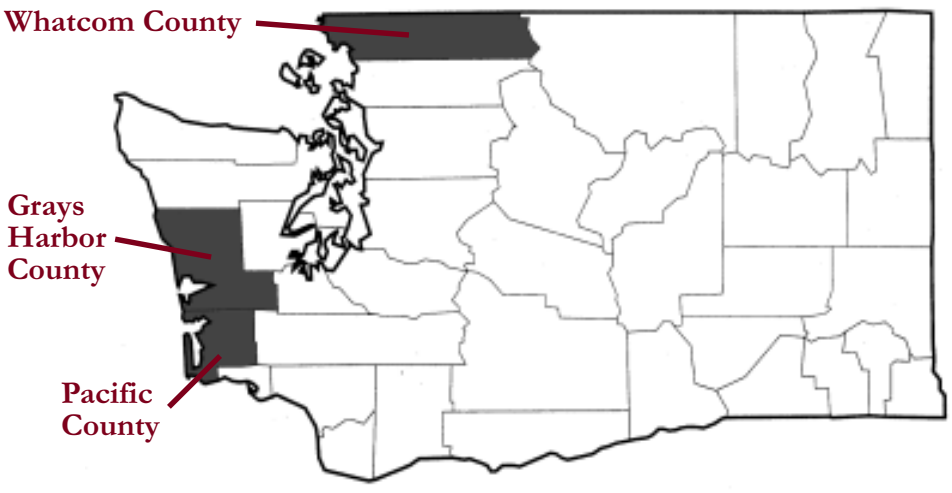
Crop Profile for Cranberries in Washington

Production Facts

- Washington ranks fifth in the United States in the production of cranberries (1).
- Washington produces 3 percent of the total U.S. crop and 15 to 20 percent of the fresh fruit market (1,7).
- 8,400 tons of cranberries valued in excess of $5.4 million were produced during the 1998 crop year on 1600 acres (2).
- Production costs (1995) averaged $3,000/acre, while establishment costs averaged $40,000/acre (8). At the current price of cranberries (<$25/bbl), production price exceeds average gross returns by $500 to $1000/acre.

Production Regions

There are three growing regions in Washington: Long Beach Peninsula (Pacific County), Grayland (Pacific and Grays Harbor counties), and Lynden (Whatcom County) regions.



Cultural Practices

Aerial view of a Long Beach, Washington, cranberry bog.

Cranberries are shallow-rooted (4 inches) evergreen vines that grow low to the ground. It is a long-lived perennial. Beds have been drained, cleared, leveled and covered with a one to two inch layer of sand before the field is planted to select vines. The sand layer over a natural peat bog provides a better rooting zone for cranberries than the peat itself, and helps reduce weed seed germination. Six- to eight-inch lengths of vine cuttings are scattered uniformly over the sand and are then disked to a depth of 3-4 inches. Several years are required to reach full production. A bed can remain productive for 50+ years if protected from pests (10, 11).

Cut-away view showing plants' shallow root system.

Important cultural practices for maintaining good productivity of established beds include pruning, sanding, fertilization, and water management. Cranberries require good drainage and fail to thrive if the soil remains saturated for short periods during the growing season. Pollination by bumblebees or honeybees is required for production. Beds are pruned after harvest to stimulate the production of uprights and to prevent the runners from becoming matted and reducing productivity. A thin layer of sand spread over the bed stimulates new root and vine growth, improves aeration and drainage of surface water, and levels out low spots to make dry harvesting easier. Ammonium or urea nitrogen fertilizers, in granular or liquid formulations and other major and minor elements are applied as necessary for optimum growth and to prevent nutritional deficiencies.

Surface waters, such as lakes, streams, and ponds, are used for a constant water supply for irrigation, frost protection, heat protection, and application of fertilizers and pesticides through permanent solid set sprinkler systems that provide complete coverage of the vines. Large quantities of water are used to flood beds for harvest. Some beds in the Pacific Coast region cannot be flooded because there are no readily available sources of water or because of topographical reasons.

Cranberries are harvested in two ways, depending on the area and intended crop use. Dry-picked berries are often sold for the fresh market.

Dry harvest workers gently pick berries for fresh market.

Wet harvest method, showing beater machinery and floating berries.

Dry harvest utilizes a picking machine that combs the berries off the vines, and may also prune the runners that come in touch with multiple knives.

Water harvest is generally used for berries intended for processing. Beds are flooded just prior to harvesting. A water-reel, commonly called a beater, knocks the berries off the vines and the buoyant berries rise to the water surface. The floating berries are moved with floating booms to one corner of the flooded bed and loaded onto trucks by conveyor belts or pumps. Although water harvesting is much more economical than mechanical dry picking machines, water harvesting affects the keeping quality of the berries. Lengthy water immersion increases physiological breakdown, especially of fruit bruised from water-reel picking, and promotes the dispersion of spores and infection by fungi that cause black rot in storage. With proper handling and storage, however, the quality of water harvested berries can be maintained through the traditional Thanksgiving and Christmas fresh fruit marketing season. About 70 percent of Washington cranberries are dry harvested and 30 percent are wet harvested. In the Grayland area, harvesting is generally done under dry conditions. These berries are marketed as fresh or processed products.

Wet harvest workers move floating berries from boom area to truck

Insect Pests

Blackheaded Fireworm
Rhopobota naevana (Hübner)

This tortricid pest occurs in all cranberry-growing states and causes economic losses every year. The pest has two generations per year, moths are very dispersive, females are quite fecund, and larvae feed on both foliage and fruit. Left alone, small infestations can reach epidemic levels within two to three years. Blackheaded fireworm overwinter in the egg stage, but hatch is difficult to predict, especially in the Pacific Northwest where the winter is mild and spring temperatures are extremely variable. Eggs are laid singly on the underside of the leaves and remain yellow until April, when they slowly turn orange as temperatures increase. The characteristic black head capsule can be recognized within the egg a day or two before hatch, which extends

Healthy cranberry bog (left) vs. cranberries with fireworm damage.

throughout late April and May, depending on weather. Very young (first instar) larvae mine the insides of cranberry leaves for a few days before moving to feed on the flower bud. First generation larvae feed upon and reside within a tightly webbed foliar bed, which protects them from predation and pesticide contact. Second generation larvae feed internally on fruit and each may consume 3 to 4 berries before it drops to the duff layer, where it pupates, then emerges as a second generation adult. In warm years, third generation larvae may continue to damage fruit before harvest or next years' foliar buds after harvest. Seasonal population development can be monitored using sweep nets to sample larvae and pheromone traps to capture male moths.

Controls

The following insecticides are currently registered for use against blackheaded fireworm larvae in cranberries: acephate 75SP AG; azinphosmethyl 50W & 2EC; chlorpyrifos 4E AG, diazinon 50W, AG500 & 4EC; and tebufenozide 2F. One or more applications per larval generation are usually required, skipped depending on pest density. All should be applied shortly after egg hatch, before larvae become encased within webbed foliage, but this timing is especially critical for tebufenozide, which kills by exponentially accelerating larval development rate. All but tebufenozide are broad-spectrum insecticides so should not be applied when pollinator bees or other beneficials are present. Pyrenone Crop Spray and Bt-based pesticides are effective if applied to young larvae. They are more selective than conventional insecticides and can be applied during bloom. A sprayable, microencapsulated formulation of female pheromones (MEC) is also registered for cranberries and is most effective at smaller isolated bogs of moderate infestation levels. MEC disrupts mating, so should be applied immediately after the first male is caught.

Cranberry Girdler

Chrysoteuchia topiaria (Zeller)

Cranberry girdler overwinter as pre-pupae inside a webbed hybernaculum (cocoon) that is very difficult to distinguish from the surrounding soil. The hybernaculum is less than 1/4-inch long, very thin, and composed of membranous webs permeated with soil. However, girdler larvae produce excrement (frass) that is visible in the mid-duff layer as piles of tiny dark orange or brown pellets the following spring. Adults emerge in early summer (May or June) and males can be monitored with pheromone traps. During July, larvae feed on roots of the vines, eventually killing them, but damage often is not apparent until late summer or during the dormant season. Larvae are quite small, perhaps highly mobile, and difficult to find until late August. Depending upon the temperature, larvae may continue to feed and develop into late September or early October. Roots girdled the previous summer can also be distinguished in late season or during the dormant season. Girdled vines die and create thin or bare spots in the canopy.

Controls

The most effective and currently registered insecticide for use against cranberry girdler is diazinon 14G (24c,WA-970001), applied two weeks after peak moth flight, followed by a second application 14 days later. Flooding the vines for 24 to 48 hours during mid-summer may kill larvae, but may also enhance fruit rot diseases or scald the berries. Entomopathogenic nematodes can be effective, but multiple applications per season may be required.

Black Vine Weevil

Otiorhynchus sulcatus (F.)

These weevils feed on roots and other underground portions of plants as larvae, reducing plant vigor. Heavy infestations may cause plant death. Damage may not show for 2 to 3 years unless the area is stressed by other factors. Larvae overwinter in the soil at a depth of 2 to 8 inches. Adults are black beetles 1/4 to 1/2 inch long. They appear May to July and start laying eggs 3 weeks after emergence. The black vine weevil is one of the most destructive insect pests in Washington and Oregon, especially on dry harvested cranberries.

Controls

Orthene applied to young adults will provide temporary knockdown, but no control.

Two applications of Furadan 15G will provide some control of adults, but can be used only on dry harvested beds. Furadan is not widely used by growers due to the hazards to the applicator and environment. Cryolite bait applied to feeding adults in June has provided good control. The bait is broadcast over the bed with a rotary spreader. Because this is a relatively new product, usage information was not available at the time of this report. Two applications may be needed.

Flooding beds in October for 2 to 4 weeks will help suppress populations. Flooding, however, is not available to many growers.

Beneficial nematodes applied in the spring or fall when larvae are present for 2 weeks may suppress girdler. Growers have noted poor control.

Beneficial fungus (*Beauveria bassiana*) has been reported to suppress weevils in one small trial, but has not been field tested by growers. More research is needed prior to making recommendations for use of this fungus.

Cranberry Fruitworm

Acrobasis vaccinii (Riley)

The cranberry fruitworm, common to most other cranberry growing regions, was recently rediscovered in the Long Beach, Washington, and Richmond, British Columbia, growing regions after a forty-year absence from the Pacific Northwest. Male moth emergence occurs during late June and can be monitored with pheromone traps. Eggs are laid singly on the fruit and oviposition may be withheld until berries are of appropriate size and color (e.g., "BB-sized"). Larvae enter the fruit immediately upon hatch and may consume five to six fruit during development.

Controls

Because this pest has only recently reappeared in the Pacific Northwest, appropriate management techniques are still in preliminary stages. Insecticide applications against second generation blackheaded fireworm may be suited to this pest. Because tebufenozide works when ingested and larvae feed as they enter the fruit, regular applications of that material against second generation blackheaded fireworm may also suppress cranberry fruitworm. Diazinon applications made after most larvae have entered the fruit may be less effective.

Cranberry Tipworm

Dasineura oxycoccana

Cranberry tipworm is well established at a few bogs in the Grayland, Washington, growing region, but is much more abundant in East Coast

and Midwestern growing regions, where its life history traits have been documented. Cranberry tipworm overwinter in the duff as pupae. Adults are short-lived, but females may lay a dozen eggs or more within the whorls of a developing foliar bud. Larvae induce terminal leaves to grow abnormally in a cupped or curled shape, making them less susceptible to contact insecticides. Larvae complete three instars before they molt to less-vulnerable pupae. Tipworm larvae feed on developing terminal buds, causing ancillary branching and additional floral development, so yield may be increased at low pest densities. Some of these traits, especially the seasonality, may be different in the Pacific Northwest, where weather conditions are less extreme and different horticultural tactics are employed. For example, four to six generations may be completed per season in the Pacific Northwest, compared to six or more elsewhere.

Controls

As in other growing regions, pesticides are most effective when targeting early instar larvae during the first or second generation. In some years, this may coincide with early-season fireworm applications, but could also occur during the pollination period. Susceptible and unsusceptible lifestages overlap during mid and late season, so insecticides may have little overall effect on total infestation level.

Diseases

Common disease problems include rosebloom, twig blight, Phytophthora root rot and fruit rots. Less common, but occasionally significant diseases include red leaf spot, early leaf spot, cottonball and stem and leaf blight. The most critical disease problem comes from fruit rots, which develop on fresh fruit held in refrigerated storage between harvest and sale during the holiday season. Twig blight (*Lophodermium oxycocci*), if not controlled, will completely destroy a bed within a few years.

Fruit rots, all caused by fungi, are the most important disease problem in cranberry production (10,11). Fruit rotting fungi (numerous species) cause cranberries to rot, either before harvest (collectively called field rots) or after harvest (storage rots), and some may also cause leaf spots or blossom blights. Generally, fungal infections remain latent and develop as storage rots later.

Upright and runner dieback is caused by *Phomopsis vaccinii* (perfect stage *Diaporthe vaccinii*). The disease develops during summer when vines are stressed by hot weather, drought, or too much moisture. Infection occurs at bud break but symptoms do not appear until plants are stressed. Infected uprights, that appear scattered among healthy vines, take on a yellowish cast and eventually turn orange, bronze, or brown.

Twig blight, caused by *Lophodermium* spp., is common in Washington. Uprights are infected primarily in July and early August, and die the following spring as the infected leaves turn from dark red to bleached tan. Its distribution in an area is spotty, so losses are usually not significant, but may be severe when the entire bed is affected.

Phytophthora root rot affects plants in poorly drained low spots where excessive water accumulates. Root systems are poorly developed and severely affected plants die. New vines planted in areas where symptomatic vines were removed usually also die unless a fungicide is used or drainage is improved.

Controls

Traditional Fungicides

Prophylactic application of one of several fungicides (Dithane, Ferbam Granuflo, Kocide, Bravo or Maneb (prebloom and postbloom) will suppress most diseases, including fruit rot. Timing of applications needs to correspond to the susceptible stages of development of the particular fungus. To control Rose bloom, fungicide is usually applied in May. Twig blight can be controlled only with two applications of Bravo in July. A delayed dormant application of Bordeaux will help control stem and leaf blight. Fruit rot control requires two to three applications of fungicides after fruit set, starting in early July. Phytophthora root rot can be

partially controlled with three applications of Ridomil (4).

Chlorothalonil 720F or 500 is a broad spectrum fungicide registered for fruit rots, *Lophodermium* leaf/twig blight, and upright dieback at 3 to 5-1/4 lb. AI/A. Applications should be made at early bloom or after petal fall and repeated at 10 to 14 day intervals for fruit rot control. Chlorothalonil cannot be applied more than 3 times per season, or within 50 days of harvest. It may be applied through sprinkler irrigation equipment, but not to flooded beds and irrigation water must not be released from beds for at least 3 days following application. Chlorothalonil is applied to 100 percent of the cranberry acres.

Copper compounds are registered for control of fruit rots and upright dieback disease, with no harvest restrictions. The various forms include Bordeaux mixture, inorganic salts (carbonates, chloride, hydroxide, oxalate, oxides, phosphate, silicate, sulfates and zinc chromate complex), and organic compounds such as acetate, naphthenate, oleate, quinolinolate and resinate. Bordeaux 8:8:100 should be applied at 24 lb./A. At least one form of copper is used on 80% of the farms in Washington.

Ferbam 76WDG is a protective fungicide registered for control of fruit rots and fairy ring. For fruit rots, applications of 1-1/2 lb. AI/A should be made early in the bloom period and repeated at 14-day intervals, with a maximum of five applications per year. It cannot be applied later than 28 days after mid-bloom. Apply 0.07 lb. AI /ft2 immediately after harvest for fairy ring, treating an area 3 feet beyond the advancing line of dead vines and 2 feet within this line.

Mancozeb 80WP, 75DF and 4F is a broad spectrum EBDC protectant fungicide registered to control fruit rots on cranberry. The fungicide may be applied by ground, air or through irrigation equipment at 2.25 to 4.5 lb. (75DF) and 2.4 to 4.8 lb. (80WP and 4F) AI/A, starting at mid bloom and repeating at 7 to 10 day intervals, with a maximum of 14.4 lb. AI/A/season. There is a 30-day interval before harvest.

Metalaxyl 2E and 5G are registered for control of soil-borne diseases caused by *Phytophthora* spp. A maximum of three applications are to be applied at 1 to 1.75 lb. AI/A, with the first application in the fall after harvest, the second in the spring and the third 45 days before harvest. No more than 5.25 lb. AI may be applied in a single season. It is rarely used in Washington.

Cultural Control

Many cranberry diseases can be partially managed by preventing excess vine vigor. This can be accomplished by avoiding over-fertilization. Reducing shading, improving air circulation around beds, and removing and destroying plant debris around beds (inoculum sources), also helps in disease prevention. For *Phytophthora*, control may be achieved by improving drainage in low areas of the bed and applying a layer of sand (one inch) to poorly drained low areas.

Nematodes

Several species of nematodes have been reported to be associated with cranberry beds, especially those on sand beds. At this point there has been no strong correlation between nematode population declines and cranberry production.

Controls

None.

Weeds

Many native and introduced plant species are considered weeds when they invade managed cranberry marshes. Most of the weeds affecting cranberry production are adapted to a wet, marshy environment and grow directly in the beds. Others tend to be found mainly in the ditches or edges of beds. In cranberry beds under dry cultivation, upland weed species cause more problems.

Weeds can account for 10 to 20% of crop losses annually. Problematic weeds are herbaceous

perennials including silverleaf, false lily-of-the-valley, birdsfoot trefoil, aster and clover. Silverleaf and lily are the most difficult to control. These perennial weeds resist control by all herbicides registered on cranberries. Weeds are a problem because they compete for water, sunlight and nutrients. Under wet harvest conditions, the beater on the harvester can spread weed seeds throughout the bog, increasing weed problems. Under dry harvest conditions, weeds clog the harvester and increase berry damage and rots. With time (5 to 15 years), a severe infestation of perennial weeds will totally destroy a commercial cranberry bed.

Perennial grasses often occur in patches, with new infestations often arising from roots, rhizomes, or stolons that contaminate the sand used for sanding operations. Rice cutgrass or sickle grass, *Leersia oryzoides* (L.) Swartz, is a wiry perennial that commonly invades thin stands in low spots and ditches. Annual broadleaves occur throughout beds or along ditchbanks and edges. Several species of beggarticks or sticktights, *Bidens* spp., are common in cranberry beds. Ragweeds, *Ambrosia* spp., are tall upland plants found only on dry areas in beds. Perennial broadleaves include aggressive plants that grow for many years from the same root system. Asters, *Aster* spp., prefer relatively dry conditions. Common and silverleaf cinquefoils, *Potentilla pacifica*, are invasive native plants that spread by slender runners. Creeping buttercup, *Ranunculus repens* L., is a trailing, creeping herb that often roots at the stem nodes and reproduces by seeds and runners. Sheep sorrel, *Rumex acetosella* L., is a native of Eurasia that spreads by extensive shallow rhizomes and also reproduces by seed. Yellow loosestrife, *Lysimachia terrestris* (L.) B.S.P., is common in wild marshes and invades cranberry beds as bulbils dispersed by water. It grows at the water's edge and spreads by stolons. The latex sap causes dermatitis in some people. Sedges, rushes, horsetails and ferns are common perennial weeds in cranberry. Numerous species of sedges or nutsedges in many genera and with various common names (e.g., bullrushes, stargrass, tussocks) invade cranberries. Rushes (*Juncus* spp.) are commonly found in wet soils around water. Horsetails, *Equisetum* spp., are perennial plants that grow in ditches or poorly drained spots in the field, and interfere with mechanical harvest. Many species of ferns occur in beds, on dikes and along roadsides. Woody plants encompass numerous species. Blackberry, brambles, or dewberry, *Rubus* spp. occur in patches, mainly on sand beds where a poor job of scalping was done before planting. They are very persistent plants that compete for light and interfere with harvest. Dewberry and brambles grow prostrate among the cranberry vines and are therefore hard to wipe for control. Willow (*Salix* spp.) trees invade beds as windblown seed.

Annual grasses are usually important only in new plantings or where vines are sparse. Some common species include barnyard grass, *Echinochloa crusgalli* (L.) and annual bluegrass, *Poa annua*.

Controls

Cultural Control

Hand weeding is used extensively on new and young beds. Cost of $3000/A is common on new plantings for hand weeding. Most perennial weeds are only temporarily suppressed by hand pulling in beds. Prolonged winter and spring flooding will suppress blackberries and a few other weed species, but will also damage the cranberry beds.

Herbicides

Pre-emergence herbicides 2,4-D, napropamide, norflurazon, and dichlobenil are used in late winter and early spring. Dichlobenil is used annually on almost all beds. Damage to cranberry beds from dichlobenil and norflurazon is common, especially under conditions of poor drainage (5).

Post-emergence herbicides Glyphosate and 2,4-D are used to wipe weeds extending above the crop canopy. These provide adequate control of tall weeds, but are not very effective for short or prostrate weeds, such as silverleaf, clover or trefoil. Clethodim and sethoxydim are used for grass control. A Section 18 for clopyralid for the past four years (1996-1999) has provided opportunity for control of legumes and asters.

2,4-D formulations are registered for control of numerous annual and perennial broadleaf weeds. The granular formulation should be applied in early spring after removal of the winter flood at 10 to 20 lb. product per acre. A liquid formulation is registered for use in Washington only (24c-WA800081). A single application should be applied at 3.8 lb. acid equivalent by wiper application.

Clethodim is a selective postemergence herbicide used to control annual and perennial grasses. It will not control sedges or broadleaf weeds. Clethodim may only be applied to nonbearing cranberries that will not bear fruit for at least one year. Herbicide rate will depend on the life habit of the weed as well as species. Apply clethodim at a rate of 0.095-0.251 lb. AI/A along with a crop oil concentrate. Since this herbicide was registered for use on cranberries after the cranberry assessment (1) was complete there is no information available on the percentage of cranberry acres treated with clethodim.

Clopyralid is a selective, postemergence, broadleaf herbicide that has had a Section 18 for use in cranberries in Washington since 1996. It is applied by either spot spray or wiper application at a rate of 0.094 to 0.25 lb. AI/A.

Dichlobenil is a benzonitrile herbicide registered for selective control of numerous perennial and annual, broadleaved and grassy weeds, including rushes and sedges. Herbicide use is limited to a single application per year at 4 to 6 lb. AI/A. It can be applied in the spring while perennial weeds are still dormant and before annual weeds have started to germinate, or after harvest in the fall. Spring applications should not be made if the bed was treated the previous fall. In the Pacific Northwest it may be applied as a split application in early spring with an interval of 3 to 6 weeks between treatments. Diclobenil is used on 95% of the cranberry acres.

Glyphosate is a non-selective herbicide without residual action, registered for control of many annual and perennial grasses and broadleaf weeds by wiper application only. A 20 percent solution (a dilution of the commercial product to equal 0.8 lb. AI/gal) should be applied by wick or other wiper applicator after fruit set and no later than 30 days before harvest, wiping herbicide on the weeds that grow taller than the cranberry plants. Treated plants slowly turn yellow, but may not die until several weeks after application. Repeat or spot treatment may be necessary where weeds were initially dense or to eliminate weeds that were missed. Glyphosate usage cannot be determined on an acreage basis since it is only used as a spot treatment.

Napropamide 10G and 50WP are registered for control of a few annual broadleaf and grass weeds. It does not control established weeds. In Washington 15 lb. AI/A of the granular formulation should be applied in beds with heavy muck soils, 6 to 9 lb. AI/A in peat beds, and 4 to 9 lb. AI/A in sand beds. The wettable powder formulation is registered for use in Washington (24c-WA920035). At least 1/4 inch of rain or sprinkler irrigation within 3 days after application is essential for weed control.

Norflurazon 5G is a soil-applied, preemergence treatment for the control of certain annual and perennial grasses, sedges and broadleaf weeds in cranberries. Herbicide is to be applied as a single ground application at 4 to 8 lb. AI/A in the early spring after removal of winter flood and before weed growth resumes, or in the fall after harvest at least two weeks before winter flood. Application rates vary depending on the weed species present, soil type, cranberry variety, and the condition of the bed. Norflurazon is limited to one application per year, not to exceed 4 lb. AI/A in a newly planted bed or 8 lb. AI/A for established beds. However, the higher rate can be damaging to cranberry vines.

Sethoxydim is a postemergence herbicide registered for the control of annual and perennial grasses in nonbearing cranberries. It should be applied to actively growing weeds at a rate of 0.3 to 0.5 lb. AI/A. A crop oil concentrate or spray adjuvant must be used along with sethoxydim to allow for thorough wetting. There is a one-year preharvest interval for nonbearing cranberries.

Critical Pest Control Issues

Synthetic chemical pesticides are an important component of pest control strategies for the various pests of cranberry; however, other management methods are routinely used in cranberry production. The cranberry industry continues to develop and adopt new means of pest suppression, both chemical and non-chemical, for incorporation into existing pest management strategies.

Insecticides are extremely important, especially to prevent damage from direct pests in areas where there is heavy insect pressure. Farmers currently depend on the conventional insecticides chlorpyrifos, diazinon, azinphos-methyl and acephate. The potential of alternative pesticides to suppress key insect pests to below economic threshold levels has not been fully determined. Only a few alternative pesticides are currently registered for use in cranberry. These, as well as other candidate insecticides, are more expensive than conventional pesticides. IPM programs that feature these alternatives and an expanded monitoring program would further increase the expense of pest management. As long as the price of cranberries remains low (<$35/barrel), it is unlikely that growers will be able to afford to fully implement alternative pest management programs.

If the major herbicides diclobenil, napropamide, and glyphosate were not available, growers would have to resort to hand pulling and mowing, and use of more herbicides that are less efficacious to attempt to control most weeds. These methods would not be as effective as the major herbicides and in most cases would be much more expensive. Yields would decline significantly, but the major impact on yield would not be seen for several years. Without some selected herbicides or any herbicide, up to half of the growers would eventually go out of business because it would no longer be profitable to farm when their beds become overwhelmed by weeds in 5 to 10 years. With some aggressive weeds growers could be out of business within 3 years.

Losses to fruit rots in both the field and in storage can be very high. Foliar diseases are also generally controlled by the same fungicides used for fruit rot control. If chlorothalonil were not available, mancozeb, ferbam and copper compounds would be used as alternatives. If the two most important fungicides, chlorothalonil and mancozeb, were not available, overall yield reductions of 20 percent would be common, with losses of up to 100 percent occurring in individual beds. For some diseases (twig blight), permanent loss of the bed could occur in some areas within 3 years if chlorothalonil was lost. A greater quantity of less-effective fungicides would probably be applied to compensate for this loss of efficacy.

Outlook for New Registrations

The IR-4 program is very supportive of cranberry projects. There are many ongoing IR-4 projects for insecticides, fungicides and herbicides. New product registration, and evaluating and researching many other pest management approaches including biological and cultural controls has the highest priority for research in the cranberry industry. Unfortunately, this aspect takes considerable time and money.

Author

Drs. Kim D. Patten and Steve Booth
Washington State University
Long Beach Research Station
Rt. 1 Box 570
Long Beach, WA 98631
Phone (360) 642-2031
Fax (360) 642-2031
pattenk@cahe.wsu.edu
booths@coopext.cahe.wsu.edu

Commodity Contact

Jere Downing, Executive Director
The Cranberry Institute
P.O. Box 535
E. Wareham MA 02538
Phone (508) 295-4132

Additional Resource

Wisconsin Cranberry Web Page:
http://www.library.wisc.edu/guides/agnic/cranberry/

Technical Contacts

Horticulture/Weed Science

Kim D. Patten
Washington State University
Long Beach Research Station
Rt. 1 Box 570
Long Beach, WA 98631
Phone (360) 642-2031
Fax (360) 642-2031
pccrf@wsu.edu

Plant Pathology

Peter R. Bristow
Washington State University
Puyallup Research and Extension Center
7612 Pioneer Way E.
Puyallup, WA 98371-4998
Phone (253) 445-4529
Fax (253) 445-4569
bristowp@wsu.edu

Entomology

Arthur Antonelli
Washington State University
Puyallup Research and Extension Center
7612 Pioneer Way E.
Puyallup, WA 98371-4998
Phone (253) 445-4545
Fax (253) 445-4569
antonell@wsu.edu

Lynell Tanigoshi
Washington State University
Vancouver Research and Extension Center
1919 NE 78th Street
Vancouver, WA 98665-9752
Phone (360) 576-6030
Fax (360) 576-6032
tanigosh@wsu.edu

References

(1) Rice Mahr, S.E. and L.J. Moffitt. *Biologic and Economic Assessment of Pesticide Usage on Cranberry.* 1994. USDA NAPIAP Publication Number 2-CA-94.

(2) Washington Agricultural Statistics Service, 1999 Report.

(3) *Pacific Northwest Insect Control Handbook*, 1998. Oregon State University. PNW Bulletin.

(4) *Pacific Northwest Disease Control Handbook*, 1998. Oregon State University. PNW Bulletin.

(5) *Pacific Northwest Weed Control Handbook*, 1998. Oregon State University. PNW Bulletin.

(6) Cranberry Agricultural Research Report 1995 through 1997, based on trials by Dr. Steve Booth and others.

(7) Personal communication, Bob Radford, Ocean Spray, Washington. 1998.

(8) Schaeffer, C.J., K.D. Patten, and R.W. Carkner. *1995 Cranberry Establishment and Production Costs and Returns, Southwest Washington Wet Harvest (1806) and Southwest Washington Dry Harvest (1805).* 1995. Washington State University Extension Bulletins 1805 and 1806.

(9) Personal communication, Sheila Fitzpatrick, Ag-Canada - British Columbia. 1998.

(10) Shawa, A. Y., C. H. Shanks, P. R. Bristow, M. N. Shearer, and A. P. Poole. 1984. *Cranberry Production in the Pacific Northwest*. Oregon State University. PNW 247.

(11) Eck, Paul. 1990. *The American Cranberry.* Rutgers Press.

Published October 1998, Revised March 2000.

COOPERATIVE EXTENSION
Washington State University

College of Agriculture and Home Economics

Use pesticides with care. Apply them only to plants, animals, or sites listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

You may order publications from the WSU Bulletin office, 1-800-723-1763, or http://caheinfo.wsu.edu.

Issued by Washington State University Cooperative Extension and the U.S. Department of Agriculture in furtherance of the Acts of May 8 and June 30, 1914. Cooperative Extension programs and policies are consistent with federal and state laws and regulations on nondiscrimination regarding race, sex, religion, age, color, creed, national or ethnic origin; physical, mental or sensory disability; marital status, sexual orientation, and status as a Vietnam-era or disabled veteran. Evidence of noncompliance may be reported through your local Cooperative Extension office. Trade names have been used to simplify information; no endorsement is intended. . Published March 1999, Revised March 2000. (Publication number MISC0350E.)