	P		P						P							P	
Azinphos-methyl (Guthion)	E	E	F-G		E	E		E			F-E		F	E	E	?	E	E	
Bifenazate (Acramite)				?			E			?									Non-bearing only
Bifenthrin (Brigade, Capture)	E		E		G-E		G-E				G-E		E		E		E		
Carbaryl (Sevin, others)	P	F-G			F-G	F-G							P		G		P	G	
Cryolite Bait			F-P								F-P								
Diazinon	G-E	F-G			F-E	F-E		E	E		P		P	E	F-G			G	
Esfenvalerate (Asana)	F-P	F-G	F		F-G	G					P		F		?		G		
Hexakis (Vendex)							E-G												
Hexythiozox (Savey)							*												
Horticultural oils (e.g. stylet oil)	G						G												
Iron phosphate												F-P							
Kaolin (Surround)	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
Lime sulfur (Sulforix , others)				G-E			F-G			G-E									Timing important
Malathion	E	F	P		F-G	F-G		?			P		P	?	F		F	P	
Metaldehyde												E							
Pyrethrin (pyganic,others)	F	P-F	F		P-F	P-F					P		P		?		?	?	
Potassium salts of fatty acides (M-Pede)	F						P-F												
Propargite (Omite)							F-G												Non-bearing only
Spinosad (Success)		G-E			G-E	G-E											?	G-E	
Sulphur (Thiolux, Wettable sulphur)				G			P			G									
Sulphur dust				G			P			G									
Tebufenozide (Confirm)		G			G				?									G-F	
Unregistered/potential chemistries																			
Abamectin (Agrimek, Avid, Zephyr, Clinch)							G												
Flonicamid	?																		
Imidacloprid (Provado, Admire, Gaucho)	E		?								?								
Indoxacarb (Avaunt)		E			E				E									G	
Thiamethoxam (Actara, Platinum)	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	Leafrollers	Misc. caterpillars	Mites	Raspberry crown borer	Raspberry fruitworm	Redberry mite	Root weevils	Slugs	Stinkbugs	Strawberry crown moth	Sawfly	Snowy tree cricket	Thrips	Winter moth	COMMENTS
Biological																			
Bacillus thuringiensis (Bt)		G			G	G													Timing critical
Beauveria bassiana (Mycotrol)	?	?	?		?						?								More research needed
Mating disruption					F														Not commercially available.
Parasitic nematodes			?								?								
Parasitoid wasps *					?	?													* Conservation of naturally occurring populations very important.
Predatory mites *							*												
Stethorus beetles *							?												
Cultural non-chemical																			
Adjacent area management		*	*							*	*								
Cover crops												P							
Enhancing habitat for beneficials	*				*	*		*	*					*				*	
Keep crates from damp soil/grass		*			*							G							
Pruning techniques (e.g. new over old)					*														
Resistant cultivars																			
Sanitation					*							G							
Weed control					*							G							
Dust Management							*												

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.

MANAGEMENT TOOLS DISEASES	Anthracnose	Armillaria root rot	Cane blight	Crown & cane gall	Downy mildew	Fruit rot	Purple blotch	Powdery mildew	Rasp. Bushy dwarf virus	Root rot	Septoria cane & leaf spot	Spur blight	Stamen blight	Verticillium Wilt	Yellow rust	COMMENTS
Registered Chemistries																
1,3-Dichloropropene (Telone II)		P		P						P				P		
1,3-Dichloropropene+chloropicrin (Telone C-17, C35)		F-G		F-G						F-G				F-G		
Captan	F-G				?	F=G	F-G	P			F	G	F			
Copper (Bordeaux)	F						P	P			F-G		?			
Cyprodinil + Fludioxonil (Switch)	?		?		?	E	?	?			?	G-E	?			
Fenhexamid (Elevate)	?		?		?	E	?	?			?	G-E	?			
Ferbam Granuflo	?				?	P	?	?			?	P	?		F	
Fixed Copper (Nordox, Copper-Count, others)	F						P	P			F-G		?			
Fosetyl-al (Aliette)					F-G					F-G						
Gallex				G												
Harpin Protein (Messenger)	?		?		?	P	?	?	?		?	?	?	?	?	
Iprodione (Rovral)	?					G	?	?			?	G	?			Resistance
Lime sulfur (Sulforix, others)	G						F				F	P-F	?		F	
Sodium methyldithiocarbamate (Vapam)										P-F				F		
Mefenoxam (Ridomil)										F-G						
Methyl bromide		?								?				?		Resistance?
Methyl bromide/Chloropicrin		G-E								G-E				G-E		Delays disease 3-4 years
Myclobutanil (Rally)	?				?		?	G-E			?	?	?		G-E	
Oils (JMS, Supreme, others)					?			FG							?	
Phosphorous acid (Fosphite)					F-G					F-G						
Potassiuk salts of fatty acids (M-Pede)								F								
Potassium bicarbonate (Kaligreen,Milstop)								G								
Pyraclostrobin (Cabrio)	?		?		?	G-E	?	?			?	?	?		?	
Sulfur (Thiolux, Wettable Sulfur)	P							F			?	?	?			
Ziram	?					F-	?				?	?	?			
Unregistered/potential chemistries																
Azoxystrobin (Heritage, Quadris, Abound)	?	?	?		?	F-G	?	?			?	?	?		?	
Boscalid + Pyraclostrobin (Pristine)	?	?	?		?	G-E	?	?			?	?	?		?	
Famoxadone+cymoxanil (Tanos)	?	?	?		?	?	?	?		?	?	?	?		?	

Table 2: Efficacy ratings for various disease 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; blank space = not used for this pest; * = used but not a stand-alone management tool.

MANAGEMENT TOOLS DISEASES	Anthracnose	Armillaria root rot	Cane blight	Crown & cane gall	Downy mildew	Fruit rot	Purple blotch	Powdery mildew	Rasp. Bushy dwarf	Root rot	Septoria cane & leaf	Spur blight	Stamen blight	Verticillium Wilt	Yellow rust	COMMENTS
Unregistered/potential chemistries																
Iodomethane (Midas)		?		?						?						Soil fumigant/pre-plant
Propiconazole (Orbit, Bumper)	?		?		?	?	?	?			?	?	?		G-E	Phyto-leaf cupping
Pyrimethanil (Scala)	?				?	?	?	?			?	?	?		?	
Thiophanate-methyl (Topsin-M)	?		F-G			?(1)	?	?			?	?	?			[1]Resistance
Biological																
Ampelomyces quisqualis								G								
Beauveria bassiana (Mycotrol)							?									
Gliocladium						?				P						
Trichoderma						?				P						
Cultural non-chemical																
Adjacent area management						F			F							
Alternate-year fruiting system	F		G-E(1)				F-G				F-G	?	F			(1) Effective, but not economically practical in red raspberries.
Certified nursery stock/tissue culture plants				F-E	G-E				G-E	G-E						
Cultivate an open canopy	F					P-F	F	P-F			F	F				
Maintain/enhance drainage										F-G						
Manage overhead irrigation	F					P-F	F	P-F			F	F				
New over old training technique	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
Primocane suppression	F		F		?	F	?	?			?	?	?		?	
Raised beds										F-G						
Resistant/tolerant cultivars	F	?	?	F	?	P		?	G-E	F-G	?	F-G	?	?	F	
Sanitation	P		P			P									F	
Solarize				P						F-G(1)				P		(1) 2+ year delay of disease
Tie up after leaf fall															G	
Weed control	F		?			P	P	?			P	P	?			
Proper amounts of nitrogen (not over fertilization)	?		?		?	P-?	?	?			?	?	?			

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.

Annual Broadleaves

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	Pursiane	Shepard's purse	Smartweed, Ladysthumb	Sowthistle	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				Post-emergent
Dichlobenil (Casoron)		F	G		G	G	G		G	G	G	G	G	G			G	G	G		G	G	Pre-emergent
Diuron (Karmex, Diuron 80 or 40)		P	G	G	F	F	G	F	F	G	G	G	G	G	G	G	G	G	F	F	P	G	Pre-emergent
Gyphosate (Roundup, others)		F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	Post-emergent
Isoxaben (Gallery)		G	G	F		G	G	G	G	G		G	G	G	G	G	G	G	G	G	G	G	Non-bearing
Napropamide (Devrinol)		G	G		P	G	P	F	F	G	G	G	P	G	G	G	P	P	P	G		G	Pre-emergent
Norflurazon (Solicam)		F					G		G	G	F	G	G				G	G	F			G	Pre-emergent
Oryzalin (Surflan)		P	G	P	P	P	F	P	G	G	G	G	P	G	P	P		P	F	P		G	Pre-emergent
Oxyfluorfen (Goal, Galigan)	■	P	P	F	G	G	G	P	F	F	G	F	G	G	F	G	G	P	F			F	Pre-emergent
Paraquat (Gramoxone)			G	S	F	G	G	A	A	F	G	G	G	G	S	G	G	G	G		G	G	Post-emergent
Pelargonic acid (Scythe)	■																						Post-emergent
Proparnide (Kerb)		P	G	P	F	P	F	P	F	F	F	F	F	P	P	P		F		P	P	F	Pre-emergent
Simazine (Simazine, Princep)		F	G			F	G		G	G	G	G	G	G			G	G	F			G	Pre-emergent
Terbacil (Sinbar)		G	G	G	G		F	P	G	G	G	G	G	F	G	G	G	G	G	G	F	G	Pre-emergent
Unregistered/potential chemisties																							
S-metolachlor (Dual Magnum)													F-G	G			F						Pre-emergent
Iodomethane (Midas)	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	Methyl bromide substitute – soil fumigant
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	

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.

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

	Annual Grasses						Perennial Grass	Perennial Broadleaves								Perennial Sedgers 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
Clethodim (Prism, Select)	G	G	G	G	F	G	F-G											Non-bearing
Dichlobenil (Casoron)	G	G	G	G		F	G		G	G			G	P-F	G		G	
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
Gyphosate (Roundup, others)	G	G	G	G	G	G	G	G	G	G			G	F-G	G		F	
Isoxaben (Gallery)									G		F-G	P-F	P-F	P-F				Non-bearing
Napropamide (Devrinol)	G	F-G		G		G	P	P		P			S	P			P	
Norflurazon (Solicam)	G	G	F			G	P										F	
Oryzalin (Surflan)	G	G	G	G		P	P	P		P			P	P			P	
Oxyfluorfen (Goal, Galigan)	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)																		
Proparnide (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	
Simazine (Simazine, Princep)	G	F	P-F	G		F	P	P	G				S	P			P	
Terbacil (Sinbar)	G	F	G	G		G	F	F	G	P			F	P	G		P	
Unregistered/potential chemisties																		
S-metolachlor (Dual Magnum)		G	G														G	
Iodomethane (Midas)	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	Methyl bromide substitute, soil fumigant.
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 chemisties					
1,3-Dichloropropene (Telone II)	E		E		
Sodium methyldithiocarbamate (Vapam)	F-G		F-G		
Methyl bromide/Chloropicrin	E		E		
Fenamiphos (Nemacur)	F-G	F-G	P	P	Raspberry only
Unregistered/potential chemisties					
Iodomethane (Midas)	E		E		
Biological					
Cultural non-chemical					
Solarization	P		P		
Cover crops	P		F		
Fallow 2 or more years	F		F		Weed free

Table 5: Toxicity Ratings for Beneficials in PNW Caneberries

Key to Beneficials: **BEB** = Bigeyed bug (*Geocoris pallens*); **DB** = Damsel bug (*Nabis alternatus*); **HB** = Honey Bee (*Apis mellifera*); **LW** = Lacewings (*Chrysopa* spp.); **LB** = Lady beetles (*Hippodamia convergens*); **MPB** = Minute pirate bugs (*Orius* spp.); **PM** = Predatory mites (*Acari: Phytoseiidae*); **PN** = Parasitic nematodes; **PW** = Parasitic wasps (*Ichneumonidae* and *Braconidae* families); **S** = Spiders (*Arachnida: Araneae*); **SF** = Syrphid flies; **TF** = Tachinid flies
Rating Scale: **O** = Non-toxic; **L** = Slightly toxic; **M** = Moderately toxic; **H** = Highly toxic; **ND** = No Data

	BEB	DB	HB	LW	LB	MPB	PM	PN	PW	S	SF	TF	Comments
Registered Material:													
Insecticides/Miticides:													
Azadirachtin (Neemix, Azatin, Azatrol)	L	L	L	L	L	L	L	ND	L	L	L	L	
Azinphos-methyl (Guthion)	H	L	H	H	H	H	M	ND	H	M	H		
Bifenazate (Acramite)	L	L		L	L	L	L	ND	L	L	L	L	
Bifenthrin (Brigade, Capture)	M	H	H	M	H	H	H	ND	H	H	H	H	
Carbaryl (Sevin, others)	M	M	H	M	H	M	H	ND	M	M	M	M	
Cryolite Bait	ND	ND	O	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Diazinon	M	M	H	M	M	M	H	ND	L	M	H		
Esfenvalerate (Asana)	M	H	O	M	H	H	H	ND	H	H	H	H	
Fenamiphos (Nemacur)													Bayer requests voluntary cancellation of all uses of fenamiphos effective May 31, 2007
Hexakis (Vendex)	L	L	L	L	L	L	L	ND	L	L	L	L	
Hexythiozox (Savey)	L	L	L	L	L	L	L	ND	L	L	L	L	
Horticultural oils (stylet oil, others)	M	M	ND	L	L	M	M	ND	L	L	ND	ND	
Iron phosphate	L	L	L	L	L	L	L	ND	L	L	L	L	
Kaolin (Surround)	ND	ND	O	ND	ND	ND	L	ND	L	ND	ND	ND	
Lime sulfur (Sulforix, others)	L	ND	O	M	M	H	L	ND	M	ND	M	M	
Malathion	M	M	H	M	H	M	H	ND	M	M	H	M	
Metaldehyde													Some toxicity to soil fauna reported.
Methyl bromide/Chloropicrin													Not toxic to foliage born beneficials
Pyrethrin	M	M	O	L	M	M	H	ND	M	H	M	M	
Potassium salts of fatty acides (M-Pede)													General mode of action may prove toxic to leaf-born beneficials
Propargite (Omite)	L	L	O	L	ND	M	M	ND	ND	ND	ND	ND	
Rotenone (Pyrellin)	ND	ND	O	M	M	ND	H	ND	M	ND	ND	ND	
Spinosad (Success)	M	M	M	M	M	M	M	ND	M	M	M	M	
Sulphur (Thiloux, Wettable sulphur)	L	ND	O	M	M	H	L	ND	M	ND	M	M	
Sulphur dust	L	ND	O	M	M	H	L	ND	M	ND	M	M	
Tebufenozide (Confirm)	O	O	O	O	O	O	O	ND	O	O	O	O	
Soil Fumigants:													
Dichloropropene (Telone II)													Not toxic to foliage-born beneficials
Dichloropropene+chloropicrin (Telone C17, C34)													Not toxic to foliage-born beneficials
Sodium methyldithiocarbamate (Vapam)													Not toxic to foliage-born beneficials
Methyl bromide													Not toxic to foliage-born beneficials
Methyl bromide/Chloropicrin													Not toxic to foliage-born beneficials
Fungicides:													
Bordeaux (copper sulfate + hydrated lime)													ND
Captan	ND	ND	ND	L	M	L	L	ND	L	ND	M	L	

Table 5: Toxicity Ratings for Beneficials in PNW Caneberries - Continued

Key to Beneficials: **BEB** = Bigeyed bug (*Geocoris pallens*); **DB** = Damsel bug (*Nabis alternatus*); **HB** = Honey Bee (*Apis mellifera*); **LW** = Lacewings (*Chrysopa* spp.); **LB** = Lady beetles (*Hippodamia convergens*); **MPB** = Minute pirate bugs (*Orius* spp.); **PM** = Predatory mites (*Acari: Phytoseiidae*); **PN** = Parasitic nematodes; **PW** = Parasitic wasps (*Ichneumonidae* and *Braconidae* families); **S** = Spiders (*Arachnida: Araneae*); **SF** = Syrphid flies; **TF** = Tachinid flies
Rating Scale: **O** = Non-toxic; **L** = Slightly toxic; **M** = Moderately toxic; **H** = Highly toxic; **ND** = No Data

	BEB	DB	HB	LW	LB	MPB	PM	PN	PW	S	SF	TF	Comments
Registered Material: Continued													
Cyprodinil + Fludioxonil (Switch)													ND
Fenhexamid (Elevate)													ND
Ferbam Granuflo	ND	ND	ND	O	L	L	M	ND	L	ND	ND	ND	
Fixed Copper (several brands)	ND	ND	ND	ND	ND	ND	L	ND	ND	ND	ND	ND	
Fosetyl-al (Aliette)													ND
Gallex													ND
Harpin Protein (Messenger)													ND
Iprodione (Rovral)	ND	ND	ND	ND	ND	ND	L	L	ND	ND	ND	ND	
Lime sulfur (Sulforix, others)													ND
Mefenoxam (Ridomil)	ND	ND	ND	ND	ND	ND	L	H	ND	ND	ND	ND	
Myclobutanil (Rally)													ND
Oils (JMS, Supreme, others)													ND
Phosphorous acid (Fosphite)													ND
Potassium salts of fatty acids (M-Pede)													ND
Potassium bicarbonate (Kaligreen, Milstop)													ND
Pyraclostrobin (Cabrio)													ND
Sulfur (Thiolux, Wettable Sulfur, others)	L	ND	ND	M	M	H	L	ND	M	ND	M	M	
Ziram	ND	ND	ND	ND	ND	L	ND	ND	ND	ND	ND	ND	
Herbicides:													
Bentazon (Basagran)													ND
Carfentrazone-ethyl (Aim)													ND
Clethodim (Prism, Select)													ND
Dichlobenil (Casoron)													ND
Diuron (Karmex, Diuron 80 or 40)	ND	O	ND	ND	M	O	M	L	ND	ND	ND	ND	
Fluazifop (Fusilade)													ND
Gyphosate (Roundup, Touchdown, others)	M	ND	ND	ND	ND	ND	H	ND	L	ND	ND	ND	ND
Isoxaben (Gallery)													ND
Napropamide (Devrinol)													ND
Norflurazon (Solicam)													ND
Oryzalin (Surflan)													ND
Oxyfluorfen (Goal, Galigan)													ND
Paraquat (Gramoxone)	ND	ND	ND	ND	ND	ND	H	ND	ND	ND	ND	ND	
Pelargonic acid (Scythe)													ND
Proparnide (Kerb)													ND
Sethoxydim (Poast)													ND
Simazine (Simazine, Princep)	ND	ND	ND	ND	M	ND	L	ND	M	ND	ND	ND	
Terbacil (Sinbar)	ND	ND	ND	ND	ND	ND	M	ND	ND	ND	ND	ND	

Table 5: Toxicity Ratings for Beneficials in PNW Caneberries - Continued

Key to Beneficials: **BEB** = Bigeyed bug (*Geocoris pallens*); **DB** = Damsel bug (*Nabis alternatus*); **HB** = Honey Bee (*Apis mellifera*); **LW** = Lacewings (*Chrysopa* spp.); **LB** = Lady beetles (*Hippodamia convergens*); **MPB** = Minute pirate bugs (*Orius* spp.); **PM** = Predatory mites (*Acari: Phytoseiidae*); **PN** = Parasitic nematodes; **PW** = Parasitic wasps (*Ichneumonidae* and *Braconidae* families); **S** = Spiders (*Arachnida: Araneae*); **SF** = Syrphid flies; **TF** = Tachinid flies
Rating Scale: **O** = Non-toxic; **L** = Slightly toxic; **M** = Moderately toxic; **H** = Highly toxic; **ND** = No Data

New Chemistries/IR-4:													
Insecticides/Miticides:													
Abamectin (Agrimek, Avid, Zephyr, Clinch)	ND	ND	ND	M	M	ND	M	ND	H	ND	L	ND	
Flonicamid	L	L	L	L	L	L	L	ND	L	L	L	L	
Imidacloprid (Provado, Admire, Gaucho)	M	M	M	M	M	M	M	ND	M	M	M	M	
Indoxacarb (Avaunt)	L	L	L	L	L	L	L	ND	L	L	L	L	
Thiamethoxam (Actara, Platinum)	L	L	M	L	L	L	L	ND	L	L	L	L	
Fungicides:													
New Chemistries/IR-4: Continued													
Azoxystrobin (Heritage, Quadris, Abound)													ND
Bacillus subtilis (Serenade)													ND
Boslaid + pyraclostrobin (Pristine)													ND
Famoxadone+cymoxanil (Tanos)													ND
Iodomethane (Midas)													ND
Phosphonic acid (Agri Phos)													ND
Propiconazole (Orbit, Bumper)													ND
Pyrimethanil (Scala)													ND
Thiophanate-methyl (Topsin-M)													ND
Herbicides:													
S-metolachlor (Dual Magnum)													ND
Thiazopyr (Visor)													ND
Soil fumigant:													
Iodomethane (Midas)													ND
Biological:													
Ampelomyces quisqualis													ND
Bacillus thuringiensis (Bt)													ND
Beauveria bassiana (Mycotrol)													ND
Gliocladium													ND
Mating disruption													ND
Parasitic nematodes													ND
Parasitoid wasps													ND
Predatory mites													ND
Stethorus beetles													ND
Trichoderma													ND
Cultural/Non-Chemical:													
Adjacent area management	ND	ND	ND	ND	ND	ND	ND	ND	H	H	H	H	May be hazardous if habitat removed
Alternate-year fruiting system													Neutral
Certified nursery stock/tissue culture plants													Neutral

Table 5: Toxicity Ratings for Beneficials in PNW Caneberries - Continued

Key to Beneficials: **BEB** = Bigeyed bug (*Geocoris pallens*); **DB** = Damsel bug (*Nabis alternatus*); **HB** = Honey Bee (*Apis mellifera*); **LW** = Lacewings (*Chrysopa* spp.); **LB** = Lady beetles (*Hippodamia convergens*); **MPB** = Minute pirate bugs (*Orius* spp.); **PM** = Predatory mites (*Acari: Phytoseiidae*); **PN** = Parasitic nematodes; **PW** = Parasitic wasps (*Ichneumonidae* and *Braconidae* families); **S** = Spiders (*Arachnida: Araneae*); **SF** = Syrphid flies; **TF** = Tachinid flies
Rating Scale: **O** = Non-toxic; **L** = Slightly toxic; **M** = Moderately toxic; **H** = Highly toxic; **ND** = No Data

	BEB	DB	HB	LW	LB	MPB	PM	PN	PW	S	SF	TF	Comments
Cultural/Non-Chemical: Continued													
Cover crops													Beneficial, habitat, shelter and alternative prey
Crop rotation													Largely neutral
Cultivate an open canopy													Short term disruption to soil dwellers
Disking													Short term disruption to soil dwellers
Enhancing habitat for beneficials													Beneficial, habitat, shelter and alternative prey
Flaming													Hazardous to foliage dwellers
Hand hoeing/weed eater	H	H	H	H	H	H	H	O	H	0	H	H	Hazardous to foliage dwellers
Keep crates from damp soil/grass													Neutral
Maintain/enhance drainage													Neutral
Manage overhead irrigation													Neutral
Mowing													Short term disruption to foliage dwellers
Mulching													Beneficial, habitat, shelter and alternative prey
New over old training technique													Neutral
Primocane suppression													Neutral
Prune infected suckers													Neutral
Raised beds													Unknown, probably beneficial to soil dwellers
Resistant cultivars													Neutral
Resistant/tolerant cultivars													Neutral
Sanitation													May be hazardous if habitat removed
Solarize													May be hazardous to soil dwellers
Tie up after leaf fall													Neutral
Weed control													May remove habitat or alternative prey for some species

Activity Table 1: ~ Northwestern Washington 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 Raspberries – Continued

Seasonal Pest Occurrence												
Insects & 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												
Root weevil adults												
Sawflies												
Slugs												
Snowy tree crickets												
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												
Psuedomonus 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												
Lambsquarters												
Mustard												
Nightshade												
Pigweed												
Prickly lettuce												
Shepard's purse												
Smartweed												
Sowthistle												
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 & 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												
Psuedomonus 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												
Lambsquarters												
Mustard												
Nightshade												
Pigweed												
Prickly lettuce												
Shepard's purse												
Smartweed												
Sowthistle												
Wild radish												
Perennial Grasses												
Quackgrass												
Rye grass												

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

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 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												
Psuedomonus 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												
Shepard'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												
Powery 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												

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

Seasonal Pest Occurrence												
Vertebrates												
Deer												
Gophers												
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												
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												

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