Crop Profile for Lettuce in Washington

Production Facts

- Washington produces less than 1% of total U.S. lettuce.
- Washington growers harvested 900 acres of lettuce in 1997 (estimate includes multiple crops on farms).
- Yield per acre in 1997 was about 200 cwt., for a total of 180,000 cwt. Average market price was $15.10/cwt.
- Total value of lettuce production in 1997 was $2,718,000.

Production Regions

Commercial production regions are centered in the Puget Sound area of western Washington, primarily Pierce and King counties. Thurston, Whatcom, Clark, Island, Kitsap, Okanogan, Snohomish, Spokane, Stevens, and Walla Walla also reported lettuce acreage in the 1997 Census of Agriculture.
General Information

Both head lettuce (iceberg, butterhead) and leaf lettuce (green leaf, romaine, red leaf) are grown for fresh markets, primarily located in western Washington and Alaska. The Washington lettuce industry is a niche industry, depending upon markets not utilized by the California lettuce industry. The average farm size is 50 to 60 acres, with the average lettuce field size being five acres. The majority of growers plant green leaf lettuce along with other varieties throughout the season in an effort to meet fluctuating market demands. Most farms plant three or, infrequently, four crops of lettuce per year in staggered plantings. Some growers plant lettuce followed by other vegetable crops such as Chinese cabbage, celery, or radish. Typically at least one-third of an individual farm is replanted into a second crop of lettuce each year.

Urban sprawl is a significant problem facing the Washington lettuce industry. King, Pierce, and Clark counties are located in a heavily urbanized area known as the Interstate 5 corridor. Due to the pressures of urban growth and the associated costs of land and taxes, growers are precluded by lack of land from using desired rotations necessary to control many soilborne diseases.

Cultural Practices

Lettuce is a cool-season annual vegetable grown for its crisp succulent leaves. It grows best between 55°F and 65°F. Both head and leaf lettuce are grown in several soil types, ranging from sandy loam to light clay. It is planted in flat rows, not ridges or raised beds.

Lettuce seed is very small (ca. 8,600/10 gm), making uniform seeding extremely difficult. For this reason, seeds are ‘pelleted’ by seed processing companies in a process which coats the seed with a powder, using water or other binders all mixed in a revolving drum. The resulting seed is round, BB-sized, and much easier to run through a seeder, but it does significantly contribute to the cost of lettuce production.

The first lettuce is generally direct seeded at the beginning of March. In April, greenhouse-grown seedlings are transplanted to the field. Fields are planted with greenhouse-grown seedlings every week in the region, May through September. Plant numbers average 286,000/acre when transplanted using a 10-inch spacing in rows, and rows spaced 22 inches apart. Seedlings are mechanically planted and no further thinning takes place. Direct-seeded plants are spaced 15 inches apart in rows, with 15-inch row spacing for an average of 278,780 plants/acre. Between-row cultivation is done mechanically. Hand thinning is done only on direct seeded lettuce and is done in conjunction with hand weeding within rows.

Depending upon variety and weather conditions, lettuce is ready for harvest approximately 50 days after transplanting and 74 days after direct seeding for spring-planted lettuce, and 45 days after transplanting and 60 to 65 days after direct seeding for summer-planted lettuce.

In general, little is known about pest problems associated with the greenhouse component of lettuce production. Growers are encouraged to minimize pest problems by practicing good sanitation measures and carefully monitoring watering levels to control disease incidence. Seedlings remain in the greenhouse for approximately 2 to 3 weeks before transplanting.

Solid-set irrigation is placed into the field as soon as a crop is transplanted or direct seeded, and is used for 1 to 1-1/2 weeks to aid in germination or to establish the transplants on a solid footing. In general, natural rainfall, which averages 35 to 40 inches per year in the primary growing region, is...
Irrigation may again be used in the field during the last 2 to 3 weeks before harvest to firm up the heads.

Harvesting is done by hand in the field and consists of cutting the heads off with a knife, stripping the outer wrapper leaves of head lettuce for cosmetic appeal, and then packing for shipping in the field. Wrapper leaves are subsequently disked into the field. As a result, there are no industry concerns regarding grazing or feeding restrictions on lettuce refuse. A few growers cello-wrap iceberg lettuce in the field. Lettuce is packed at 24 heads to a carton in waxed cardboard cartons. When trimmed, the lettuce weighs approximately 1 lb.; a case weighs an average of 25 lbs. Average yield for lettuce is 800 cases/acre. A few growers have hydrocoolers on their farms, which they use to bring the lettuce cartons to an internal temperature of $34^\circ C$ before shipping. Most growers send their lettuce to a processor located within a few miles of the farm that vacuum cools the lettuce and then ships it to markets. Vacuum cooling is a process in which tender leaves are cooled by rapid evaporation of water.

Quality control for insect contamination and visual appeal must be extraordinarily high as lettuce does not undergo further processing before arriving at the consumer’s dinner table.

Pests are ranked in order of importance to the lettuce industry, with weeds being foremost, closely followed by diseases and then followed by insects. Within sections, pests are ranked by importance in descending order.

**Weeds**

**Description**

Weeds compete with lettuce seedlings for nutrients, sunlight, water, and space. Weeds may severely impact harvest operations by interfering with the cutting of lettuce plants, reduce crop value due to contamination with weed seed or plant parts, as well as serving as a reservoir for insects and disease pathogens. Lambsquarter, prickly lettuce and pigweed particularly serve as aphid reservoirs. Common grass weeds include annual bluegrass (*Poa annua*), quackgrass (*Elytrigia repens*), Italian ryegrass (*Lolium multiflorum*), and barnyardgrass (*Echinochloa crus-galli*). Broadleaf weeds such as horsetail (*Equisetum spp.*), shepherdspurse (*Capsella bursa-pastoris*), mayweed chamomile or dog fennel (*Anthemis cotula*), common groundsel (*Senecio vulgaris*), mustard (*Brassica spp.*), purslane (*Portulaca oleracea*), common lambsquarters (*Chenopodium album*), common chickweed (*Stellaria media*), knotweeds/smartweeds (*Polygonum spp.*), henbit (*Lamium amplexicaule*), and redroot pigweed (*Amaranthus retroflexus*) are common. Common groundsel and common lambsquarters are becoming a more serious problem each year because registered herbicides are not adequate for their control. Yield losses due to weeds can reach 100% without control.

**Controls**

**Cultural - general strategy**

Crop rotations are carefully planned to ensure that fields returned to lettuce production are not heavily contaminated with weed seed. Direct-seeded lettuce requires at least two mechanical cultivations between the rows and hand-thinning/weeding within the row. Transplanted lettuce requires one or two cultivations and usually only a quick hand weeding. Mechanical cultivation is usually not done until lettuce seedlings are over 2 inches tall, as
some soil is pushed into the row by the equipment. Control of small (2- to 4-leaf) weeds with cultivation is usually very good. If weeds are too large, however, or if rainfall occurs too soon following tillage, cultivation is less effective.

Hand-weeding costs range from $50 to $200 per acre, depending upon the severity of the infestation. Most growers use some amount of hand labor for weeding lettuce fields since herbicides rarely control all the weeds in a field. Herbicides, however, may significantly reduce the weed population, making hoeing crews more efficient and less expensive.

**Chemical - stale seedbed method**

**Glyphosate** (various trade names, 0.25 to 0.5 lbs. ai/a). Glyphosate is most often used as a preplant application on actively growing weeds in conjunction with site preparation. The idea of a stale seedbed is to reduce the supply of non-dormant weed seed in the top inch or so of the soil. Weed seeds buried deeper than that generally do not germinate anyway. Seedbeds are prepared and weed seeds near the surface are allowed to germinate prior to seeding/transplanting the crop. These weed seedlings are then killed with a glyphosate application. Within three to five days after treatment, lettuce usually is seeded/transplanted. Tillage after glyphosate application is not recommended, since tillage will bring up buried weed seeds that could then germinate and infest the crop. Glyphosate may also be used after seeding but prior to emergence of the crop, but only emerged weed seedlings will be controlled. There is no soil activity of this product. Glyphosate is a particularly effective herbicide if perennial weeds are a problem in the field, as a foliar application translocates to roots to control many perennial species that cannot effectively be controlled by other registered herbicides. Horsetail, however, is very tolerant to glyphosate.

**Paraquat** (Gramoxone Extra at 0.47 to 0.94 lbs ai/a). Paraquat is a restricted-use pesticide used as a preplant application on actively growing weeds in conjunction with site preparation. Use of paraquat will be similar to that of glyphosate, above. Paraquat is strictly a contact herbicide that does not translocate in the plant, so perennial weeds are only suppressed from one application. Paraquat provides excellent control of most seedling weeds, as well as good burn-down of emerged perennial weed species, including horsetail. It also helps control weed species that tolerate low rates of glyphosate and are sometimes troublesome in lettuce fields such as willowweed (*Epilobium* spp.), mallow (*Malva neglecta*), and dandelion (*Taraxacum officinale*). There is no soil activity of this product in most cases.

Both of these chemicals are critical uses to the industry. While glyphosate poses less risk to the applicator it does not adequately control all weeds that trouble the industry.

**Chemical - preplant, preemergence and postemergence applications**

**Pronamide** (Kerb 50W at 1-2 lbs. ai/a). 55 day PHI. Pronamide is a restricted-use pesticide for leaf or head lettuce, usually applied preemergence, shortly after seeding. Rainfall-incorporation or irrigation within is required to prevent volatilization and loss from the soil. Pronamide does not have postemergence activity, but can be applied to head lettuce immediately following hand-weeding/tillage, after thinning of direct-seeded head lettuce, or following transplanting of head lettuce, provided that soil is weed-free. Pronamide has some activity on several species of broadleaf weeds as they germinate (such as common chickweed, common lambsquarters, henbit, and the knotweeds), but is generally stronger on grasses. Pronamide controls quackgrass only when applied in winter/early spring when plants are dormant. Common groundsel is not controlled by pronamide. Pronamide works best when soil temperatures are less than 55°F; the warmer the soil temperature, the more quickly the herbicide dissipates. Consequently, season-long weed control is not always possible.

**Sethoxydim** (Poast at 0.1 to 0.3 lbs. ai/a). 15 day PHI for leaf lettuce, 30 day PHI for head lettuce. Sethoxydim is a herbicide that gives excellent control of many annual grass species, but has no activity on broadleaf weeds. Annual bluegrass is tolerant to sethoxydim, and quackgrass (a perennial) is suppressed, but not killed. In a short season crop like lettuce, however, suppression is
often adequate. A nonphytotoxic crop oil at 2 pints per acre must be mixed with sethoxydim. Sethoxydim is not widely used because broadleaf species are more prevalent than grasses in this production region. Weed pressure from foxtail (*Setaria* spp.), bentgrass (*Agrostis* spp.), or volunteer grains (wheat, barley, rye), however, can be locally heavy and if the grass does come up in the lettuce, the only effective herbicide currently available is sethoxydim.

**Bensulide** (Prefar 4E at 5 - 6 lbs. ai/a). Bensulide is a preplant-incorporated herbicide that can be used in direct-seeded lettuce. Only four weed species relevant to Washington production are listed on the Bensulide label: common lambsquarters, purslane, redroot pigweed, and barnyardgrass. Because most common weeds are not adequately controlled by bensulide used alone, the product is generally most useful as a combination treatment with another herbicide. Bensulide must be incorporated within 36 hours of application for optimal weed control; incorporation may be accomplished using either tillage equipment or by rainfall/irrigation.

**Benefin** (Balan DF at 1.12 -1.5 lbs. ai/a). Benefin is a preplant-incorporated herbicide that can be used in direct-seeded lettuce. Benefin has activity on a few annual broadleaf weed species (such as common chickweed, knotweeds, common lambsquarters, purslane, and redroot pigweed) and many annual grasses (annual bluegrass, barnyardgrass, and Italian ryegrass). Many of our common broadleaf weeds are not adequately controlled by benefin. Benefin must be mechanically incorporated within 4 to 8 hours of application (prior to seeding) for optimal weed control.

Together, these herbicides are critical uses to the industry as each fills a niche in production systems. Critical needs for this industry include postemergence herbicides that control mid- and late-season weed flushes. Registrations for additional products would be very helpful to growers because weed populations are constantly shifting and weed species that are not currently a problem can increase to sizeable infestations within only a few years. Most registered products are fairly old, and use rates are high (up to 2 lbs. ai/a of Kerb or 6 lbs. ai/a of Balan per treatment).

### Diseases

#### BOTTOM ROT

*Rhizoctonia solani*

This fungal disease is widespread, occurring most often on muck soil. It commonly attacks ‘Big Boston’ types of head lettuce. The disease appears as heads approach maturity. Necrotic spots appear on stems and midribs of lower leaves and may enlarge over the entire stem. A brown exudate appears on the surface of the spots, and the infection continues to produce sunken brown spots. The fungus may advance through the leaf blade until the entire head is destroyed. Brown sclerotia develop near leaf axils, and the fungus may produce a noticeable network of growth around the head. The head becomes slimy and dries to a blackened mummy. Bacterial soft rot often follows bottom rot invasion. Under severe disease pressure, heads are unmarketable, but even under less favorable conditions, the extra trimming required to remove infected leaves reduces head weight and size and influences packaging and marketability. Up to 100% of the acreage can be affected in favorable years. The disease can occur each year and usually affects less than 5% of the crop due to the use of fungicide spray programs. Losses can reach 50-100% if fields are not treated, however. All types of lettuce, and escarole and endive are hosts for this disease.

#### Controls

**Cultural**

Plowing instead of disking buries sclerotia.

**Chemical**

**Iprodione** (Rovral 50 WG at 0.75 - 1 lbs. ai/a). 14 day PHI. Application in not less than 40 gallons per acre water nor more than 3 times per crop. It is applied at the 3-leaf stage of growth and again 10 days later. A third application can be made in another 10 days if disease pressure persists. This product is a critical use to the industry.
Vinclozolin (Ronilan 50 DF at 0.5-1 lbs. ai/a). 28 day PHI. Application in not less than 100 gallons per acre water or more than 6 pounds per acre per year. It is applied within 2 days of thinning or 7 to 10 days of transplanting. Up to two additional applications can be made at 14-day intervals on direct-seeded lettuce; one additional application can be made on transplants. This product is important to the industry although not as useful an alternative as Rovral since PHI is longer.

Downy Mildew
*Bremia lactucae*

This disease is distinguished by light green or yellowish areas on the upper leaf surface and downy patches on the undersurface. The downy growth results when the fungus produces spores. Affected parts turn brown, and leaves die. Early infections may lead to systemic infection, resulting in discoloration of the vascular stem tissues. The pathogen overwinters on wild hosts and weeds. It is serious in field-grown winter crops as well as in greenhouses, and causes severe diseases during damp, foggy weather between 43° and 53°F. Insensitivity to metalaxyl is widespread in *Bremia* populations in other lettuce-growing areas but has not been studied in Washington. Up to 100% of acres can be affected each year, especially in early spring and fall crops. Approximately 10% yield loss can occur, mainly due to crop appearance. Wild and cultivated lettuce species serve as hosts.

**Controls**

*Cultural*

Growers use thorough cultivation practices, particularly controlling weeds in the vicinity, because other *Lactuca* species are hosts. Management of sprinkler irrigation is practiced so that leaves have time to dry.

*Host Resistance*

Resistant strains of lettuce, such as those developed in the Imperial Valley, are used. ‘Bullseye’ (II, III), ‘Target’ (I, III), ‘Dynasty’ (I), ‘Bounty’ (I), ‘Alpine’ (I), and ‘Salinas’ (I) are resistant to the respective strains noted in the parentheses. The cos cultivar, ‘Valmarie’ is tolerant. Washington growers report that resistance seems to break down in a few years. This is consistent with what has been reported elsewhere.

**Chemical**

*Fosetyl Al* (Aliette 80 WDG at 1.6-4 lbs. ai/a). 3 day PHI. Applications are on a 7-21 day interval and are limited to no more than 7 per year. To reduce leaf speckling, pH is adjusted to 6.0 or higher when long periods of wet weather are expected. Cannot be used in greenhouses.

*Mancozeb* (Maneb 75 DF at 1.125-1.5 lbs. ai/a). 10 day PHI. No more than 9.6 pounds active ingredient are allowed per year. To minimize the risk of residues, leaves are stripped and trimmed from head lettuce at harvest.

*Metalaxyl* (Ridomil 2E). Ridomil 2E is registered in Washington but not available due to phase out into the Ridomil Gold product line. Product is applied by broadcasting and incorporating to a depth of 2 inches, or in a 7-inch band, if *Pythium* is a problem. If head lettuce is planted in beds, applications are broadcast and incorporated into the soil before the beds are formed.

*Mefenoxam* (Ridomil Gold EC at 1-2 lbs. ai/a). Can be used for downy mildew control. Applied primarily to control *Pythium* damping-off, it offers some control of downy mildew on young plants. However, to minimize the development of Ridomil-resistant fungi, foliar applications of Ridomil are not made if Ridomil was applied at planting. A separate 24c registration (WA970002 at 0.06-0.125 lbs. ai/a) is also used. It has a 7-day PHI and is only for use as a tank mix with other fungicides on head lettuce. Used as a preventative foliar application with a limit of two applications per crop. Prohibited if downy mildew is already present. Not used if already applied at planting. Its use is prohibited in greenhouses.

These chemistries are all critical to the industry for resistance management. Without alternation of chemistries, resistant strains would overcome single chemicals and within one year subsequent to that the entire Washington industry would collapse due to disease pressure.
**DAMPING-OFF**

*Pythium ultimum* and *Rhizoctonia solani*

These and other soil-dwelling fungi attack seedlings of many different crops. Seedlings may be attacked before or after they emerge from the soil, resulting in gaps and uneven stands. Young plants suddenly wilt and topple over. Water-soaked lesions are apparent on stems at the soil line. As seedlings mature, they become resistant to attack. The disease can be a serious problem in cool, wet soils. The disease can occur on up to 100% of acres during a favorable year and can result in a 5-10% loss. It can also affect greenhouse-grown transplants.

**Controls**

**Cultural**

Growers are attentive to greenhouse watering schedules to minimize favorable conditions for the disease.

**Chemical**

*Metalaxyl* (Ridomil 2E). Ridomil 2E is registered in Washington but not available due to phase out into the Ridomil Gold product line. Product is applied by broadcasting and incorporating to a depth of 2 inches, or in a 7-inch band, if *Pythium* is a problem. If head lettuce is planted in beds, applications are broadcast and incorporated into the soil before the beds are formed.

*Mefenoxam* (Ridomil Gold EC at 1-2 lbs. ai/a). Applied primarily to control *Pythium* damping-off, it offers some control of downy mildew on young plants. However, to minimize the development of Ridomil-resistant fungi, foliar applications of Ridomil are not made if Ridomil was applied at planting. A separate 24c registration (WA970002 at 0.06-0.125 lbs. ai/a) is also used. It has a 7-day PHI and is only for use as a tank mix with other fungicides on head lettuce. Used as a preventative foliar application with a limit of two applications per crop. Prohibited if downy mildew is present. Not used if already applied at planting. Its use is prohibited in greenhouses.

*Fosetyl-Al* (Aliette 80 WDG at 1.6-4 lbs. ai/a). 3 day PHI. Application are made on a 7-21 day interval and are limited to no more than 7 per year. To reduce leaf speckling, pH is adjusted to 6.0 or higher when long periods of wet weather are expected. Cannot be used in greenhouses.

These are critical uses to the industry. Registration of efficacious compounds that can be applied to greenhouse seedlings is a critical need for the industry.

**ANTHRACNOSE**

*Microdochium panattonianum* (formerly *Marssonina panattoniana*)

This fungus overwinters on crop refuse or in soil as microsclerotia and can survive in soil as long as four years. This pathogen affects all lettuce cultivars as well as several *Lactuca* weed species including prickly lettuce (*L. serriola*). The disease is important only during prolonged periods of wet weather when it may cause heavy losses. It can occur each year and up to 100% of the acreage can be affected when weather is favorable. Yield losses due to quality damage can reach 50-100%, but losses usually approach 25% in wet springs and <1% in dry springs. It is usually the first planting that sustains significant loss; damage is usually not a problem on second and third plantings.

(continued)
Controls

Cultural

Growers avoid cultivating during wet weather and practice deep plowing after harvest to minimize soil compaction and sclerotia survival. Prickly lettuce and other weed hosts are controlled within the lettuce fields. Growers practice greenhouse sanitation including treating benches and seedling trays with a dilute bleach solution and removing and destroying infected seedlings promptly.

Host Resistance

Resistant varieties such as green leaf, bibb, or red leaf types are not heavily utilized since they are not profitable. Susceptible varieties such as Romaine and head lettuce types drive market demands.

Chemical

Mancozeb (Maneb 75 DF, at 1.125-1.5 lbs. ai/a). 10 day PHI. Maneb is registered for downy mildew control on lettuce and is reported to give some anthracnose control, unless disease pressure is severe. A total of 9.6 lbs. ai/a are allowed per year. This is a critical use for the industry as there are no other registered products for control of this disease. The registration of other products effective against this disease is a critical need for the industry. Efficacy data has been generated for registration of Quadris, which is not as effective as mancozeb in controlling anthracnose. Without any chemical controls, the lettuce industry would be unable to survive even a single season.

DROP (WATERY SOFT ROT)

Sclerotinia sclerotiorum and S. minor

Both Sclerotinia sclerotiorum and S. minor are the causal organisms of “drop.” The disease overwinters on lettuce refuse on the ground and as sclerotia in soil. There are two phases: the damping-off phase, which attacks seedlings, and the important field phase called “drop,” which causes a watery, soft rot. Both are severe whenever lettuce is grown under cool, moist conditions, particularly under short rotations. Under moist conditions, outer leaves wilt, and there is a slimy rot of the plant. The drop phase appears in midsummer or later after leaf wilt; it begins with the oldest leaves and continues until the plant collapses. Up to 100% of acres can be affected and losses of 1% occur on an annual basis. This is an emerging disease that is expected to result in a larger percentage of losses in the near future.

Controls

Cultural

Corn, cereals, grasses, onions, table beets, and spinach are not susceptible and make good rotation crops in some situations, but these rotation crops are not economically feasible for south-western Washington fields.

Host resistance

All lettuce cultivars tested have been susceptible to this disease to varying degrees.

Chemical

Vinclozolin (Ronilan 50 DF at 0.5-1 lbs. ai/a). 28 day PHI. Application in not less than 100 gallons per acre water, applied within 2 days of thinning or 7 to 10 days of transplanting. Up to two more applications can be made at 14-day intervals on direct-seeded lettuce; one more application is made on transplants. Applications cannot exceed more than 6 pounds per acre per year.

Iprodione (Rovral 50 WG at 0.75-1 lbs. ai/a). 14 day PHI. Application in not less than 40 gallons per acre water, applied at the three-leaf stage of growth and again 10 days later. A third
application can be made 10 days later if disease pressure persists. No more than three applications per crop. Fields should not be cultivated after application. It is a critical use to growers since the PHI is shorter than vinclozolin.

---

**Varnish Spot**

*Pseudomonas cichorii*

This soilborne bacterium can survive in soil for some time after the lettuce crop is removed. The source of the inoculum is unclear—possibly surface water used for irrigation or insects. Usually only a few fields are affected, but the disease has been more prevalent during the last few years. Dark brown, firm, necrotic spots a few millimeters in diameter occur on leaves and petioles of lettuce several layers within the head. Because outer layers of leaves are rarely affected, the disease is usually impossible to detect without destroying the head. This bacterium infects numerous hosts including lettuce, chicory, endive, cabbage, cauliflower, chrysanthemum, tobacco and celery.

### Controls

**Cultural**

Several years of crop rotation to non-hosts are recommended, but Washington growers are unable to practice adequate rotation because of constraints on land availability. Carefully managing overhead irrigation before harvest may help minimize the disease.

**Chemical**

Not available. This is a critical need for the industry.

---

**Mosaic**

The lettuce mosaic virus is the cause; it is transmitted by seed and by the green peach aphid. Chemical controls are not effective against the virus itself but are aimed against the aphid vector. Aphids transmit the virus from infected plants, primarily weed hosts. In young plants, the seedling leaves roll up on the long axis and the first true leaf is irregularly shaped and slightly lobed. Vein clearing and bronzing follow; bronzing is caused by necrotic flecking of the leaf blade, especially along the veinlets. Symptom expression varies with variety and climatic factors. It is one of the most potentially damaging diseases of lettuce. Up to 100% of the acreage can be affected if the disease is not managed properly although generally, this disease has not been a problem in Washington because prickly lettuce and other weed hosts are managed. Weed and ornamental species in the lettuce family are hosts.

### Controls

**Cultural**

Using disease-free seed is the best means of control. Classic studies have established tolerance thresholds of 0 infected seeds in 30,000. Planting cultivars not tested for mosaic in the same field with tested material is avoided. Weed control, particularly wild lettuce near the planting, is practiced. Diseased plants are rogued whenever apparent.

**Chemical**

See aphid control in the Insect section, following.

### Other Issues

Lettuce seed germination rates are often affected by seed treatment compounds. Thiram, an industry standard, is known not to affect germination rates, but other chemicals have not been tested by the industry. At present, it would be cost prohibitive to index each lettuce variety with new compounds, such as Maxim, that are registered on lettuce seed.

The lettuce industry has identified a need for new compounds to control *Rhizoctonia*, *Sclerotinia*, powdery mildew and anthracnose in the field, and damping off and downy mildew in the production of greenhouse transplants.
Insects

**APHIDS**

Green peach aphid, *Myzus persicae*
Lettuce root aphid, *Pemphigus bursarius*
Lettuce aphid, *Acyrthosiphon lactucae*

Small, soft-bodied insects, yellowish-pink to pale green. Aphids suck plant sap from foliage causing a yellowing or wilting of the plant and a sticky “honeydew” exudate. In addition, aphids can vector several viruses. Aphids appear annually in lettuce production fields; the 1999 growing season had a late infestation of aphids that were impossible to control. Yield losses are generally <2% under normal management including chemical controls. Losses can range from 75%-100% without the timely use of chemical controls.

Lettuce and related weeds are hosts to the lettuce aphid. There are many hosts of the green peach aphid. Poplar tree is a host to the lettuce root aphid. There are no registered chemicals for control of root aphid on lettuce; it is generally managed by avoiding planting near poplar plantations. As land constraints mount, this pest may become more of an issue.

**Controls**

**Cultural**

Lettuce fields are not planted adjacent to poplar plantations and weed control in fields is emphasized.

**Chemical**

*Endosulfan* (various trade names at 0.75-1 lbs. ai/a). 14 day PHI. Applied when insects first appear or when feeding is noticed. Growers cannot exceed three applications after thinning of head lettuce, and must remove wrapper leaves at harvest. No more than two applications per year can be made to leaf lettuce. Cannot exceed 3 lbs. ai/a per year.

*Acephate* (Orthene 75S at 0.5-1 lbs. ai/a). 21 day PHI. Product is registered for crisp head lettuce only. A total of 6.66 lbs./acre/year cannot be exceeded.

*Lambda-cyhalothrin* (Warrior T at 0.02-0.03 lbs. ai/a). 1 day PHI. Limited to 0.3 lbs. ai/a per season. Growers often make two applications of Thiodan early in the season and then use Warrior for a late season spray as its PHI works with the necessity of having to pack insect-free lettuce.

This trio of insecticides controls all of the insects of economic importance to the lettuce industry. Applications of these chemicals to control one insect generally serve to control all of them, particularly following the spray regime outlined above. In some locations green peach aphid has shown resistance to endosulfan, so it is important to maintain registrations of acephate and lambda-cyhalothrin for resistance management.

**WESTERN SPOTTED CUCUMBER BEETLE**

*Diabrotica undecimpunctata*

These yellowish-green, black-spotted beetles attack seedlings and feed on foliage. Adults are 6 to 7 millimeters long. Cucumber beetles can transmit bacterial wilt and cucumber mosaic virus. There are potential losses of 100% if the beetles are not managed. Yield loss with management is generally < 2.5%. Cucumber beetles were a problem when peas and cucumbers were grown in lettuce growing areas. Now the beetles appear sporadically because these crops no longer adjoin lettuce fields.

**Controls**

**Cultural**

Lettuce fields are not planted adjacent to pea and cucumber fields.

**Chemical**

*Lambda-cyhalothrin* (Warrior T at 0.02-0.03 lbs. ai/a). 1 day PHI. No more than 0.03 lbs. ai (2.4 pints) are allowed per acre per year. Sprays used to control aphids also serve to control cucumber beetle.
CUTWORMS AND ARMYWORMS

several species including
Spotted Cutworm, *Acanthoscelides obtectus*, and
Western Yellowstriped Armyworm, *Spodoptera praefera*

Red, brown, and green worms that feed on stems and leaves. They can usually be found in the soil during the day but usually only on field edges. A sporadic pest that even at field margins can periodically wipe out a substantial amount of lettuce.

Controls

**Chemical**

Endosulfan (various trade names at 0.75 lbs. ai/a). 14 day PHI. Product is applied when insects appear or feeding is noticed. No more than three applications can be made after thinning of head lettuce, and wrapper leaves need to be removed at harvest. No more than two applications per acre per year can be made on leaf lettuce. A maximum of 3 lbs. ai/a per year cannot be exceeded.

Acephate (Orthene 75S at 1 lbs. ai/a). 21 day PHI. Registered on crisp head lettuce only. A maximum of 6.66 pounds per acre per year cannot be exceeded.

Lambda-cyhalothrin (Warrior T at 0.015-0.025 lbs. ai/a). 1 day PHI. Limited to 0.3 lbs. ai/a per season.

This trio of insecticides controls all of the insects of economic importance to the lettuce industry. Applications of these chemicals to control one insect generally serve to control all of them, particularly following the spray regime mentioned above.

 LOOPERS

Alfalfa Looper, *Autographa californica*

Cabbage Looper, *Trichoplusia ni*

Worms are slender, dark olive green with paler head. They’re marked with three dark stripes and move in a looping manner. These pests are very rare as the regular spray program of Thiodan, Orthene, and Warrior used for other insect problems also takes care of looper. Losses may reach up to 100% however, if control measures are not followed.

Controls

**Chemical**

Endosulfan (various trade names at 0.75 lbs. ai/a). 14 day PHI. Applied when insects appear or when feeding is noticed is registered. No more than three applications can be made after thinning of head lettuce; wrapper leaves need to be removed at harvest. No more than two applications per acre per year can be made to leaf lettuce. Cannot exceed a maximum of 3 lbs. ai/a per year.

Acephate (Orthene 75S at 0.5-1 lbs. ai/a). 21 day PHI. Registered for crisp head lettuce only. A maximum of 6.66 lbs./acre/year cannot be exceeded.

Lambda-cyhalothrin (Warrior T at 0.02-0.03 lb. ai/a). 1 day PHI. Limited to 0.3 lbs. ai/a per season.

This trio of insecticides controls all of the insects of economic importance to the lettuce industry. Applications of these chemicals to control one insect generally serve to control all of them, particularly following the spray regime mentioned above. While *Bacillus thuringiensis* (Bt) sprays will control young loopers, aphids and *Lygus* spp. are not controlled, except by the insecticides listed above. Therefore Bt is not used by growers.

(continued)
**TARNISHED PLANT BUG**  
*Lygus lineolaris*

Attacks the head of lettuce, causing small holes with brown margins in the leaves. Damage can be sufficiently severe to make the heads unmarketable. This insect problem is noted every few years, usually later in the summer months. Potentially 100% of the acreage can be affected without appropriate management.

**Controls**

**Cultural**  
Lettuce fields are not planted next to alfalfa fields.

**Chemical**  
*Lambda-cyhalothrin* (Warrior T at 0.02-0.03 lbs. ai/a). 1 day PHI. Limited to 0.3 lbs. ai/a per season. Sprays used to control aphids also serve to control tarnished plant bug.

**Additional Issues**

Cultural controls such as crop rotation, which could be useful in decreasing disease incidence, are not widely available to this industry due to severe limits on land availability. As a consequence, this industry is heavily reliant on chemical controls to keep pest populations low. Newer, softer chemistries are a critical need. Growers want to become certified under programs such as Fred Meyer’s ‘Nutriclean’, but many current product residues preclude them from doing so. New chemical registrations however, are extremely difficult to obtain for leafy vegetables. Head lettuce registrations are somewhat easier to obtain since heads are tightly closed during application season and outer wrapper leaves that may carry any residues are stripped off before shipping to market. The consuming public however, is demanding open-headed types such as leaf and romaine lettuces.

**Authors**

Dr. Debra Ann Inglis and Erick Vestey  
Washington State University  
Mount Vernon Research and Extension Unit  
16650 State Route 536  
Mount Vernon, WA 98273-9761  
Phone (360) 848-6120  
Fax (360) 848-6159  
Email: dainglis@wsu.edu  
URL: [http://mtvernon.wsu.edu/plant_pathology/plant_path.htm](http://mtvernon.wsu.edu/plant_pathology/plant_path.htm)

**Acknowledgements**

We thank Jim Kropf, Frankie Porter, and Ron Sasaki for reviewing this profile.
Technical Contacts

Diseases
Dr. Debra Ann Inglis
Washington State University
Mount Vernon Research and Extension Unit
16650 State Route 536
Mount Vernon, WA 98273-9761
Phone (360) 848-6120
Fax (360) 848-6159
Email: dainglis@wsu.edu
URL: http://mtvernon.wsu.edu/plant_pathology/plant_path.htm

Insects
Dr. Arthur Antonelli
WSU Puyallup
7612 E. Pioneer Way
Puyallup, WA 98371-4998
Phone (253) 445-4545
Fax (253) 445-4621
Email: antonell@wsu.edu

Weeds
Dr. Tim W. Miller
Washington State University
Mount Vernon Research and Extension Unit
16650 State Route 536
Mount Vernon, WA 98273-9761
Phone (360) 848-6120
Fax (360) 848-6159
Email: twmiller@wsu.edu

References
5. Personal communication with Ms. Frankie Porter, Wilbur Ellis, Auburn, WA. March 17, 2000, and July 12, 2000.
6. Personal communication with Mr. Ron Sasaki, Orting, WA. January 28, 2000, and July 18, 2000.
7. Personal communication with Mr. Tom Hulbert, Skagit Seed Services, Mount Vernon, WA. July 25, 2000.

August 2000
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.

Copyright 2000 Washington State University

WSU Cooperative Extension bulletins contain material written and produced for public distribution. You may reprint written material, provided you do not use it to endorse a commercial product. Alternate formats of our educational materials are available upon request for persons with disabilities. Please contact the Information Department, College of Agriculture and Home Economics, Washington State University for more information.

You may order publications from the WSU Bulletin office, 1-800-723-1763, or [http://pubs.wsu.edu](http://pubs.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 August 2000. (Publication number MISC0359E.)