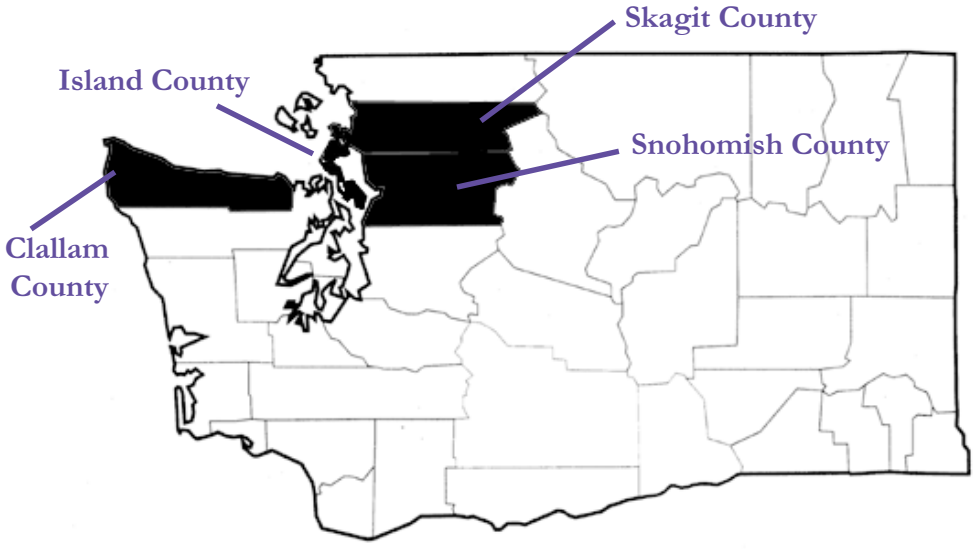
# Crop Profile for
# Cabbage Seed
# in Washington

## Production Facts

- Washing ton State supplies 75% of the U.S. production and 50% of the world production of cabbage seed (1).
- 1200 acres of cabbage seed are grown annually in Washington State (600 acres hybrid seed and 600 acres open-pollinated) (1).
- Value of market seed sold to commercial growers is $22.4 million (1).
- Grower production costs are $3000/acre for hybrid seed and $1000/acre for open-pollinated varieties.

## Production Regions

**Major cabbage seed-producing areas are Skagit, Snohomish, Island, and Clallam counties in western Washington (1).**



## General Information

***Dried cabbage seed.***

There is no open market (non-contracted) small-seeded-vegetable seed production in Washington. Commercial vegetable seed is produced under bailment contracts, where the seed companies (bailors) provide growers (bailees) with the seed necessary to produce a crop. The seed company retains ownership of the seed, growing crop, and resulting harvested seed. Growers produce and harvest the crop and are then paid the contract price for the resulting seed if it meets quality criteria stated in bailment contracts, typically an 85% germination rate and a 99% purity. Weed seeds which are the same or nearly the same size/shape as the vegetable seed are difficult to remove at the conditioning plant and can cause seed companies to reject a seed crop (4). Federal regulations for moving seed into interstate commerce require that seed must be completely free of all noxious weeds.

Small seeded vegetable seed production takes place on approximately 6,000 acres in western Washington contracted by approximately 25 seed companies. The average field size for cabbage seed production is 5 acres for hybrid seed production and 15 acres for open pollinated seed production. Rotation periods for cabbage are a minimum of 5 years to mitigate disease problems. Companies control the location of seed crop fields in order to prevent cross-pollination of varieties of the same crops (cabbage open pollinated seed vs. cabbage hybrid seed) and of cross-compatible crops (e.g. beet and Swiss chard). Isolation distances vary depending on whether the crops are wind or insect pollinated, are grown for market or stock seed, and can range from one-quarter mile to 2 miles or more. Cabbage is bee pollinated. Market seed is produced and used for vegetable production. Stock seed is grown specifically for use in planting seed crops.

Company representatives meet with county agents at the WSU Mount Vernon each spring in a "pinning" meeting to plot map locations of seed crops planned for that year. It is worth mention that with the increased urbanization of the Skagit Valley, and the presence of hobby farmers, it is more difficult to control pollen flow and ensure the isolation necessary for hybrid seed production.

***Drier bins.***

In Washington State, small seeded vegetable seed crops are considered non-food and nonfeed sites for pesticides use (4).

## Cultural Practices

Cabbage, *Brassica oleracea*, is a biennial crop when grown for seed. Other biennial *Brassica* species include Brussels sprouts, cauliflower, collards, kohlrabi, and kale. Seed is sown in a plant bed or greenhouse, then at the six to eight-leaf stage, seedlings are transplanted into production fields in mid-August through mid-September. The crop overwinters in the field, then bolts and flowers in the spring. Bees are used for pollination. Seed development and maturation occurs in June and July. In early August the crop is cut (hybrid production is hand cut while open pollinated production is machine swathed), turned, then threshed after curing 14 days in the windrow. Hybrid cabbage seed is sufficiently valuable to require hand-turning during the field drying stage. After harvest the seed is then dried artificially in commercial driers and cleaned at local conditioning facilities.

The cool maritime environment of western Washington is ideal for overwintering *Brassica oleracea* production. Winters are generally not cold enough to freeze the crop, yet are cold enough to properly vernalize the plants. Summer weather is cool, providing optimum plant and seed development.

***Gravity separator.***

Cabbage prefers soils that are well drained especially during the over-wintering period. Cabbage seed crops often fail on fields in high water tables or that become flooded for extended periods of time during fall/winter or early spring. During the growing season, after bloom, it is critical that there be sufficient soil moisture during the seed fill period otherwise the seed may become shrunken and non-viable or non-marketable because of its small size.

Other related *Brassica* crops grown for seed include: arugula, broccoli-raab, Chinese cabbage, Chinese kale, Chinese mustard, kale, mustard, pak choi, radish, and turnip. Many of these crops are grown as annuals and are direct-seeded rather than transplanted. All of the *Brassica oleracea* are very susceptible to certain insects and diseases, requiring extensive control for successful seed production (1). Weeds are only problematic during the early growth phase of the crop.


***Seed conditioning area with clean seed bins.***

# Insect Pests

The most serious insect pest of cabbage seed is the cabbage maggot, followed by cabbage aphid, turnip aphid, cabbage seedpod weevil, loopers and cutworms.

## Cabbage Maggot
*Delia radicum*

Cabbage maggots are the larval stage of a small gray fly that lays its oblong white eggs at the base of plants. The white larvae dwell in the soil and feed on roots and underground plant parts. Damage by root maggots weakens, lodges, and kills plants (2). Potential yield loss to growers is 100% if root maggots are not controlled (1).

### *Chemical Controls*

**Diazinon (Diazinon 14G at 2-3 lbs AI/A).** It is used on 100% (1200 acres) of area planted for cabbage seed and is applied at transplant (1). Transplant drenches may also be used (Diazinon 4E or 50W at 2-4 ozs. AI/A).

**Chlorpyrifos (Lorsban 4E at 0.05-0.86 lbs AI/1000 linear ft. row, Lorsban 15G at 0.04-0.09 lbs AI/1000 linear ft. row).** 30-day PHI. Chlorpyrifos is used at transplant on 100% (1200 acres) of area planted for cabbage seed (1). Foliage is not treated as phytotoxicity may occur.

**Fonofos (Dyfonate at 2 lbs AI/A).** Fonofos is applied to 50% of area planted to cabbage seed (600 acres) at transplant (1). Tolerances will expire Dec. 31, 2002. Continued use is limited to existing stock.

**Azinphos-methyl (Guthion 50W at 0.125-0.19 lbs. AI/A).** Five percent (60 acres) of area planted to cabbage seed is treated at transplant. Guthion 35, Guthion 2S, and Guthion Solu-Pak 50WP are also registered for use.

***Temporary seed storage area.***

## Cabbage Aphid
*Brevicoryne brassicae*

## Turnip Aphid
*Hydaphis pseudobrassicae*

Both aphid species are mealy gray and feed in colonies on the foliage, on heads, or in buds resulting in plant decline (2). Potential yield loss to growers is 50% if aphids are not controlled (1).

### *Chemical Controls*

**Pirimicarb (Pirimor 50-DF at 1-3 oz AI/A).** 1999 Washington Crisis Exemption (File No. 99-WA-44), expiration date of 9/15/99 (3). This is the fifth year the exemption has been requested. A maximum of two applications per season is allowed. In 1998 it was applied to 70% (840 acres) of cabbage seed crops at bloom (1).

**Dimethoate (various trade names, at 0.25-0.5 lbs. AI/A).** 3-day PHI. Dimethoate is applied to 25% (300 acres) of cabbage seed crops after bloom (1).

**Methamidophos (Monitor 4 at 0.5-1 lbs. AI/A).** 35-day PHI. It is applied to 95% (1140 acres) of cabbage seed crops after bloom for control of aphids (1).

### Cabbage Seedpod Weevil
*Ceutorhynchus assimilis*

This is a small, dark gray "snout beetle" which congregates on blooms. The larvae feed on seed in the pods resulting in seed loss. Potential yield loss to growers is 25% if weevils are not controlled (1).

#### *Chemical Controls*

**Endosulfan (Thiodan 50WP, 3EC, at 1 lb AI/A).** (24c, WA-780029 & WA-770016). Endosulfan is used on 100% (1200 acres) of cabbage seed at bloom (1). Timing of applications are when bees are not active (below 50 F). This is a critical use to the industry.

### Cabbage Looper
*Trichoplusia ni*
### Alfalfa Looper
*Autographa californica*
### Cutworms
various species including
red-backed cutworm, *Euxoa ochrogaster*

Cabbage loopers are the pale green larvae of a gray-brown moth that feeds on foliage and other tender, aboveground plant parts causing plant decline. Alfalfa loopers are similar in appearance and cause similar damage. Cutworms are the variously-colored and -patterned larvae of moths which typically feed on foliage, causing plant decline. They may also completely sever stems of young plants, resulting in plant loss. Potential yield loss to growers is 25% if loopers and cutworms are not controlled (1).

#### *Chemical Controls*

**Permethrin (Ambush at 0.05-0.2 lbs. AI/A).** 1-day PHI. Permethrin is used at time of transplant on 10% (120 acres) of area planted to cabbage seed (1). This product is a critical use to the industry.

***Bacillus thuringiensis* (various trade names, at various rates).** It is applied to 2% (24 acres) of the cabbage seed crop up to time of bolting (1).

## Diseases

Diseases are listed in order of importance to the industry. Sclerotinia watery soft rot is the most important disease, causing problems "year in and year out." There has only been one outbreak of Black rot within Washington State, but there is zero tolerance allowed in seed lots. The same is true of Alternaria leaf spot. Infected fields or seed lots must be destroyed, leaving the grower with a total crop loss.

### Sclerotinia Watery Soft Rot (White Blight)
*Sclerotinia sclerotiorum*

This fungal disease typically occurs on aboveground plant parts, causing a cottony white mold on the affected tissues. Small black sclerotia are formed in the cottony mold, and serve as overwintering structures for the fungus. The sclerotia persist in the soil for several years. Stem infections in seed crops can cause particularly severe losses (10). Potential yield loss is up to 100% if *Sclerotinia* is not controlled (1).

#### *Cultural Controls*

Crop rotation with nonsusceptible crops such as grass or grains is practiced. Plantings are oriented to provide maximum air movement.

#### *Chemical Controls*

**Benomyl (Benlate at 1 lb AI/A).** Usually more than one application is made at 2 lbs. product/acre. The first application is made at first petal fall then two additional applications are made un-

der conditions favorable for disease at 14-day intervals. Resistance management is practiced by the industry. Other fungicides, such as Rovral, are used in combination with Benlate or alternated. Benlate applications were made to 100% (1200 acres) of cabbage grown for seed production during 1998 (1).

**Iprodione (Rovral at 1-2 lbs AI/A).** (24c, WA-810052). Applied with a spreader sticker. When disease pressure is severe, applications are made at full bloom, pod set, and before harvest. Applications of Rovral also help control Alternaria leaf spot (10). Total cabbage seed crop area treated is 80% (960 acres).

## Black Rot

*Xanthomonas campestris* pv. *campestris*

Black rot is caused by a bacterium that persists in infected plant debris up to two years (8) and may survive in soil for months. It can also survive on seed and this inoculum is the major source of disease. Infections through the stomata on the cotyledons of young cabbage seedlings enter the xylem and become systemic. Infections of leaves of older plants can also develop into systemic infections. Black veins develop in yellow lesions along leaf margins and water uptake may be impaired. All Brassica species and several cruciferous weeds are susceptible to *X. campestris* pv. *campestris*. The pathogen may be spread by water, insects, equipment, and animals (10). Water is required for spread of the disease. Warm temperatures (80° to 86° F) are optimal for disease development (10).

### *Cultural Controls*

Sanitation and the use of disease free stock seed are the primary cultural controls used to prevent disease establishment. In general, seed companies assay stock seed for the disease before planting. Any doubts result in a hot water treatment at 122 F for 30 minutes. This is the primary method used if the pathogen is detected in stock seed. Practices also include rotating out of crucifers (2 years in field and 3 years in planting bed) (10), and management of weeds and insect pests. A few resistant cultivars are also available.

### *Chemical Controls*

There are no chemical controls for this pathogen. This is a critical need of the industry. Infected crops or seed lots are destroyed to prevent spread of the disease.

## Alternaria Leaf Spot

*Alternaria brassicae* and *A. brassicola*

Yellow-brown leaf spots that later turn necrotic are the major symptom of *Alternaria* infections. The fungus can be spread via infected seed, wind, splashing rain, contaminated soil or equipment and typically overwinters in crop debris and residue of cruciferous plants, including weeds, or by surviving in infected seed (10). Potential yield loss is estimated at 100% if the disease is not controlled (1). Seeds are not marketable if infected with Alternaria.

### *Cultural Controls*

Growers reduce inoculum levels by using long (3-5 year) crop rotations out of crucifers, incorporating crop debris into the soil, removing cull piles, and managing cruciferous weeds.

### *Chemical Controls*

**Chlorothalonil (Bravo Weather Stik at 1.13 lb AI/A).** 7-day PHI. Applications are made at bloom and during the growing season when conditions are favorable for disease or at 7- to 10-day intervals. Chlorothalonil also has efficacy against downy mildew (9). Applications are made to 100% (1200 acres) of the total cabbage seed crop (1).

**Iprodione (Rovral at 1-2 lbs AI/A).** (24c, WA-810052). Iprodione is applied with a spreader sticker. When disease pressure is severe, applications are made at full bloom, pod set, and before harvest. Applications of Rovral also help to control Sclerotinia watery soft rot (10). Total cabbage seed crop area treated is 80% (960 acres) (1).

## Bacterial Soft Rot
*Erwinia carotovora* subsp. *carotovora*

Infection by the soft rot bacterium occurs through wounds caused by insects, other diseases, mechanical damage or through natural plant openings during suitable weather. The disease is also associated with winter injury. Infected areas appear water-soaked and spread quickly, with rapid collapse of affected plant parts. Seed stalks will not be produced if plants are infected. Disease development is favored by extended periods of moisture from rain or irrigation and moderate temperatures, all prevalent conditions in western Washington. The pathogen is spread by insects, splashing rain, contaminated tools and clothing, or infected plant material. Soft rot bacteria can survive on plant debris and for several months in the soil (8). Potential yield loss is as much as 50% if this disease is not controlled.

### *Cultural Controls*

Growers orient plant spacing to provide good airflow and avoid plant injury to reduce infection sites.

### *Chemical Controls*

**Copper hydroxide (Kocide DF).** Applications are made at a rate of 1 to 2 lbs. product/acre beginning when heads are 1.5 inches in diameter. Generally, more than one application is used on a 7- to 10-day interval. Copper may cause a flecking of wrapper leaves. Approximately 20% of the total cabbage seed crop acreage (240 acres) is treated with one of the copper fungicides to control bacterial soft rot (1).

**Copper hydroxide (C-O-C-S WDG).** Usually more than one application (7- to 10-day intervals) is made at a rate of 3 to 4 lbs. product/acre when conditions are favorable for disease. Copper may cause a flecking of wrapper leaves. Approximately 20% of the total cabbage seed crop acreage (240 acres) is treated with one of the copper fungicides to control bacterial soft rot (1).

## Damping-Off
*Pythium* spp., *Fusarium* spp., and *Rhizoctonia solani*)

*Pythium* spp., *Fusarium* spp. and *Rhizoctonia solani* are soilborne fungi. They can survive in soil indefinitely and attack vulnerable seedlings of many plant species including *Brassica* species. If infection occurs prior to seedling emergence, the germinating seedling is killed. Low seedling numbers can be easily confused with poor seed germination due to a lack of vigor. Young plants can also be attacked during emergence, resulting in plant loss due to damping-off. Damping-off is favored by cool weather, high humidity, and saturated or compacted soils (10). Under favorable conditions, seedling death may reach 100% if untreated seed is planted in soils where these fungi are established (1).

### *Cultural Controls*

Soil pasteurization in greenhouses or seedbeds, as well as excellent sanitation (including removal or decomposition of plant debris) and crop rotation with cereals is practiced to reduce the inoculum level.

### *Chemical Controls*

**Thiram (Thiram 50WP).** Seed is treated at a rate of 8 oz. product/100 lb. of seed. All of the cabbage seed planted for commercial seed production is treated (1). Seed treatment may reduce germination and/or seed and seedling vigor if treated seed is damaged or weakened.

### Downy Mildew
*Peronospora parasitica*

This fungus can affect nearly all cultivated and weedy plants (including wild mustards) in the Brassicaceae (Cruciferae). Infection can occur at any stage of growth. Seedling plants may become systemically infected following cotyledon infection. Infection of leaves causes chlorotic areas on the upper leaf surface which later turn papery. Infection of lower leaves can result in systemic stem infection. *P. parasitica* overwinters in roots or infected plant debris and may be spread on seeds as a surface contaminant. The disease is favored by high humidity, fog, drizzling rains, and heavy dew, with optimum temperatures for infection 46° to 61° F for at least four successive nights and 75° F or lower during the day (10). Potential yield loss to growers is 30% if downy mildew is not controlled (1).

#### *Cultural Controls*

Growers follow eradication programs for susceptible cruciferous weeds, such as wild mustards, to reduce inoculum. Irrigation schedules are adjusted to reduce periods of high humidity that favor the pathogen. Resistant commercial cultivars are under development, but are not yet available (10).

#### *Chemical Controls*

**Metalaxyl/chlorothalonil (Ridomil Bravo 81W at 1.22 lb AI/A).** 7-day PHI. Applications begin prior to infection when conditions are favorable for disease. Additional applications are made at 14-day intervals up to a total of 4 applications per season. Chlorothalonil also provides protection against *Alternaria* infection. Resistance to Ridomil has been confirmed within the Pacific Northwest (10). Fifty percent (600 acres) of the cabbage seed crop is treated (1).

**Chlorothalonil (Bravo Weather Stik at 1.13 lbs AI/A).** 7-day PHI. Applications are made at bloom and during the growing season during periods favorable for disease at 7- to 10-day intervals. Applications are made to 100% (1200 acres) of the cabbage seed crop(1). The applications also control Alternaria leaf spot (10).

**Cymoxanil (Curzate 60 DF at 0.12 lbs. AI/A).** (24c, WA-990021). Must be used in combination with products containing mancozeb or chlorothalonil for resistance management. Initial application of 3.2 ounces of product/acre begins when conditions indicate downy mildew infection is imminent. Additional applications can be made at 5 to 7 day intervals. This is a newly granted SLN, no data is available on acreage treated.

**Mancozeb (Dithane at 1.5 lbs AI/A).** (24c, WA-960022). Apply at 7-10 day intervals at first signs of disease threat. Must be used in combination with products containing cymoxanil or chlorothalonil for resistance management.

### Botrytis Stem Blight
*Botrytis cinerea*

Botrytis stem blight is an emerging pathogen in western Washington. Only certain varieties of cabbage are affected by this pathogen. Non-infected cabbage bolts in early spring (March). In infected fields in 1999, seed stalks broke off or the cabbage head rotted and no seed stalk was formed. Disease etiology is being further documented (9). An estimated 5% of fields were affected in 1999.

## Weeds

Weed competition can significantly reduce the yield and performance of *Brassica* crops planted for seed production. Crop yield loss can be as much as 100% if broadleaf weeds are not controlled, and 50% if annual and seedling perennial grasses are uncontrolled (1). In general, weed control is most important early in the season while the cabbage is small and unable to compete. In later spring (April), the seed crop is able to compete

against seedling annual weeds, ultimately choking them out as the seed crop becomes tall and dense.

More important concerns are that many weed species serve as hosts for diseases and insects that affect the seed crop (10), and that weed seeds can be contaminants of harvested cabbage seed, affecting marketability. Wild mustard, catchweed bedstraw and redstem filaree are particularly problematic as their seeds are the same size as cabbage seed (11). Typical weeds include barnyard grass (*Echinochloa crus-galli*), chickweed (*Stellaria media*), lambsquarters (*Chenopodium* spp.), pigweed (*Amaranthus* spp.), henbit (*Lamium amplexicaule*), common groundsel (*Senecio vulgaris*), mustard (*Brassica* spp.), nightshade (*Solanum* spp.), pale smartweed (*Polygonum lapathifolium*), annual grasses (including annual ryegrass [Italian ryegrass], *Lolium multiflorum* and annual bluegrass, *Poa annua*), seedling perennial grasses (such as perennial ryegrass, *Lolium perenne* and quackgrass, *Elytrigia repens*), Canada thistle (*Cirsium arvense*), wild buckwheat (*Polygonum convolvulus*), vetch (*Vicia* spp.), pineapple-weed (*Matricaria matricariodes*), volunteer grains (such as wheat, *Triticum aestivum* and barley, *Hordeum vulgare*), and catchweed bedstraw (*Galium aparine*) (1,5,6).

## Cultural Controls

Growers practice crop rotation, primarily to control diseases, which also helps in weed control. Handweeding is the major cultural control employed to prevent weed contamination.

## Chemical Controls

**Simazine (Simazine at 0.8lb AI/A ).** (24c, WA-980011 for 90WDG and 24c, WA-900005 for Simazine 4L). Simazine is applied late fall and early spring to 50% (600 acres) of area planted to cabbage seed to control barnyard grass, mustard, chickweed, lambsquarters, and pigweed (1). This is the most critical use for the industry.

**Trifluralin (Treflan at 0.5-1 lbs AI/A).** Trifluralin is applied as pre-plant to 100% (1200 acres) of area planted to cabbage seed to control annual bluegrass, barnyard grass, chickweed, lambsquarters, pigweed, and henbit (1). It does not control established weeds. Because it does not control members of the mustard, nightshade or sunflower families, this herbicide cannot stand alone in weed control programs. However, this is still a critical use to the industry.

**Oxyfluorfen (Goal at 0.25-0.5 lbs. AI/A).** Oxyfluorfen is applied pre-plant to 50% (600 acres) of area planted to cabbage seed to control lambsquarters, groundsel, henbit, pigweed, mustard, and barnyard grass (1). This can only be used on transplanted cabbage (11). Because this active ingredient primarily controls broadleaf weeds, it cannot stand alone in a weed control program. However, this is still a critical use to the industry.

**Fluazifop-P-butyl (Fusilade DX, 0.19-0.25 lbs AI/A).** (24c, WA-950029). It is applied at pre-bloom stage to 35% (420 acres) of the cabbage seed crop to control annual grasses and seedling perennial grasses.

**Clopyralid (Stinger at 0.094-0.125 lbs AI/A).** (24c, WA-970033). It is applied at pre-bloom stage to 20% (240 acres) of the cabbage seed crop to control wild buckwheat, thistle, pineapple-weed, and vetch (1).

**Sethoxydim (Poast at 0.28 - 0.47 lbs AI/A).** (24c, WA-880022). It is applied at pre-bloom stage to 10% (120 acres) of the cabbage seed crop to control annual grasses and seedling perennial grasses.

## Other Control Methods

In addition to chemical controls, hand hoeing at the pre-bloom stage of the crop is performed to control any escapes from the chemical controls. Seventy percent (840 acres) of cabbage seed crops are hand-hoed to control weeds such as volunteer grain, catchweed bedstraw, mustards, vetch, thistle, chickweed, henbit, groundsel, and annual ryegrass (1). Labor costs comprise the majority of cabbage seed production costs.

## Authors

Lenora J. Jones
Research Assistant
WSU Puyallup
7612 Pioneer Way E.
Puyallup, WA 98371-4998

Carrie R. Foss
Pesticide Education Coordinator
WSU Puyallup
7612 Pioneer Way E.
Puyallup, WA 98371-4998
(253) 445-4577
cfoss@wsu.edu

Special thanks to Tim Loeffler of Alf Christianson Seed Company for his editorial review.

## Technical Contacts

***Weed Science***
Dr. Tim W. Miller
Extension Weed Specialist
WSU Mount Vernon
16650 State Rte. 536
Mount Vernon, WA 98273-9761
(360) 848-6120 ext. 6138
twmiller@wsu.edu

***Plant Pathology***
Dr. Debra Inglis
Research/Extension
Plant Pathologist
WSU Mount Vernon
16650 State Rte. 536
Mount Vernon, WA 98273-9761
(360) 848-6134
dainglis@wsu.edu

***Entomology***
Dr. Art Antonelli
Extension Entomologist
WSU Puyallup
7612 Pioneer Way E.
Puyallup, WA 98371-4998
(253) 445-4545
antonell@wsu.edu

## Industry Contact

Puget Sound Seed Growers Association
Kirby Johnson, President
2017 Continental Place Suite 6
Mount Vernon, WA 98273
(360) 424-7327

# References


(1) Puget Sound Seed Growers Association. *1998 Cabbage Seed Crop Outline*, unpublished data.

(2) *Pacific Northwest Insect Control Handbook.* Oregon State University, 1998.

(3) Washington State University Pesticide Information Center On-Line Label Database (PICOL). http://picol.cahe.wsu.edu

(4) Thomas, Jane et al. *Washington's Small-Seeded Vegetable Seed Industry*. Washington State University Extension Bulletin 1829. 1997.

(5) Whitson, Tom D., et al. *Weeds of the West.* The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities Cooperative Extension Services, 1996.

(6) Hitchcock, C. Leo and Cronquist, Arthur. *Flora of the Pacific Northwest*. University of Washington Press, 1990.

(7) Howard, Ronald J., et al. (eds.). *Diseases and Pests of Vegetable Crops in Canada.* The Canadian Phytopathological Society, 1994.

(8) *Pacific Northwest Disease Control Handbook.* Oregon State University, 1998.

(9) Dr. Debra Inglis, WSU Mount Vernon. Personal communication, December 1998.

(10) Dr. John Stark, WSU Puyallup. Personal communication, December 1998.

(11) Al-Khatib, K. *Weed Control in Cabbage, Table Beet, and Spinach Grown for Seed.* Washington State University Extension Bulletin 1798. 1995.


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, color, gender, national origin, religion, age, disability, and sexual orientation. 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 2000. (Publication number MISC0358E.)