Pest Management Strategic Plan
for
Western U.S.
Sugarbeet Production

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Summary of the Most Critical Needs in Western U.S. Sugarbeet Pest Management

(Pest-specific and crop-stage-specific aspects of these needs, as well as additional needs, are listed and discussed throughout the body of the Foundation document following.)

Research Priorities

1. Research how cropping systems impact weed, insect, disease, and nematode issues, as well as soil health and soil tilth in sugarbeets.
2. Research new pesticides for possible use on sugarbeets; this includes new chemistries as well as existing pesticides that are not yet registered on sugarbeets.
3. Research the impacts of tank mixes, adjuvants (e.g., drift agents), and application timing (e.g., pre-plant soil-applied vs. post-emergence) on sugarbeets, rotational crops, and the pest complex.
4. Develop and refine economic thresholds and prediction models for all pests.
5. Research green manures for pest control, nutrient addition to soil, and economic benefits.
6. Evaluate new chemical and non-chemical control systems for pest management (e.g., reduced risk, biological control, replacements for organophosphates).
7. Research the biology of emerging pests and their management (e.g., common mallow, dodder, volunteer potatoes, velvetleaf, yellow nutsedge).

Regulatory Priorities

1. Adjust IR-4 mandate to include crops that fall between major (e.g., corn, soybeans) and minor (e.g., lettuce, carrots) crops.
2. Maintain registration of aldicarb (Temik) for insect and nematode control.
3. Improve collaborations between state departments of agriculture, USDA, EPA, and universities for emerging pest issues.
4. Expedite registration of crop protection tools.
5. Consider resistance management and crop rotation issues in the Section 18 process.
6. Maintain registration of terbufos (Counter) for root maggot and other insects.
7. Expedite seed treatment registrations such as clothianidin (Poncho).

Education Priorities

1. Educate state legislators about the critical lack of research and extension personnel (e.g., entomologists) in the West.
2. Educate growers about the economics of pest management through all stages of sugarbeet production (including storage and processing). This includes the use of green manures, the use of economic thresholds, and the management of weeds during the growing season so they do not cause problems in the storage piles.
3. Educate the public about the need for pest management activities, including the use of biotechnology products (they can be used as an alternative to spraying certain chemicals; they can help make up for the labor shortage and labor costs) and the food safety implications of these products.
4. Educate granting agencies about the importance of providing money for research toward effective and economical pest management options.

5. Develop a sugarbeet production manual that includes pest management activities.
6. Educate growers about the importance of crop rotation to manage pests (including nematodes, weeds, insects, diseases), including an awareness of pest management activities on other crops [e.g., ethofumesate (Nortron)].
7. Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.

Introduction

The Environmental Protection Agency (EPA) is now engaged in the process of re-registering pesticides under the requirements of the Food Quality Protection Act (FQPA). The Agency is examining dietary, ecological, residential, and occupational risks posed by certain pesticides. EPA's regulatory focus on the organophosphate (OP), carbamate, and B2 carcinogen pesticides has created uncertainty as to the future availability of these products to growers. At some point, EPA may propose to modify or cancel some or all uses of these chemicals on sugarbeets. The regulatory studies that EPA requires registrants to complete may result in some companies voluntarily canceling certain registrations for sugarbeets.

The Endangered Species Act (ESA) mandates that Federal agencies such as EPA consult with the National Oceanic and Atmospheric Administration (NOAA-Fisheries) if that agency takes an action that may affect threatened or endangered species. Lawsuits have been filed against EPA stating that they failed to complete this consultation process. The result of one of these lawsuits is that mandatory no-spray buffer zones have been imposed for certain pesticides in salmonid habitat in Washington, Oregon, and California. Other threatened and endangered species are located throughout sugarbeet growing regions and there are likely to be further no-spray buffer requirements, whether lawsuit-mandated or resulting from the consultation process. Because they are not in general use, no one knows the impact of buffer strips on agro-ecosystems or the pest complex. Whether planted to crops, planted to vegetation that is habitat for beneficial insects, abandoned to weeds, or managed for other values, buffer strips have great potential to play a positive or negative role in the pest complex. If pest management needs in buffer areas are not addressed or understood, growers may simply resort to cultivation to keep buffer zones free of weeds, a practice that if not done properly may lead to increased sediment loads in streams.

The total effects of ESA implementation and FQPA re-registration are yet to be determined. Clearly, however, new pest management strategies will be required in the sugarbeet industry.

In a proactive effort to identify pest management priorities and lay a foundation for future strategies, sugarbeet growers, industry representatives, crop consultants, members of federal agencies (e.g., USDA-ARS, USEPA) and university specialists from Colorado, Idaho, Montana, Oregon, Washington, and Wyoming formed a work group and assembled the following document. The growing regions represented by this document are contiguous with areas in western Nebraska and western North Dakota where sugarbeets are grown. Therefore, these states are included in the description of growing regions, although they were not represented in the work group. Members of the group met for two days in December 2004, in Boise, Idaho, where they discussed the FQPA and possible pesticide regulatory actions and drafted a document containing critical needs, general conclusions, activity timetables, and efficacy ratings of various management tools for specific pests. The resulting document was reviewed by the workgroup, including additional people who were not present at the meeting. The final result was this document, a comprehensive transition foundation addressing many pest-specific critical needs for the sugarbeet industry in the western United States.

The document begins with a region-by-region overview of sugarbeet production in the western states, followed by discussion of critical production aspects of this crop including the basics of Integrated Pest Management (IPM) in sugarbeets. The remainder of the document is an analysis of pest pressures during the production of sugarbeets, organized by crop life stages. Key control measures and their alternatives (current and potential) are discussed. Differences between production regions represented are discussed where appropriate.

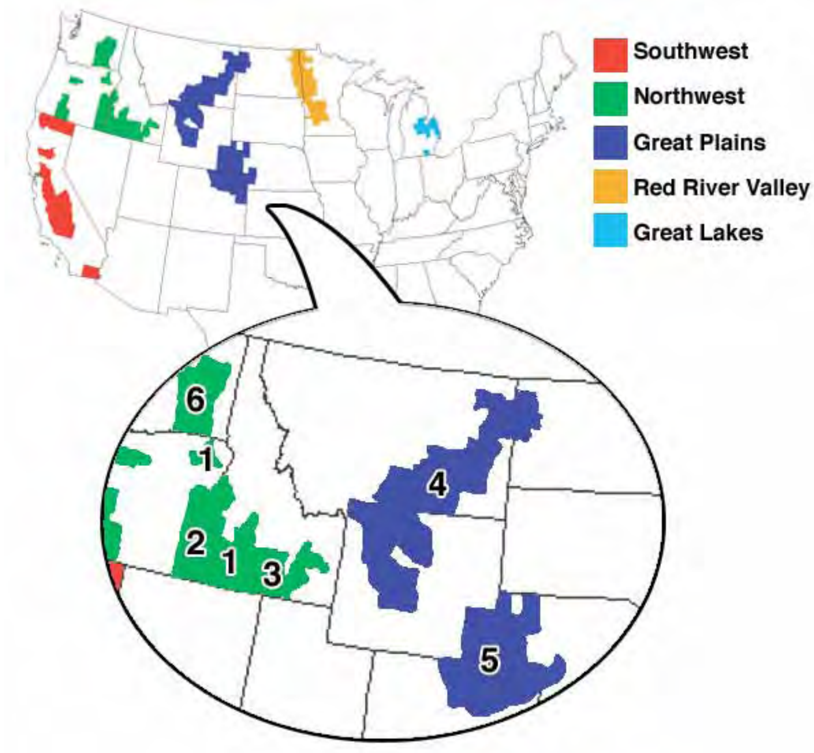
Each pest is mentioned in the crop stage in which IPM, cultural controls (including resistant varieties), chemical controls (including seed treatments and pre-plant pesticide treatments), or damage from that pest occurs. Descriptions of the biology and life cycle of each pest are described in detail under the crop stage(s) in which they are present. Within each major pest grouping (nematodes, weeds, diseases, and insects), individual pests are presented in alphabetical order, not in order of importance.

Production of sugarbeets grown for seed is not covered by this document.

The use of trade names in this document does not imply endorsement by the work group or any of the organizations represented. Trade names are used as an aid in identifying various products.

Western U.S. Sugarbeet Production Overview

Production Regions



The adjacent map shows, at top, the sugarbeet growing regions in the United States, according to the USDA Economic Research Service as of 2000. The oval enlargement map has been overlaid with numbers corresponding to the sugarbeet growing regions addressed in this document. We have assigned these numbers, 1 through 6, in order of production ranking among the regions.

Region 1: Magic Valley (South Central Idaho) and La Grande (Northeastern Oregon)

Idaho

The major growing area for sugarbeets in Idaho, and the highest producing area represented in this document, is in the southern part of the state along the Snake River Plain. The Magic Valley includes Blaine, Cassia, Gooding, Jerome, Lincoln, Minidoka, and Twin Falls counties. This area produced 3,691,000 tons of sugarbeets in 2003 and harvested a total of 129,000 acres. Idaho ranks 2nd in the nation in sugarbeet production, and the majority of Idaho sugarbeet acres (62%) are in the Magic Valley.

Oregon

La Grande, Oregon (Union County) is not contiguous with the Magic Valley of Idaho, but their growing practices and pest issues are similar, so it was placed in the same growing region for purposes of this document. La Grande produced 51,000 tons of sugarbeets in 2003, and harvested 2,100 acres.

Region 2: Treasure Valley (Western Idaho and Eastern Oregon)

Idaho

Adjacent to the Magic Valley, and also along the Snake River Plain, the Treasure Valley includes Ada, Canyon, Elmore, Owyhee, Payette, and Washington counties. The Treasure Valley produced a total of 1,209,000 tons of sugarbeets in 2003, and harvested a total of 40,300 acres (19% of Idaho's total acres).

Oregon
Oregon is ranked 10th nationally in sugarbeet production, and the majority (74%) of that production is in Malheur County in the Treasure Valley. Malheur County produced 232,155 tons of sugarbeets on 7,370 acres in 2003.

Region 3: Upper Snake River Valley (Eastern Idaho)
Bingham and Power counties account for 18% of Idaho sugarbeet acres. In 2003, these two counties produced 1,145,000 tons of sugarbeets on 37,300 harvested acres.

Sugarbeets grown in Regions 1, 2, and 3 are shipped to and processed by the Amalgamated Sugar Company, a grower-owned cooperative with factories located in Mini-Cassia, Twin Falls, and Nampa, Idaho. At the time of this workshop there was a factory in Nyssa, Oregon. It closed in the winter of 2004 to 2005, and sugarbeets previously shipped to this factory will now ship to Nampa, Idaho.

Region 4: Montana, Northwestern Wyoming, and Western North Dakota

Montana
Montana is ranked 6th in the nation for sugarbeet production, with a total of 1,308,000 tons produced on 51,500 harvested acres in 2003. The major growing areas for Montana sugarbeets are in the sandy loam soils along the Yellowstone River and its tributaries, from Park City in the west to the Hardin area in the south to Sidney in the east. Northeastern Montana counties include Dawson, Richland, Roosevelt, and Sheridan; south central counties include Big Horn, Carbon, Stillwater, Treasure, and Yellowstone; and southeastern counties include Custer, Prairie, and Rosebud. Sidney Sugar Company (formerly Holly Sugar, which was purchased by American Crystal Sugar) in Sidney works with growers from Mile City, Montana east into North Dakota. American Crystal is a grower-owned cooperative, but is owned by growers in the Red River Valley (North Dakota). Western Sugar Company, a grower-owned cooperative in Billings, works with growers from Mile City west to Park City, Montana in southeastern and south central counties along the Yellowstone River.

Wyoming
Wyoming is ranked 8th in the nation for sugarbeet production, with 685,000 tons of sugarbeets harvested in northern Wyoming in 2003 on 30,000 acres. Eighty-nine percent of Wyoming sugarbeets are grown in the northwestern part of the state. Sugarbeets in this area of Wyoming are shipped to the Wyoming Sugar Company in Worland, Wyoming. It is a Limited Liability Corporation (LLC). The largest shareholder is the Washakie Beet Growers Cooperative. Wyoming Sugar, Worland Factory, covers Washakie, Park, Big Horn, Hot Springs, and Fremont counties.

North Dakota
North Dakota ranks 3rd in the nation in sugarbeet production, although the majority of North Dakota sugarbeets are produced in the eastern part of the state, outside of the region covered by this document. In western North Dakota (Williams County), 4,700

acres of sugarbeets were harvested in 2003, with a total production of 107,000 tons. While North Dakota sugarbeet production per se is not covered in this document, Williams County is contiguous with the parts of Montana and Wyoming, designated as "Region 4," and is therefore included.

Region 5: Colorado, Southeastern Wyoming, and Western Nebraska

Colorado
Sugarbeet production is found in the following Colorado counties: Adams, Boulder, Kit Carson, Larimer, Logan, Morgan, Phillips, Sedgwick, Washington, Weld, and Yuma. Colorado is ranked 9th in the nation in sugarbeet production, with a total of 644,000 tons harvested from 27,400 acres in 2003.

Wyoming
In 2003, growers in southeastern Wyoming produced 66,800 tons of sugarbeets (out of 752,000 tons for the whole state; see also Region 4) on 3,700 acres. Sugarbeet production in southern Wyoming takes place in Goshen, Laramie, and Platte counties.

Nebraska
Nebraska sugarbeets are all produced in western Nebraska, in an area contiguous with the Colorado and Wyoming counties designated "Region 5" in this document. As with North Dakota in Region 4, Nebraska sugarbeet production is not officially represented in this document, but shares many characteristics with the rest of the region. In 2003, Nebraska produced 861,000 tons of sugarbeets on 42,400 acres. Nebraska ranks 7th in the nation for sugarbeet production.

Sugarbeets in Region 5 are shipped to factories run by the Western Sugar Company in Scottsbluff, Nebraska; Torrington, Wyoming; and Fort Morgan, Colorado. Like many sugar companies in the western United States, Western Sugar is a grower-owned cooperative.

Region 6: South Columbia Basin (Benton County, Washington and Umatilla County, Oregon)
Most Washington State sugarbeet production took place in the central Washington region known as the Columbia Basin until the sugar factory in Moses Lake, Washington closed. Counties then producing sugarbeets included Grant, Adams, Franklin, Lincoln, Walla Walla, and Benton. Currently, sugarbeet production in Washington State is limited to one farm in Benton County, Washington. Five Washington growers harvested 4,000 acres of sugarbeets in 2003, with total production of 161,200 tons of sugarbeets. There is one sugarbeet grower across the Columbia River in Umatilla County, Oregon, who harvested 17,310 tons of sugarbeets from 445 acres in 2003. Sugarbeets grown in the south Columbia Basin were trucked or railed to the Amalgamated Sugar Company storage and processing facility in Nyssa, Oregon until this plant closed during the winter of 2004 to 2005. The sugarbeets will now go to the Nampa, Idaho facility.

Integrated Pest Management

Sugarbeet growers rely on Integrated Pest Management (IPM) for crop production, including such strategies as the use of green manures, fall plowing, and crop rotation.

Green manure crops can effectively manage the sugarbeet cyst nematode (SBCN). Special varieties of SBCN-resistant oil radish (*Raphanus sativus* spp. *oleifera*) and white mustard (*Sinapis alba*) have been developed for enhanced SBCN management. When these crops are grown in nematode-infested soil, they trigger nematode eggs to hatch, but the larvae are unable to develop past the larval stage. These crops can suppress nematodes by simply acting as "non-hosts" and preventing them from reproducing. Green manure crops can also have great influence on soilborne diseases, although the effect will vary depending on the cultivar of green manure crop grown.

Fall plowing can contribute to suppression of soilborne, polyphagous insects such as white grub larvae, wireworm larvae, and certain species of cutworm larvae. Tillage physically injures larvae, exposes them to predators, places eggs deep in the soil profile, and removes a feed source for the larvae and an egg-laying source for the adult. By itself, cultivation is insufficient to reduce densities of these pests to non-economic levels; it must be used as a tactic within an overall IPM system.

Crop rotation impacts future pest management decisions and plays an important role in the economics of the crop. Rotation is essential for the management of difficult-to-control pests and has historically been an integral part of a sugarbeet IPM strategy. Unfortunately, sugarbeet rotations are getting shorter because growers can often make more money on sugarbeets than any of the other crops in the rotation.

Small grains (barley, wheat) offer more and different management opportunities for broadleaf weeds such as kochia (*Kochia scoparia*), which are difficult to control in sugarbeets due to a lack of effective herbicides registered in sugarbeets. Planting grains also offers advantages in disease management and control of wind erosion. Rhizoctonia root and crown rot and Verticillium wilt are examples of diseases that are better managed with grains in the rotation.

Potatoes or dry beans in the sugarbeet rotation will reduce the sugarbeet cyst nematode population more than any other rotational crop. Aldicarb (Temik) applied to dry bean fields at the low rate will stimulate eggs to hatch and the hatching larvae will not survive on beans.

Foundation for the Pest Management Strategic Plan

CROP ROTATION

Sugarbeets are the most sensitive crop in the rotation, so plant-back restrictions of some herbicides are taken into consideration when planning herbicide applications in rotational crops. Herbicides such as rimsulfuron (Matrix), metribuzin (Sencor), and pendimethalin (Prowl), which are used for weed control in potatoes; imazamox (Raptor), trifluralin (Treflan), and ethafluralin (Sonalan), which are used for weed control in dry beans and alfalfa; and imazamethabenz (Assert), which is used in small grains, are effective herbicides, but can persist in the soil and prevent planting sugarbeets following these crops. Likewise, rotational crops following sugarbeets are considered when using ethofumesate (Nortron SC and Etho SC), clopyralid (Stinger), and trifluralin (Treflan) for weed control in sugarbeets, because these herbicides can be detrimental to subsequent crops in the rotation and/or have a plant-back restriction that precludes directly following sugarbeets with certain rotational crops.

In Region 1, a typical rotation is 2 to 3 years long. In the Idaho portion of Region 1 (Magic Valley), the sugarbeets are rotated with small grains, potatoes, alfalfa, dry beans, corn (sweet and field), peas, and/or alfalfa seed; in the Oregon portion of Region 1 (La Grande), the rotational crops are grass seed, mint, small grains, potatoes, alfalfa, dry beans, corn (sweet and field) peas, and/or alfalfa seed. In Region 2 (Treasure Valley), sugarbeets are rotated with small grains, potatoes, onions, corn, beans, alfalfa, peas, and/or seed crops (including alfalfa seed) every 3 to 4 years. Region 3 (Upper Snake River Valley) practices a 3- to 4-year rotation of sugarbeets with small grains, potatoes, corn, and/or alfalfa. In Region 4 (northwestern Wyoming, Montana, and western North Dakota), the sugarbeet rotation is 2 to 4 years, including barley, wheat, corn, dry beans, and/or alfalfa. In Region 5 (western Nebraska, Colorado, and southeastern Wyoming), a typical rotation is 3 years long and includes barley, corn, dry beans, and/or alfalfa. A 3-year rotation is also practiced in Region 6 (southern Columbia Basin), where sugarbeets can be rotated with small grains, onions, sweet corn, peas, and/or grass seed.

Green manures may be planted before or after sugarbeets, but are not considered a rotational crop because they are not planted for harvest.

Critical Needs for Crop Rotation

Research

- Improve understanding of weed, insect, and disease control in rotational crops.
- Research pest management in the entire cropping system.
- Research the economics of pest management in prior crops and determine which crop rotations will provide the most economic benefit.
- Research the economics of cropping systems compared to economics of individual crops.
- Research the effects of different sequences of rotational crops.

- Improve understanding of grain pathogens that may affect sugarbeets (e.g., *Fusarium*).

Regulatory

- Consider the impact of crop insurance and commodity programs on selection of rotational crops (restraints).
- Improve plant-back restrictions on pesticide labels to facilitate crop rotations.
- Improve collaboration among state departments of agriculture, USDA, EPA, and universities on all emerging pest issues.
- Consider resistance management and crop rotation issues in the Section 18 process.

Education

- Work with rotational crops to develop compatible labeling.
- Provide more outreach of results of pest management research.

PRE-PLANT

Pre-plant is defined as the time period after harvest of the previous crop until just prior to planting a new crop of sugarbeets in the spring.

Fall plowing is important in managing some heavier soil types and also assists in pest and pesticide management. The practice helps control weeds and helps dilute remaining pesticide residues in the soil to facilitate breakdown and reduce carryover injury to the subsequent crop. If a green manure crop was planted, plowing it down incorporates the crop into the soil, releasing nutrients and contributing to physical and microbiotic soil improvement, which in turn can contribute to pest control.

Green manures are planted late summer to fall. Green manures are different in each region because of climate differences. Green manure crops provide several benefits to a sugarbeet crop. One of the main reported benefits of using green manure crops is these crops' ability to reduce populations of nematode, weed, and disease pests. Pesticide inputs to beet crops can often be reduced because of the lower pest pressure when following oilseed radish or white mustard crops. Fall-planted green manure crops can also reduce soil erosion and tie up residual nitrogen from the previous crop that might otherwise be leached below the root zone during the winter. Nutrients taken up by the green manure crop are released into the soil after incorporation of the residue, where they become available for uptake by the following crop. When compared to standard rotations, higher quality beet crops are generally grown on soils where oilseed radish or white mustard residues have been incorporated. The residues from these green manure crops add humus that improves soil tilth, water-holding capacity, and nutrient availability.

Nematodes

Several species of nematodes affect sugarbeet production in the Western growing area. Sugarbeet yield losses due to nematodes have been estimated between 10 and 80 percent.

The severity of damage depends on the species of nematode present and population densities in the soil at time of planting. The nematode having the greatest impact on sugarbeet production in Colorado, Idaho, Oregon, Montana, and Wyoming (but not present in the Columbia Basin of Washington) is the sugarbeet cyst nematode (SBCN, *Heterodera schachtii)*. Yield losses can also be attributed to root-knot nematode *(Meloidogyne hapla, M. chitwoodi)* and stubby-root nematode *(Paratrichodorous* spp., *Trichodorous* spp.) and, in Colorado, to the false root-knot nematode *(Nacobbus dorsalis)*, but these occur on a localized basis and are usually not at economically threatening levels.

Damage:
Nematodes parasitize sugarbeets, causing symptoms of nutrient deficiency. Severe infestations may cause death in small seedlings, while surviving sugarbeets are typically small with excessively hairy roots. While the damage is not done at this crop stage, control measures may take place at this stage as nematodes can persist in soil and on plant hosts. Juvenile nematodes of various species can survive on weed hosts and sugarbeet cyst nematodes can survive in the soil for a number of years as cysts containing eggs. More details about damage are provided in the Emergence to Row Closure crop-stage section.

IPM and Cultural Controls:
Growers find that rotating to non-host crops in a three- to four-year rotation scheme aids in managing populations, but in many years treatment is still necessary. Weed control is essential, as certain weed species such as curly dock (*Rumex crispus*), knotweed (*Polygonum* spp.), common lambsquarters (*Chenopodium album*), wild mustard (*Brassica kaber*), nightshade (hairy and black predominate; cutleaf is also a factor; *Solanum sarrachoides*, *S. nigrum,* and *S. triflorum*, respectively), common purslane (*Portulaca oleracea*), saltbush (*Atriplex* spp.), redroot pigweed (*Amaranthus retroflexus*), and powell amaranth (*Amaranthus powellii*) are hosts to nematodes. Another cultural control is the removal of tare dirt, i.e., the dirt and foreign material left behind by the beet piler after harvest.

As discussed in the Integrated Pest Management section earlier in this document, trap (catch) crops such as SBCN-resistant varieties of oil radish and white mustard have been specially developed for cyst nematode management. As the trap crop develops in nematode-infested soil, it triggers the nematode eggs to hatch, but once hatched, they are unable to develop into reproductive adults. To most effectively reduce sugarbeet cyst nematodes, a green manure crop requires eight to ten weeks of growth with soil temperatures above 60º F. This long growing period may be difficult to achieve when frost is expected. Oil radish tolerates frost as low as 22º F, while mustard cannot withstand frosts below 26º F. They can be planted either in early spring or late summer. Often, the green manure crop can be conveniently planted after the grain harvest. If this practice is chosen, planting date for the green manure crop is usually between the last week in July and the last week in August. Fall planting is most common because most producers cannot afford to grow green manure in season.

Soil sampling is done at the Pre-plant stage to identify the quantity of nematodes present in the soil.

Chemical Controls:
1, 3-dichloropropene (Telone II) is applied in Colorado, Idaho, Montana, Oregon, and Wyoming. Application is made by either plowing down or injecting to a depth of 8 inches and sealing the soil immediately. As a soil fumigant, Telone kills almost everything it comes into contact with, and therefore targets all nematode species. There is some work being done with in-row fumigation. Growers get the same basic results as a regular application, using 1/3 less product. The cost of application is approximately the same as using the high rate of aldicarb (Temik), but there is the added benefit of rhizomania and other soilborne disease control. This could either be a result of the fumigation itself, or a result of better overall plant health.

Aldicarb (Temik 15G) is also applied in Colorado, Idaho, Montana, Oregon, and Wyoming. Treatment is usually made in a split application, the first being banded pre-plant, at-plant, or post-plant and incorporated into the soil. The second application depends upon irrigation method. Under furrow irrigation, it is applied by side dressing into the soil on the furrow side of the row after thinning and preceding irrigation; under sprinkler irrigation it is dropped alongside the disk openers on a cultivator. The total in two applications does not exceed 33 lb/A. Temik is effective on all of the nematodes with economic impacts on sugarbeet (i.e., sugarbeet cyst, root-knot, and stubby-root nematodes). The degree of control is affected by timing of application relative to when the nematodes become active in the soil, temperature, susceptibility stage of the crop, and whether or not the applicator can feasibly place the product in the soil where it can be taken up into the plant adequately. Temik will control all species of nematodes but nematode populations must be within thresholds for cyst and root-knot nematodes. Temik will control lesion and stubby root nematodes at higher population levels.

Sugarbeet cyst nematodes are treated with Temik or Telone II. Temik can be used for root-knot and stubby-root nematodes, though sugarbeets are rarely treated specifically for these nematodes. Where more than one species of nematode is found in a region and only one is treated (e.g., in the Treasure Valley where sugarbeet cyst nematode is treated and stubby-root and root-knot nematodes are not), it is implied that the treatment directed at one nematode also manages the others, or that populations of the non-treated nematode are not high enough to warrant control on their own.

Critical Needs for Management of Nematodes in Western U.S. Sugarbeets Pre-plant

Research

- Research the use and nitrogen mineralization of green manures in different growing regions.
- Investigate methods to facilitate naturally occurring biological control.
- Research the incorporation of resistance genes.
- Seek economical alternatives to aldicarb (Temik) and 1,3-dichloropropene (Telone II).

Regulatory
- Maintain registration of aldicarb (Temik) and 1, 3-dichloropropene (Telone II).

Education
- Encourage soil sampling for nematodes.
- Educate growers about the use of economic thresholds.
- Educate growers on the use of green manures.
- Provide multi-disciplinary education to incorporate all types of inter-related information.
- Educate growers on the effect of crop rotation on nematode control.
- Educate users on the effect of pesticide application on endangered species.

Weeds

Weeds compete with sugarbeets for nutrients, water, and light as well as serving as hosts for insects, disease organisms, and nematodes. The weed spectrum in sugarbeet production is so varied that weed control programs must be tailored to fit the individual grower's needs. Broadleaved weeds found in the growing area include nightshades (*Solanum* spp., including volunteer potatoes, *Solanum tuberosum*), pigweeds (*Amaranthus* spp.), common lambsquarters (*Chenopodium album*), kochia (*Kochia scoparia*), Canada thistle (*Cirsium arvense*), Russian thistle (*Salsola iberica*), smartweed (*Polygonum* spp.), knotweed *(Polygonum* spp.), lady's thumb *(P. persicaria)*, wild buckwheat (*P. convolvulus)*, common mallow (*Malva neglecta*), annual sowthistle (*Sonchus oleraceus*), velvetleaf (*Abutilon theophrasti*), dodder (*Cuscuta* spp.), field bindweed (*Convolvulus arvensis*), sunflower (*Helianthus annuus*), and common cocklebur (*Xanthium strumarium*). Grass weeds include barnyardgrass (*Echinochloa crus-galli*), foxtail species (*Setaria* spp.), wild oats (*Avena fatua*), volunteer grain (*Hordeum* and *Triticum* spp.), wild-proso millet (*Panicum miliaceum*), and quackgrass (*Elytrigia repens*). Yellow nutsedge (*Cyperus esculentus*) is also a problem in western Idaho and eastern Oregon.

IPM and Cultural Controls:
When fall cover crops are planted in sugarbeet fields to control erosion, cultivation can be used to remove the cover crop and to control weeds and improve soil tilth. Tillage during seedbed preparation controls many early-germinating weeds. Rotation is utilized for weed control. Volunteer potatoes are extremely difficult to remove from sugarbeets, and there are currently no effective herbicides for controlling potatoes in sugarbeets. Chemical control on the previous crop is often used to control weeds preceding sugarbeets.

Chemical Controls:
Pre-plant and pre-emergence herbicides have traditionally been applied to control early-germinating weeds and cover crops. To the best of their ability, producers rotate herbicide modes of action to reduce the development of herbicide resistance in weeds. However, choices are limited. The goal of herbicide application pre-plant is to slow weed

germination such that the sugarbeets are allowed to grow as much as possible before subsequent herbicide applications are necessary, since sugarbeets are inherently sensitive to herbicide application.

A typical weed program may include a glyphosate (Roundup) application before seeding or within 14 days following seeding. Glyphosate (Roundup) is effective upon contact against a broad spectrum of weeds, but does not provide any soil residual.

Fumigation with metam sodium (Vapam) or metam potassium (K-Pam) is used in the fall in the Treasure Valley to control yellow nutsedge. If a grower fumigates with 1,3-dichloropropene (Telone), metam sodium, or metam potassium not specifically for weeds, but for nematodes or diseases, they reap the added benefit of reduced weed seed germination.

Pyrazon (Pyramin) is a broadleaf herbicide that can be applied pre-plant or pre-emergence, depending on whether the crop is sprinkler or furrow irrigated. It does not control grasses. Pyrazon is tank-mixed with ethofumesate (Nortron) in the Upper Snake River Basin.

Ethofumesate (Nortron) and cycloate (Ro-Neet) can also be used. Both are soil applied, persist in the soil, and inhibit weed germination. The use of one or the other is largely dependent on weed spectrum present and irrigation regime.

Cycloate (Ro-Neet) is a broadleaf and grass herbicide applied pre-plant in Colorado, Idaho, Montana, Oregon, and Wyoming. It can be applied broadcast in the fall or spring and must be incorporated immediately by mechanical tillage. Cycloate is more likely to cause crop injury than ethofumesate. It is fairly active on redroot pigweed, common lambsquarters, and grasses. Under furrow irrigation, cycloate is usually the pre-plant herbicide of choice.

Ethofumesate (Nortron) also can be applied pre-plant or pre-emergence, depending on how the crop is irrigated. Ethofumesate is more effective on broadleaf weeds than cycloate (Ro-Neet) or pyrazon (Pyramin), but does not control all weed species found in sugarbeets. Ethofumesate is more active on kochia, Russian thistle, black nightshade *(Solanum nigrum)*, and wild oats. It is usually spring-applied but requires the right moisture conditions to be activated; it has to be applied right before rain or with sprinkler irrigation. It can be costly to use. Currently, there is a 12-month plant-back restriction to spring barley and spring wheat after using ethofumesate. It is typically applied during late March or April, if preplant or pre-emergence, but can be applied as late as June if used post-emergence in sugarbeets. Therefore, growers cannot rotate to small grains, important rotational crops, after sugarbeets if ethofumesate is used later in the season. Weed Scientists have been researching the effects of Nortrol carryover on spring grains in an effort to refine the plant-back restriction.

Critical Needs for Management of Weeds in Western Sugarbeets Pre-plant

Research

- Understand weed emergence and the weed seed bank in the soil.
- Discover fumigant alternatives or evaluate metolachlor (Dual) as a plow-down application to complement fumigation for yellow nutsedge control.
- Research new herbicides for pre-plant applications.

Regulatory

- Maintain herbicide registrations.
- Facilitate registration of economical and efficacious herbicides.
- Address use of ethofumesate (Nortron) in sugarbeets and rotation to barley.
- Control amount of weed seed brought in with feed grains and bird seed.

Education

- Educate growers on the importance of controlling weeds in other crops and non-crop areas.
- Educate government agencies, railroad companies, and other entities in charge of controlling weeds in rights-of-way about herbicide movement and the importance of weed control.
- Inform the public why herbicides are used.
- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.
- Educate users on the effect of pesticide application on endangered species.

Diseases

Pre-plant disease control measures are usually directed at soilborne diseases. Soil sampling and fertilizer application for proper fertility are essential for good disease management. Because most root diseases are favored by poor plant-soil-water relations, various pre-plant soil tillage operations are conducted to reduce compaction, improve tilth, and improve water infiltration and drainage. Operations may include timely disking, plowing, ripping, reduced tillage, and/or fall bedding, depending on soil physical and chemical properties, and slope.

Pythium and Phytophthora Root Rots, *Pythium aphanidermatum, Phytophthora drechsleri,* and *P. cryptogea*

Pythium aphanidermatum is the primary causal pathogen for root rot in sugarbeet. While it can also cause damping-off in seedlings, *P. aphanidermatum* is favored by warm temperatures, therefore it generally manifests later in the season, as root rot.

Damage:
No damage is done by these diseases at this time. Damage is detailed in the Row Closure to Harvest section.

IPM and Cultural Controls:
Reduction of compaction, good drainage, and avoiding excessive irrigation are management practices that will usually prevent problems with these diseases.

Chemical Controls:
There are no chemical controls for these diseases at this crop stage.

Rhizoctonia Crown and Root Rot, *Rhizoctonia solani* AG 2-2
Rhizoctonia crown and root rot caused by the fungus *Rhizoctonia solani* in the anastomosis group (AG) 2-2 is one of the most damaging sugarbeet diseases worldwide. It is discussed in greater detail in the Emergence to Row Closure section.

Damage:
No damage is done by this disease at this time.

IPM and Cultural Controls:
Crop rotation is an important control measure for this disease.

Chemical Controls:
Growers sometimes fumigate with metam sodium (Vapam) or metam potassium (K-Pam) in the Treasure Valley of Idaho and Oregon. There is very little data available on these fumigants.

Rhizomania, Beet Necrotic Yellow Vein Virus (BNYVV)
Rhizomania is considered the most serious disease of sugarbeets worldwide, and is a serious problem in Colorado, Idaho, Montana, Oregon, and Wyoming.

Damage:
No damage is caused to the sugarbeet crop at this stage. It is discussed in greater detail in the following sections, Planting and Emergence to Row Closure.

IPM and Cultural Controls:
Although the disease will only move a few inches per year through soil without aid, it is easily spread by infected plant material, soil adhering to non-host root crops, agricultural equipment carrying contaminated soil, irrigation water, and any other means that can move even small amounts of soil. Therefore, all farm equipment that moves soil is sanitized. Proper weed management throughout the rotation can be helpful. Data from preliminary experiments indicate a benefit from planting oilseed radish and incorporating it as a green manure after eight weeks' growth. Utilization of proper cultural practices to reduce compaction and improve drainage will help prevent any of the root diseases.

Chemical Controls:
The only registered control for this disease is 1,3-dichloropropene (Telone II), a pre-plant fumigant. It is not used because it is cost prohibitive.

Critical Needs for Management of Diseases in Western Sugarbeets Pre-Plant

Research
- Research the use of green manures to control rhizomania and other diseases.
- Establish protocols for detection methods and threshold levels for any soilborne fungal pathogens.
- Research new sources of host plant resistance.

Regulatory
- Maintain pesticide registrations.

Education
- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.
- Educate users on the effect of pesticide application on endangered species.

Insects

Several soil-dwelling insect and arthropod pests often are present in fields before the sugarbeet crop is planted. These pests include a multi-species complex of cutworms, garden symphylans, white grubs, and wireworms. By definition, because these pests infest fields before the sugarbeet crop is seeded, none of these can be directly damaging during the pre-plant period. Hence, descriptions of the pests and their biology appear in subsequent sections of this document.

Cutworms, various species
Cutworms are described in more detail in the Emergence to Row Closure section.

Damage:
Cutworms do not cause damage at this time.

IPM and Cultural Controls:
Cutworms often build up in rotational crops that precede sugarbeets, such as cereals and alfalfa. Monitoring can indicate whether cutworm numbers are high enough to put a sugarbeet crop at risk. Cutworm larvae can be difficult to identify; it may be more practical to monitor activity of adult moths with pheromone traps. A region-wide cutworm monitoring program including nine states and one Canadian province is coordinated on the Internet at http://cutworm.org. Disking and effective weed management can be useful practices in reducing cutworm numbers, but are not

recommended as stand-alone practices for controlling cutworms. Fall and spring cultivation will help reduce populations of overwintering larvae or pupae.

Garden Symphylan, *Scutigerella immaculata*
Garden symphylans are described in more detail in the Pre-emergence section.

Damage:
No damage is done by this pest at this crop stage.

IPM and Cultural Controls:
While no formal economic thresholds exist for symphylan insecticide treatment decisions, IPM principles are utilized. Growers monitor populations and treat affected areas when economically appropriate. Often symphylan infestations are caused by planting sugarbeets behind onions, which are also hosts. Symphylans are often associated with fields that have a history of heavy manure use or very high organic matter. Deep vigorous tillage may reduce symphylan numbers, but severe infestations may require fumigation.

Chemical Controls:
Currently, the only registered control is 1, 3-dichlorpropene (Telone II), a pre-plant soil fumigant. Symphylan infestations by themselves seldom if ever justify the expense of soil fumigants, but fields in the Treasure Valley, Upper Snake River Basin, Montana, and northern Wyoming are typically fumigated, therefore symphylan are controlled chemically in these areas. There are no effective “rescue” treatments that can be applied post-emergence in sugarbeets for symphylans.

White Grubs, *Phyllophaga* spp.
White grubs are described in more detail in the Emergence to Row Closure section.

Damage:
No damage is done by this pest at this crop stage.

IPM and Cultural Controls:
White grub infestations are most likely when sugarbeets follow grassy pastures. Grasses are the preferred host plants both for oviposition and larval feeding. Some species require two or more years for egg-to-adult development, so old pasture can be infested with substantial populations of last-stage (large) grubs that are especially damaging to seedling sugarbeet plants. Plowing grasslands in the fall helps to destroy grubs. White grubs have many natural enemies including birds, skunks, and insect parasites and predators. When planting sugarbeets following pasture or grassland, consultants recommend chemical treatment.

Chemical Controls:
All chemical controls for white grubs are applied at planting.

Wireworms, *Limonius californicus, L. canus* and others
Wireworm biology is described in more detail in the Pre-emergence section.

Damage:
No damage is done by wireworms at this crop stage.

IPM and Cultural Controls:
Only those fields known to have wireworm populations sufficient to cause crop loss are treated. Wireworm larval densities can be assessed before planting by either constructing solar bait stations or by direct soil sampling. Solar bait stations do not always give accurate results. In particular, soil temperature at 6 inches must be at least 45ºF; if soil temperatures are cooler, baits do not detect wireworms even when they are present because larvae will not be active and so will not crawl through the soil to the lure where they can be recovered. Because sugarbeets usually are planted before wireworm activity begins, bait sampling must be scheduled during the fall prior to seeding. Soil core sampling is more labor-intensive, but does not depend upon soil temperature.

Summer fallow (i.e., complete absence of any growing plant) with frequent tillage theoretically can reduce wireworm infestations but is economically impractical. In sugarbeet fields with a high risk of wireworm damage, wireworms can be controlled with seed treatments or with the use of soil insecticides. In other crops, the best wireworm control results from the use of soil insecticides applied in the furrow; however, sugarbeets are very sensitive to organophosphate insecticides applied at planting, therefore this is not practiced. In some cases, replanting is necessary due to early season crop damage from wireworms. Profitable rotational schemes are difficult to devise, not only because the host range of wireworms includes the major agricultural crops typically grown in rotation with sugarbeets, but also because larvae have life cycles that range from one to eight years. Other cultural controls include not planting sugarbeets after crops that had a heavy wireworm infestation the previous year without fallowing, tilling, or applying an effective insecticide.

Chemical Controls:
While wireworm management includes monitoring, no formal economic thresholds exist for wireworm insecticide treatment decisions. Decisions to use insecticides for wireworm management must be made before planting since no rescue treatments are available. Infestation levels vary from year to year. Wireworms have become a greater problem in recent years since the dissipation of residues of chlorinated hydrocarbon insecticides last used during the 1970s, but are not a problem in all geographic regions. Colorado, for example, has limited problems with this pest. Terbufos (Counter) is an effective chemical option.

Critical Needs for Management of Insects in Western Sugarbeets Pre-plant

Research

- Develop practical sampling methods and/or predictions for soilborne insects.

- Develop local, research-based economic thresholds for pests; include a hazard rating on fields (i.e., if a field has exceeded a certain threshold, and therefore a hazard rating, the grower would know not to plant sugarbeets in that field due to the abundance of a certain pest).
- Develop better tactics for biological control, including enhancing already present natural enemies, as well as developing microbial insecticides.

Regulatory
- Maintain pesticide registrations.

Education
- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.

PLANTING

Pest management activities that occur during the planting stage include any treatment to the seed or any activities that take place during or immediately following the opening and closing of the planting furrow. At-plant insecticide application in sugarbeets often employs a technique known as “modified in-furrow” application. This involves pesticide placement in a seed furrow or plant row in a way that reduces immediate contact of the pesticide with the germinating seed or emerging seedling to reduce pesticide phytotoxicity. For example, insecticides can be applied to the soil after the seed opener on a planter has placed the seed and the soil has been dragged over the opening and seed but before the press wheel has firmed the soil. In addition to preventing the seed’s direct contact with the insecticide, this technique results in the granular insecticide being pressed into the soil, preventing off-target drift. Some liquid insecticides can be similarly applied but caution is taken not to apply too much water with the application, causing the press wheel to become muddy. Herbicides are usually either layered into the soil just ahead of or just behind the seed. When applied just ahead of the seed, the planter disk opener and the press wheel serve to incorporate the herbicide. When an herbicide is sprayed behind the press wheel, it is typically incorporated with overhead sprinklers.

Row spacing and plant spacing within the row are critical factors in sugarbeet production. Normal row spacing for sugarbeets is either 22 or 30 inches, though plantings as close as 18 inches have been known to be effective. Plants within the row are generally between 5.5 and 7 inches apart. Growers count on 90% of planted sugarbeets coming up. Ideally, after germination, a grower will have one beet every 8 inches. Spacing, of course, may not be this uniform, but an average of 2 sugarbeets every 16 inches, or within the range of 80 to 180 sugarbeets per 100 feet of row, is the target for optimum productivity. If a stand has fewer than 80 sugarbeets per 100 feet of row, replanting may be necessary, whereas counts greater than 180 sugarbeets may require stand thinning. Sugarbeets planted closer together will not get as big, but may have an increase in sugar content. However, if the sugarbeets are too small, they fall through the harvester.

Planting dates are slightly different in every region, but most sugarbeets are planted between mid-March and early May. Table 1, below, outlines average planting and harvest dates for each region, as well as presenting production statistics.

Table 1: Production facts and dates for sugarbeets in the western United States.

Region	Planting Date	Harvest Date	2003 Harvested Acres	2003 Yield (Tons per acre)
1 Magic Valley (ID) and La Grande (OR)	Mar 8 – May 31	Sept 15 – Nov 5	ID: 129,000; OR: 2,100	ID: 28.5; OR: 24.5
2 Treasure Valley (ID, OR)	Mar 10 – May 5	Oct 5 – Nov 10	ID: 40,300; OR:7,370	ID: 30.0; OR: 31.5
3 Upper Snake River Basin (ID)	Mar 15 – May 25	Sept 15 – Nov 5	37,300	30.7
4 Montana, northerwestern Wyoming, western North Dakota	April 1 – May 15	Mid Sept – early Nov	MT: 51,500; WY: 30,000; ND: 4,700	MT: 25.4; WY: 22.8; ND: 22.8
5 Colorado, western Nebraska, southeastern Wyoming	April 1 (insurance date)	Late Sept though Nov	CO: 27,400; WY: 3,700	CO: 23.5 WY: 18.1
6 southern Columbia Basin (WA, OR)	April 1 – 15	Late Sept – early Nov	WA: 4,000 OR: 445	WA: 40.3 OR: 38.9

Nematodes

Early planting is used in some regions to reduce damage by nematodes. Varieties with resistance to sugarbeet cyst nematode (SBCN), *Heterodera schachtii*, are beginning to become available commercially. One such variety was released, on a very limited basis, in Colorado in 2005. These resistant varieties cause concern on the part of some researchers, however, as the single-gene resistance they offer is likely to be easily overcome by the SBCN, creating a stronger race of SBCN that would make management even more difficult.

Critical Needs for Management of Nematodes in Western U.S. Sugarbeets at Planting

Research

- Research a less expensive chemical alternative to aldicarb (Temik) and 1, 3-dichloropropene (Telone II).
- Expand research and development of nematode-resistant varieties.
- Research sugarbeet varieties resistant to cyst nematodes.

Regulatory

None listed.

Education

- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.
- Educate users on the effect of pesticide application on endangered species.

Weeds

Ethofumesate (Nortron) is a broad-spectrum herbicide applied in all states. It is the only effective material for Russian thistle control. An estimated 80 to 90% of sugarbeets grown in Washington are treated with ethofumesate; the primary target is Russian thistle (*Salsola iberica*), but it controls many other weeds in the Region 6 (Columbia Basin) weed spectrum as well. Ethofumesate is used in Idaho to control kochia (*Kochia scoparia*), black nightshade *(Solanum nigrum)*, and wild oats *(Avena fatua)*, as well as other broadleaf weeds. Application is made at planting by banding over the row followed by one-half inch or more of irrigation water to incorporate. Banding at these lower rates reduces the potential residue carryover. However, with the introduction of generic ethofumesate, the price has declined and more growers are applying it broadcast.

Pyrazon (Pyramin) is a broadleaf herbicide that can be applied pre-plant or pre-emergence, depending on whether the crop is sprinkler or furrow irrigated. It does not control grasses. Pyrazon is tank-mixed with ethofumesate (Nortron) in Region 3 (Upper Snake River Valley).

Critical Needs for Management of Weeds in Western U.S. Sugarbeets at Planting

Research

- Research weed control strategies that involve delayed planting to allow weed germination and emergence before sugarbeet emergence.
- Research a method to minimize soil crusting with overhead moisture.

Regulatory
- Maintain herbicide registrations.

Education
- Educate consumers about the benefits to planting Roundup Ready seed to increase its acceptance.
- Educate growers on how to use Roundup Ready seed.
- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.
- Educate users on the effect of pesticide application on endangered species.

Diseases

Growers use disease-resistant varieties because this is typically the most effective and economical form of disease control. Resistance of a particular variety is on a continuum that ranges between "short of complete susceptibility" through "immunity." True immunity is rare in sugarbeet germplasm; most resistance is partial or moderate. That is, under most conditions, the grower will suffer little or no yield loss. In some situations resistant varieties have lower yield potential and growers must weigh the risk of disease loss versus the lower yield potential. Table 2 lists the diseases for which selection of resistant varieties are commonly used in the western United States. The timing of planting impacts some diseases and is manipulated by some growers as a means of cultural disease control in an integrated pest management program. Diseases listed in this section do not cause damage at this time, but management activities do take place at this crop stage.

Beet Curly Top Virus

Beet curly top is an extremely destructive disease of sugarbeets. It is vectored by beet leafhoppers, which are the sole source of its transmission.

Damage:
Damage occurs later and is discussed in the Emergence to Row Closure section.

IPM and Cultural Controls:
Curly top-resistant varieties are used throughout all states represented by this document and their use almost eliminates the need for chemical control of the leafhopper vector. In the absence of curly top, these disease-tolerant varieties generally yield less than non-tolerant varieties; hence, some growers are interested in planting higher-yielding susceptible varieties and protecting them from leafhopper with insecticides. In areas of high disease pressure, however, this is not a recommended practice. Curly top zones have been defined and processors for whom a crop is grown under contract often specify that only those varieties be planted that have adequate curly top resistance for each specific zone.

Chemical Controls:
There are no chemical controls for this virus.

Table 2: Diseases for which resistant varieties are commonly selected.

Disease	**Comments**
Aphanomyces Black Root Rot (*Aphanomyces cochlioides*)	Partial resistance. Most of the locally adapted cultivars have been developed for the Red River Valley (Minnesota and North Dakota). There are no locally adapted cultivars for Colorado, Wyoming or Idaho.
Beet Curly Top Virus	Specific level of resistance is required for variety approval by companies and cooperatives in ID, CO, WY, MT.
Cercospora Leaf Spot (CLS)	Resistance is partial and fungicides are still required. Historically, sugarbeets with high levels of resistance to CLS have lower yields and sugar content than susceptible varieties when produced under an appropriate fungicide spray program. However, the use of moderately resistant varieties is now widely accepted in most production areas because varieties with this level of resistance are competitive with susceptible varieties sprayed with fungicides.
Bacterial Vascular Necrosis and Rot (*Erwinia cartovora* subsp. *Betavasculorum*)	Single-gene resistance is available and effective in all areas.
Fusarium Yellows	Some resistance is available but efficacy varies in different areas. Also, more than one species can cause Fusarium yellows, but resistance has been developed for *F. oxysporum* only.
Powdery Mildew (*Erysiphe polygoni*)	Only partial resistance is available; fungicides are still required.
Rhizoctonia Crown and Root Rot (*Rhizoctonia solani* AG2-2).	Only partial resistance is available, and the available resistance impacts root and crown rot only, not damping-off. Growers experience a 10 to 15% yield penalty when using resistant varieties in absence of disease.
Rhizomania (Beet Necrotic Yellow Vein Virus)	Single-gene resistance. Strains that are not controlled by this gene are known in the region. No genes have been identified that are effective against the resistant strain.

Beet Western Yellows Virus
More details about this virus can be found in the Row Closure to Harvest section.

Damage:
No damage is done by this virus at this crop stage.

IPM and Cultural Controls:
There are some sugarbeet varieties that show resistance to beet western yellows.

Chemical Controls:
There are no chemical controls for this virus.

Fusarium Yellows
This disease is found in sugarbeets grown in Colorado, Montana, the Treasure Valley, and Wyoming. *Fusarium oxysporum* f. sp. *betae* is the primary cause, but other *Fusarium* species may be involved in some areas. At least four other species have been reported to cause yellows symptoms.

Damage:
No damage is done by these diseases at this stage.

IPM and Cultural Controls:
Crop rotation is a cultural control, but efficacy is limited. There is not sufficient data on efficacy of crop rotation for control of species other than *F. oxysporum*. Irrigation level and timing can be used in some areas to reduce the damage from the wilt stage of the disease. Any kind of water stress is avoided, as either excessive or insufficient water can increase severity. *Fusarium* species can cause damping-off and affect the stand as well—particularly if the soil is warm. Management of sugarbeet cyst nematode is also important, since co-infection will increase disease severity. Growers avoid mechanical and insect feeding injury. Varieties are only mildly resistant to the disease.

Chemical Controls:
There are no chemical controls for this virus.

Rhizoctonia Crown and Root Rot, *Rhizoctonia solani* AG2-2

Damage:
No damage is done by this disease at this crop stage. Damage is detailed in the Row Closure to Harvest section.

IPM and Cultural Controls:
Where disease pressure is high, growers can plant specialty varieties with resistance. Available resistance is incomplete and these varieties typically have yield potentials 10 to 20% less than the best approved varieties, although some newer varieties are 0 to 10% lower yielding than the best approved varieties. However, these varieties usually do not

have sufficient resistance to other important diseases such as curly top, rhizomania, Fusarium yellows, Aphanomyces black root rot, or Cercospora leaf spot.

Chemical Controls:
The strobilurin fungicides, azoxystrobin (Amistar), trifloxystrobin (Gem), or pyraclastrobin (Headline) are labeled for control. They can be applied at planting (in-furrow) or at the 4- to 8-leaf stage. Application is made before soil temperature at the 4-inch depth exceeds 70 to 77°F. Research has shown that post-emergence applications are more effective than in-furrow treatment and that azoxystrobin provides better control than the other strobilurin fungicides**.**

Rhizomania and Beet Necrotic Yellow Vein Virus, *Polymyxa betae*
Rhizomania is considered the most serious disease of sugarbeets worldwide. It was first detected in Idaho and Wyoming in 1992 and is now also a serious issue in Colorado and Oregon. It was first diagnosed in Columbia River basin in 2000, and only recently in Montana. This disease is caused by a virus, Beet necrotic yellow vein virus (BNYVV), which is transmitted by the fungus *Polymyxa betae*, commonly found in soil. Although it is found in all sugarbeet growing regions, it is a more serious issue in Idaho.

Damage:
No damage is done by this pest at this crop stage. Damage is detailed in the Emergence to Row Closure section.

IPM and Cultural Controls:
Most growers in Idaho and eastern Oregon are planting resistant varieties. Seed companies are no longer developing non-rhizomania resistant varieties and all rhizomania-susceptible varieties are being phased out. Resistance is incomplete, and in 2004 a resistance-breaking strain of BNYVV was identified in Idaho. At this time, resistance has not been identified to the resistance breaking strain. Proper weed management throughout the rotation can be important to rhizomania management.

Chemical Controls:
No chemical controls are registered for this disease.

Seedling Diseases:
Aphanomyces Damping-off and Black Root Rot, Phoma Black Leg, Pythium Damping-off, Rhizoctonia Damping-off, Fusarium Damping-off
Sugarbeets are susceptible to numerous seedling pathogens, expressed as seed decay, pre-emergence damping-off, and post emergence damping-off. Disease severity is influenced strongly by the inoculum potential of the pathogen(s), environmental factors (soil moisture, temperature, soil characteristics), seedling vigor, depth of planting, stress factors such as presence of certain insecticides or herbicides, and the effectiveness of seed treatment fungicides. With the exception of the Phoma black leg pathogen, all seedling disease pathogens are common soil-inhabiting microbes. Again with the exception of Phoma, these pathogens are most important in the planting through stand

establishment phases, although some pathogens (e.g., *Aphanomyces* and *Fusarium*) may cause damage until harvest.

These diseases do not cause damage at this stage but are controlled by a combination of seed treatments and resistant varieties. All sugarbeet seed is purchased pre-treated with a combination of fungicides. The treatments depend on the disease spectrum in each region. For instance, in Idaho, seed is treated with thiram (Thiram) and metalaxyl (Allegiance or Apron). Pythium is the most severe seedling disease in Idaho, and Apron is very specific to “water molds,” which include Pythium and Phytopthora. Thiram is a general fungicide that protects the seed from rotting and some Rhizoctonia problems. Hymexazole (Tachigaren) also has activity on Pythium, but not as much as Apron. It is very active on Aphanomyces, which is not a serious problem in Idaho. Therefore, hymexazole (Tachigaren)-treated seed is not planted in Idaho, though it is planted in Montana, Colorado, and Wyoming.

Aphanomyces Damping-off and Black Root Rot
Aphanomyces cochlioides is a relatively common soil-inhabiting fungus causing damping-off and root rot problems worldwide. It is favored by wet soil conditions and soil temperatures above 60°F.

Damage:
No damage is done by this disease at this time. More details are provided in the Emergence to Row Closure section.

IPM and Cultural Controls
Partially resistant varieties are available for some production areas. Unfortunately, these varieties may not have as high a yield potential as approved susceptible varieties in the absence of this disease. Therefore, it is common practice to index soils as a measure of disease potential and to use the partially resistant varieties only where disease potential is high. Because this fungus infects and causes disease under warm, wet conditions, planting early so that seedlings are well established prior to 60°F and planting into well drained soils will reduce overall disease severity. Aphanomyces is frequently present in fields where sugarbeets are planted in close rotation. It has been demonstrated that a 3- to 4-year rotation to non-host crops, such as corn or wheat, will help to keep soil populations from building up.

Chemical Controls:
Currently, the only effective chemical control is the use of hymexazole (Tachigaren) seed treatment. At higher rates, pelleted seed must be used to avoid phytotoxicity problems. A delay in emergence can occur with higher rates or on some genotypes that have poor seedling vigor. The use of seed treatment is encouraged wherever this disease occurs even on partially resistant varieties. Tachigaren-treated seed is not planted in Idaho, since there is much less incidence of Aphanomyces than other areas.

Phoma Black Leg
The causal fungus, *Phoma betae*, is primarily seedborne.

Damage:
No damage is done by this disease at this crop stage. More details are included in the Emergence to Row Closure section.

IPM and Cultural Controls:
Through germination tests done by seed companies, highly infected lots are discarded owing to their low germination.

Chemical Controls:
Control of the seedling-damping-off phase is currently reliant on the use of thiram (Thiram) seed treatment.

Pythium Damping-off
Several species of Pythium may be involved, but *P. ultimum* and *P. aphanidermatum* are the most common. They cause soilborne diseases that result in seed decay, damping-off (both pre- and post-emergence), and infection of the roots or hypocotyl of emerged plants. These microbes are ubiquitous soil inhabitants. Moist conditions are generally required. *Pythium ultimum* damage is generally more prevalent in soils < 60°F whereas *P. aphanidermatum* damage is more common in warmer soils.

IPM and Cultural Controls:
Planting high germination, high vigor seeds into soil conditions that allow for rapid germination and emergence are critical to reducing losses to Pythium damping-off. Soil temperatures greater that 50°F are required for germination and soil moisture must be such that the seed reaches 50% moisture or more. Planting on fall-established ridges in the spring is a common tactic where soil type and topography permit, since these ridges warm up faster than flat planting beds and they are less likely to be excessively wet, a condition that favors Pythium damping-off. Planting early into cool soil can control *P. aphanidermatum*, although it is not effective for controlling *P. ultimum*.

Chemical Controls:
Seed treatment with metalaxyl (Apron or Allegiance) will control Pythium damping-off for up to 2 weeks after planting. Currently almost all seed is treated with thiram (Thiram) and metalaxyl (Apron or Allegiance). The use of hymexazole (Tachigaren) seed treatment will also aid in Pythium control.

Rhizoctonia Damping-off
Rhizoctonia solani AG 4 and AG 2-2 are both involved in both pre- and post-emergence damping-off. They are both ubiquitous soil inhabitants and like *Pythium* spp. they are favored by conditions that slow emergence and seedling growth. The *R. solani* AG 4 anastomosis group can attack some plants that are non-hosts to AG 2-2, and literature suggests that damping-off from this anastomosis group may be more severe on sugarbeets following alfalfa. Dry beans are an alternative host for *Rhizoctonia solani* AG 2-2.

Damage:
No damage is done by this disease at this crop stage. Damage is detailed in the Pre-emergence section.

IPM and Cultural Controls:
Planting high germination, high vigor seeds into soil conditions that allow for rapid germination and emergence are critical to reducing losses to Rhizoctonia damping-off. Soil temperatures greater that 50°F are required for germination and soil moisture must be such that the seed reaches 50% moisture or more. Early planting into soils between 50 and 59°F can reduce damping-off by *R. solani*.

Growers avoid rotations including dry beans or soybeans and maintain at least 3 years of rotation using non-host crops such as cereal grains or alfalfa to help keep soil populations of Rhizoctonia low. Once soil populations of *R. solani* AG 2-2 build up, rotations are of little value. Growers also avoid cultivating soil such that soil is deposited into the plant crown. Good fertility is maintained and over-irrigation is avoided.

Chemical Controls:
Currently, thiram (Thiram) seed treatment protects against pre-emergence damping-off caused by Rhizoctonia. Azoxystrobin (Amistar, Quadris) applied in furrow at-planting will provide protection for up to 3 weeks against both pre- and post-emergence damping-off.

Critical Needs for Management of Diseases in Western U.S. Sugarbeets at Planting

Research

- Develop sampling and other methods for disease prediction.
- Develop biological controls that work with standard seed treatments.
- Develop new sources of resistance for seed selection and maintenance of host resistance.
- Understand pathogen variability.
- Develop biotech seed for disease resistance.
- Research methods of rapid strain detection and resistance identification (as with rhizomania).
- Investigate the importance and extent of Fusarium yellows in Idaho.

Regulatory

- Maintain registrations for metalaxyl (Allegiance, Apron) and thiram (Thiram).

Education

- Educate growers about product stewardship for thiram (Thiram).
- Educate growers about soil preparation, tilth management, and irrigation management for impacts on diseases.
- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include

multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.

- Educate users on the effect of pesticide application on endangered species.

Insects

Beet Leafhoppers, *Circulifer tenellus*
Beet leafhoppers are described in more detail in the Emergence to Row Closure section. This insect's primary importance to the sugarbeet industry is its connection to beet curly top virus, which is described in the Disease subsection above.

Damage:
Beet leafhoppers do not cause economic damage through feeding activity at any crop stage. They are not present at this crop stage.

IPM and Cultural Controls:
No cultural controls take place for leafhopper; cultural controls for curly top are discussed in the Disease subsection above.

Chemical Controls:
Three generations of leafhoppers occur each year, making chemical control difficult. The following insecticides are registered for leafhopper control but are rarely used solely for leafhoppers. Less than 1,000 acres in Idaho and Oregon are treated each year specifically for leafhopper control. No formal economic thresholds exist for beet leafhopper insecticide treatment decisions. Growers do not treat for leafhopper unless they are concerned about curly top. Growers in Colorado and southern Wyoming can adequately control curly top with resistant varieties and do not treat for leafhoppers.

- Terbufos (Counter 15G). A modified in-furrow at-plant treatment.
- Aldicarb (Temik). Applications can be made by banding the product 1 to 3 inches below the seed row before planting or banding behind planter.
- Phorate (Thimet). Application can be made at planting by drilling granules to the side of seed row or banding over seed row. Phorate is not always the chemical of choice at-planting due to phytotoxicity problems in the past.
- Imidacloprid (Gaucho). Seed treatment. May be used, but is not very efficacious.

Terbufos (Counter 15G) and aldicarb (Temik) are the main leafhopper insecticides used at planting. Most growers consider sugarbeet root maggot control when planning their at-planting insecticide applications. Beet leafhopper control is an added benefit of using at-planting insecticides, but not the driving force behind their use.

Cutworms
Cutworms are described in more detail in the Emergence to Row Closure section.

Damage:
Cutworms do not cause any damage at this crop stage.

Chemical Controls:

- Terbufos (Counter 15G) is only used at planting and only suppresses cutworms.
- Chlorpyrifos (Lorsban).
- Zeta-cypermethrin (Mustang) is beginning to be used by Montana producers, who modified planters to apply an in-furrow band.

Flea Beetles
Flea beetles are described in more detail in the Emergence to Row Closure section.

Damage:
Flea beetles do not cause damage at this crop stage.

IPM and Cultural Controls:
Cultural control methods include clean cultivation since weed species such as wild mustard or common lambsquarters can serve as alternate hosts.

Chemical Controls:

- Imidacloprid (Gaucho) is used as a seed treatment.
- Zeta-cypermethrin (Mustang) is beginning to be used by Montana producers, who modified planters to apply an in-furrow band.

Leafminers, various spp., including **Pea Leafminer**, *Liriomyza huidobrensis* and **Spinach Leafminer**, *Pegomya hyoscyami*)

Leafminers are described in more detail in the Emergence to Row Closure section.

Damage:
No damage is done by leafminers at this crop stage.

IPM and Cultural Controls:
Growers monitor and treat only when populations reach economically damaging levels.

Chemical Controls:
No formal economic thresholds exist for leafminer insecticide treatment decisions. Leafminers are always present, but they do not always reach levels of economic importance. If a grower knows from experience that he will have a problem with leafminers, he will treat at planting with aldicarb (Temik), which aids in control but does not eradicate leafminers.

- Aldicarb (Temik 15G)
- Phorate (Thimet 15G) at planting has shown to be phytotoxic to developing seedlings. Most growers therefore will not use it at planting.

Sugarbeet Root Aphid, *Pemphigus populivenae*
Sugarbeet root aphids are described in more detail in the Emergence to Row Closure section.

Damage:
Root aphids do not cause damage at this crop stage.

IPM and Cultural Controls:
Seed and variety selection are imperative to root aphid control. Sugarbeet varieties with partial resistance to sugarbeet root aphid feeding are available.

Chemical Controls:
There are no controls registered for this pest.

Sugarbeet Root Maggot, *Tetanops myopaeformis*
Sugarbeet root maggots are described in greater detail in the Emergence to Row Closure section.

Damage:
Root maggots do not cause damage at this crop stage because adult flies do not colonize fields and lay eggs until plants develop to the seedling stage. In Idaho, larval feeding normally does not begin until 1 or 2 months after planting. Other than local pest history, there is no way to know at planting if root maggots will reach damaging levels.

IPM and Cultural Controls:
IPM practices have been developed and are being followed toward control of this pest. Sticky stake traps are placed in sugarbeet fields to monitor ovipositional flights of adult flies. Rather than preventively applying insecticides at planting time, growers instead can apply insecticides after plant emergence if traps signal that economic damage is likely. Insecticide treatments are normally made after fly populations have reached an economic threshold level. A degree-day program is utilized to forecast fly activity. However, fly populations have been known to build so rapidly that waiting until the economic threshold is reached to apply insecticides has resulted in intolerable crop losses. Therefore, upon early detection, treatment may be indicated. Knowing the history of the area is essential. In some areas, yearly populations are variable, and the IPM practices work well, while in others, at-planting treatment is required every year.

Although sugarbeet root maggot is not known to occur in Washington at this time, Washington producers sanitize equipment coming into the area to prevent accidental introduction of root maggot eggs, larvae, or pupae into from invading Columbia Basin farms.

Sugarbeets are the only widely grown commercial host plant; table beets, spinach, and Swiss chard also are larval host plants but plantings essentially are limited to backyard gardens. Other management tools include distancing of sugarbeet fields in a given area to minimize movement of adults from previous year to current fields and early establishment of vigorous stands that can withstand more damage. Distancing of fields is difficult to implement because root maggot adults can travel several miles. Chemical controls are critical for significant sugarbeet root maggot control.

Chemical Controls:
Sugarbeet root maggots annually reach economically damaging levels. Some growers, especially in the Burley and Paul areas of Idaho (Region 1, Magic Valley), will make insecticide treatments before peak adult flight based on a field history of severe sugarbeet root maggot problems. Although no damage is done at this crop stage, some chemical controls are applied at planting in fields with a history of consistent, severe damage.

- Aldicarb (Temik) application can be made by soil injection at planting.
- Terbufos (Counter 15G) is applied either as a modified in-furrow treatment at planting or banded after emergence.
- Chlorpyrifos (Lorsban).
- Zeta-cypermethrin (Mustang), although registered for application at planting, is not used at this time because the product does not persist in the soil until pest emergence.
- Phorate (Thimet).

White Grubs, *Phyllophaga* spp.
White grubs are described in more detail in the Emergence to Row Closure section.

Damage:
Although white grubs are present, they do not cause any damage at this crop stage.

IPM and Cultural Controls:
IPM and cultural controls are described in more detail in the Pre-plant section.

Chemical Controls:
No formal economic thresholds exist for white grub insecticide treatment decisions. There are no effective “rescue” treatments that can be applied post-emergence in sugarbeets for white grubs. Terbufos (Counter 15G) and zeta-cypermethrin (Mustang) are both registered for at-planting applications against white grubs. The problem with both of these chemicals is they need to be placed in the soil where the grubs are active. This cannot be done effectively once seed has been planted. White grub problems in sugarbeet are uncommon in Colorado, Montana, and Wyoming, and treatment for this insect would not likely be economic unless planting into a high-risk situation (e.g., following sod or grass).

Wireworms, *Limonius californicus, L. canus,* others
Wireworm descriptions and biology are detailed in the Pre-emergence section.

Damage:
No damage is done by wireworms at this crop stage. Damage is detailed in the Pre-emergence section.

Chemical Controls:
No formal economic thresholds exist for wireworm insecticide treatment decisions. Decisions to use insecticides for wireworm management must be made before planting since no rescue treatments are available. Infestation levels vary from year to year. Wireworms have become a greater problem in recent years since the loss of chlorinated hydrocarbon insecticides.

- Terbufos (Counter 15G).
- Chlorpyrifos (Lorsban).
- Imidacloprid (Gaucho) seed treatment.
- Diazinon (Diazinon) is applied in Idaho and Oregon. Application is made by broadcasting with immediate incorporation just before planting.
- Zeta-cypermethrin (Mustang) is beginning to be used by Montana producers, who modified planters to apply an in-furrow band.

Critical Needs for Management of Insects in Western U.S. Sugarbeets at Planting

Research

- Develop sugarbeet varieties with host resistance.
- Develop seed-applied or at-planting biologicals for pest control.
- Research alternatives to conventional insecticides for sugarbeet root maggot control.
- Develop practical sampling methods and thresholds for leafminers and sugarbeet root aphid to avoid pre-plant insecticide applications.
- Continue ongoing research for new pest control tools.
- Develop more economical methods of controlling pests.
- Provide funding for applied entomologists.

Regulatory

- Register clothianidin (Poncho) for use as a seed treatment.
- Protect the terbufos (Counter 15G) label.

Education

- Provide training on pest identification.
- Provide training on the use of economic thresholds and treatment guidelines.
- Provide training on the use of biologicals and products with new modes of action as they become available.
- Educate growers about insect pest life cycles and biology.
- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.
- Educate users on the effect of pesticide application on endangered species.

PRE-EMERGENCE

Pre-emergence is defined as the time between planting and crop emergence.

Weeds

Glyphosate (Roundup) is a broad-spectrum herbicide applied in all states represented by this document to control ground cover vegetation, volunteer grain, and other weeds prior to beet emergence. Sugarbeets usually emerge within 12 to 14 days following seeding, so a grower's typical glyphosate application will be 7 to 10 days after planting. Other herbicides that may be used at this time are ethofumesate (Nortron), cycloate (RoNeet), and pyrazon (Pyramin).

Critical Needs for Management of Weeds in Western U.S. Sugarbeets at Pre-emergence

Research

- Research a method to keep the soil from crusting when water is applied by sprinkler irrigation after ethofumesate (Nortron) application.
- Research the interactions between the herbicides and soil amendments.
- Research glyphosate (Roundup) resistance management.
- Evaluate other (chemical and non-chemical) weed management alternatives.
- Understand weed emergence relative to growing degree-day models, dormancy, and soil moisture conditions.
- Improve understanding of sugarbeet emergence.

Regulatory

- Maintain herbicide registrations.

Education

- Educate growers about glyphosate (Roundup) resistance management.
- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.
- Educate users on the effect of pesticide application on endangered species.

Diseases

Sugarbeet growers practice irrigation water management during the pre-emergence period to manage soil moisture to avoid diseases caused by pathogens such as *Pythium*.

Seedling Diseases:
Pythium Damping-off, Rhizoctonia Damping-off

Pythium Damping-off
Damage may be either pre- or post-emergence damping-off or seed rot. When pre-emergence damping-off occurs, seeds rot before the plants break the soil surface. Moist conditions are generally required.

Chemical Controls:
No chemical controls are used at this stage.

Rhizoctonia Damping-off
Rhizoctonia solani AG 4 and AG 2-2 are both involved in pre-emergence damping-off. They are both ubiquitous soil inhabitants and are favored by conditions that slow emergence and seedling growth. Generally once plants have 4 or more true leaves Rhizoctonia damping-off is not as common.

Damage:
Clearly defined cankers start below the soil surface and extend to the soil surface. Affected tissues will be firm and have gray to tan to light brown color. Plants can grow out of light infections and grow normal roots.

IPM and Cultural Controls:
Growers also avoid cultivating soil such that soil is deposited into the plant crown. Good fertility is maintained and over-irrigation is avoided.

Chemical Controls:
No chemical controls are used at this stage.

Critical Needs for Management of Diseases in Western U.S. Sugarbeets at Pre-emergence

Research
None listed.

Regulatory
None listed.

Education
- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.

Insects

Cutworm, various species
A diverse complex of cutworms attacks sugarbeets as well as many crops commonly grown in rotation with sugarbeets. Regionally important species include pale western cutworm (*Agrotis orthogonia*), black cutworm (*A. ipsilon*), granulate cutworm (*A. subterranea*), glassy cutworm (*Apamea devastator),* variegated cutworm, (*Peridroma saucia),* army cutworm (*Euxoa auxiliaris*), spotted cutworm (*Xestia* spp.*)*, redbacked cutworm (*E. ochrogaster*), and darksided cutworm (*E. messoria*). Cutworm infestations are very spotty, usually near field borders, and control measures generally consist of spot treating as opposed to treating the total field. Details of life cycles (such as generations per year and overwintering stage) vary among the different species as well as within the same species across different geographic regions. Species that overwinter as partially mature larvae are especially damaging because these feed when sugarbeet plants are still seedlings. Some larvae overwinter in the soil, especially in grassy or weedy situations.

Damage:
Pale western cutworms feed below ground and can damage stands during the pre-emergence crop stage. Sugarbeets planted into a winter cereal cover crop are at high risk for cutworm damage.

IPM and Cultural Controls:
Cutworms often build up in rotational crops such as cereals and alfalfa that precede sugarbeets. Larval monitoring can indicate whether cutworm numbers in these rotational crops are high enough to put a sugarbeet crop at risk if planted in a given year. Sugarbeets are scouted early and often during establishment so the extent of infestation and damage can be assessed. Because cutworms are difficult to detect, scouting must include some attention to the progression of emerging plants. If emergence or stand density starts to decline, the problem is thoroughly evaluated and immediate action taken. Cutworm larvae sometimes are difficult even for experts to correctly identify; depending on the seasonal life history, it may be more practical to monitor activity of adult moths with pheromone traps. Disking and effective weed management can reduce cutworm numbers. Fall and spring cultivation will help reduce populations of overwintering larvae.

Chemical Controls:
Consideration is given to treating for cutworms when spraying herbicides to kill the cover crop. Applications of chlorpyrifos (Lorsban), methomyl (Lannate), carbaryl (Sevin), esfenvalerate (Asana), and zeta-cypermethrin (Mustang) insecticides can be mixed and applied with glyphosate (Roundup).

Garden Symphylan, *Scutigerella immaculata*
Symphylans are fast-moving soil arthropods that resemble tiny centipedes. They grow up to 0.375-inch long, have long antennae, and can have up to 12 pair of legs. Their entire life cycle is spent in the soil. Like wireworm larvae, symphylans move up and down in the soil depending on soil moisture and temperature. Symphylans feed on decaying vegetable matter and small root hairs on the plants.

Damage:
Roots can be severely pruned to the point of very few secondary roots. This damage in the field is quite obvious but most often it is confined to localized spots. Symphylans occur in unpredictably spotty infestations and generally are considered minor pests. The worst infestations usually are associated with fields that have a sustained history of manure applications. The damage is mainly done to the germinating seed by the pest entering, then destroying, the seed germ. Plant stands can be greatly reduced in areas of high symphylan population.

IPM and Cultural Controls:
IPM principles are utilized by monitoring populations and treating affected areas when garden symphylans reach economically damaging levels. Deep, vigorous tillage may reduce symphylan numbers, but severe infestations may require pre-plant fumigation.

Chemical Controls:
No chemical controls are used for garden symphylans at this stage.

Wireworms, *Limonius californicus, L. canus,* others
Wireworms are the larval stage of a family of beetles commonly called click beetles. Adults (which are harmless) are brown or black and elongate, tapering toward each end but more so toward the rear; they are the only life stage that appears above ground. Larvae (the damaging life stage) are hard-bodied, cylindrical, shiny yellow-to-brown "worms" approximately 3/4- to 1-inch long when mature. Although they have three pairs of small legs behind the head, wireworms do not crawl rapidly. Most do not travel more than 1 or 2 yards their entire lives. Wireworms overwinter both as larvae and as adults up to 2 feet below the soil surface. Females deposit eggs in the soil during late spring. When the eggs hatch, larvae feed on roots. Larvae feed for three or four years before reaching mature size and pupating in the soil during late summer. Most damage is caused by older larvae. Emergent adults remain in the soil until the following spring.

Damage:
Wireworm larvae feed on the germinating seed and/or the developing root. It is an insect that works below the soil surface attacking and killing the seedlings, causing stand reduction. Under a heavy infestation, bare spots may appear in fields making reseeding necessary. Wireworm infestations are more likely to develop where grasses, including grain crops, are growing or were grown in the previous year. Small grains, corn, potatoes, sugarbeets, and vegetables are susceptible to wireworm injury. Legumes are less often injured. Damage from larval feeding appears as seed destruction during germination. On older plants, wireworms scar and channel the taproot surface and chew winding tunnels into the taproot.

Chemical Controls:
There are no rescue treatments available at this stage, so chemical controls must be applied at planting.

Critical Needs for Insect Management in Western U.S. Sugarbeets at Pre-emergence

Research
- Improve predictive models for cutworms.
- Research life cycles of damaging insect pest species.
- Develop non-chemical controls for insect pests.
- Improve knowledge of natural enemies of insect pests.

Regulatory
- Maintain registration for chlorpyrifos (Lorsban 4E).

Education
- Provide information about insect management, especially soil-dwelling pests.
- Educate growers about how soil-dwelling pests are best managed.
- Educate growers about insect pest sampling.
- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.
- Educate users on the effect of pesticide application on endangered species.

Vertebrates

Birds and rodents eat germinating and emerging sugarbeet seeds. Birds are a problem only during pre-emergence, but rodents are a continuous problem. Large populations of mice will actually burrow down a row and eat every seed. It is hypothesized that in fields where aldicarb (Temik) is used to treat soilborne pests, birds are less likely to eat the seeds, possibly because of the smell. Additionally, overhead irrigation detracts birds.

Critical Needs for Vertebrate Management in Sugarbeets at Pre-emergence

Research
- Research the theory that odor from soil-applied products may repel birds.
- Identify the effects of irrigation that will repel vertebrates.

Regulatory
- Work with USDA to get the label finished for zinc phosphide (ID, WA).

Education
- None listed.

Emergence to Row Closure

Nematodes

Damage:
General nematode injury begins to be visible in fields as small patches of poorly growing plants with stunted growth, yellowing foliage, and other symptoms of nutrient deficiency. Infected plants may wilt on warm days, and wilting may persist even with adequate soil moisture. Small seedlings are especially susceptible to death in heavy infestations, and surviving sugarbeets are typically small with excessively hairy roots. Yields decrease as the severity of the infection increases. If the infestation is severe enough, entire seedling stands can be lost.

IPM and Cultural Controls:
Weed control is essential, as certain weed species such as curly dock, knotweed, common lambsquarters, wild mustard, nightshade (hairy and black), common purslane, saltbush, and redroot pigweed are hosts to nematodes.

Chemical Controls:
Aldicarb (Temik 15G) is applied in Colorado, Idaho, Montana, Oregon, Washington, and Wyoming. Treatment is usually made in split applications in a band and incorporated into the soil followed by a second application applied by side-dressing into the soil after thinning on the water furrow side of the row preceding in furrow irrigation, or both sides under sprinkler irrigation.

Critical Needs for Management of Nematodes in Western U.S. Sugarbeets at Emergence to Row Closure

Regulatory
None listed.

Research
None listed.

Education
None listed.

Weeds

Herbicide choices are limited at this stage due to many factors including the crop's tolerance to the specific herbicide and the herbicide's efficacy on key sugarbeet weeds.

Troublesome weeds at this stage include volunteer potatoes *(Solanum tuberosum)*, kochia *(Kochia scoparia)*, common lambsquarters *(Chenopodium album)*, redroot pigweed *(Amaranthus retroflexus)*, hairy nightshade *(Solanum sarrachoides)*, common mallow (*Malva neglecta*), annual sowthistle (*Sonchus oleraceus*), annual sunflower (*Helianthus annuus*), common cocklebur (*Xanthium strumarium*), dodder (*Cuscuta* spp.), cutleaf nightshade *(Solanum triflorum),* velvetleaf (*Abutilon theophrasti*), yellow nutsedge (*Cyperus esculentus*), Canada thistle (*Cirsium arvense*), wild oats (*Avena fatua*), green foxtail (*Setaria viridis),* barnyardgrass (*Echinochloa crus-galli*), volunteer small grain cereals, wild-proso millet (*Panicum miliaceum*), and yellow foxtail (*Setaria glauca*). Kochia and other broadleaf weeds are difficult to control because there are no sugarbeet herbicides that are particularly effective.

IPM and Cultural Controls:
Weeds are controlled between the rows by cultivation prior to the crop reaching full canopy cover. The last cultivation prior to canopy closure is called "lay-by." Occasional hand hoeing may be required to remove weeds that escape herbicide applications and/or cultivation, but hand labor is costly.

Chemical Controls:
All of the sugarbeet acres represented in this document are treated for weeds. Producers try to rotate among herbicides with various modes of action to reduce the development of herbicide resistance in weeds.

Depending on the weed spectrum present, chemical control can include pre-plant or pre-emergence herbicide(s) and/or post-emergence herbicide(s). Most herbicide applications are post-emergence. Post-emergence treatments are applied as standard rates or micro rates. Standard rates are typically applied in a 7- to 11-inch band. One of the reasons for banding is to reduce chemical costs. Micro rates were developed by using the same amount of herbicide in a 7-inch band and applying it as a broadcast application in combination with a methylated seed oil (MSO). Micro herbicide rates are applied at 5- to 7-day intervals compared to 7- to 10-day intervals with the standard rates. Advantages of the micro rate herbicide applications include: 1) they can be made at any air temperature, 2) they allow the grower to spray at a faster speed and consequently cover more acres in a day, 3) they allow the herbicides to be applied by air when soil conditions are too wet for ground equipment, and 4) they control weeds between the rows as well as within the rows.

With post-emergence applications, the first tank mix application typically includes desmedipham + phenmedipham (Betamix) or ethofumesate + desmedipham + phenmedipham (Progress) and triflusulfuron (UpBeet). The second application may include Progress or Betamix, UpBeet, and clopyralid (Stinger). If grass weeds are present, quizalofop (Assure II), sethoxydim (Poast), or clethodim (Select) may be used. Preceding the third post-emergence application, which is identical to the second application, the sugarbeets are cultivated. Some growers use dimethenamid-P (Outlook) or s-metolachlor (Dual II Magnum) in combination with the third application.

Progress contains ethofumesate in addition to phenmedipham and desmedipham, making it more effective on some of the harder-to-kill weed species such as kochia, but also causes more injury. Phenmedipham + desmedipham (Betamix), a broad-spectrum herbicide, is preferred if weed species permit.

Clopyralid (Stinger) is a broadleaf herbicide that is normally used in conjunction with Betamix or Progress to enhance control of some harder-to-kill weed species such as Canada thistle, hairy nightshade, and common cocklebur. Stinger is one of the most effective controls for volunteer potatoes when sugarbeets follow potatoes in the crop rotation. Multiple applications have controlled potatoes. This treatment is phytotoxic to sugarbeets, resulting in injuries resembling those from 2,4-D. However, the sugarbeets recover and will produce a good crop.

Trifulsulfuron-methyl (UpBeet) is a broadleaf herbicide used to improve control of weeds missed by Betamix. The main target weed is kochia, however it is also used for redroot pigweed control. It is usually applied with Betamix.

Sethoxydim (Poast) is a grass herbicide that also targets wild oats and volunteer grain. It is not applied as a micro-rate tool.

Clethodim (Select) is a grass herbicide. Wild oats and volunteer grains are the main target weeds.

Quizalofop-P-ethyl (Assure II) is a grass herbicide. It is not applied as a micro-rate tool. Grasses, wild oats, and volunteer grains are the main targets.

Both dimethenamid-p (Outlook) and s-metolachlor (Dual Magnum) can be applied once sugarbeets have two leaves. They help control late-emerging weeds including pigweed species, hairy nightshade, and barnyardgrass, as well as suppressing yellow nutsedge. S-metolachlor may have some phytotoxicity issues.

Trifluralin (Treflan) is an inexpensive, broad-spectrum herbicide. It can cause phytotoxicity problems.

EPTC (Eptam) is effective on nightshade species.

Glyphosate (Roundup) can be used at this stage as a wiper application, often called a "Roundup wick." This treatment consists of a cotton rope attached to a tube filled with a very concentrated glyphosate (Roundup) solution. The cotton gets rubbed against weeds (those that are taller than the sugarbeets at this time). Roundup wicking is sometimes used in Idaho and Montana as a late-season weed control measure. When the sugarbeet canopy is filled in, previous weed control measures have been exhausted, and hand labor is either too expensive or not available, wicking (wiping) Roundup on the weeds protruding above the beet canopy can be effective on large weeds. The herbicide must not contact the crop leaves. Few growers are familiar with this technique and it is not widely used.

Lay-by

Lay-by is defined as the last pesticide application before row closure. Cycloate (Ro-Neet 6E) can be applied at lay-by, when a full crop canopy has developed, through center pivots. Fall applications are not allowed by label in Washington State, which decreases the utility of this herbicide for spring applications where a cover crop is still growing in the furrows.

Micro rate Herbicides:
Betamix and Progress can be applied at reduced rates with methylated seed oil (MSO); rate of application depends upon sugarbeet growth stage. These herbicides can also be applied in a tank mix with reduced rates of UpBeet and/or clopyralid (Stinger, Clopyr Ag) broadleaf herbicides and Assure II, Poast, or Select grass herbicides.

Critical Needs for Management of Weeds in Western U.S. Sugarbeets at Emergence to Row Closure

Research

- Research the amount of surfactant/MSO to be added to standard pesticide rates, not reduced rates.
- Develop reduced plant-back restrictions for clopyralid (Stinger).
- Research the use of soil-applied herbicides and post-emergence herbicides as a tank mix application (Dual II Magnum, Outlook, and Nortron/Pyramin).
- Research dodder control.
- Research the addition of anti-drift agents to pesticide tank mixes.
- Understand the relationship between weed size and timing and rate of herbicide treatments.
- Research the use of growing degree-day (GDD) models for herbicide application timing and weed emergence.
- Evaluate the degree of damage when using herbicides in a tank mix.
- Research alternative controls for yellow nutsedge.
- Research alternative controls for kochia.
- Develop control measures for volunteer potatoes, lambsquarter, velevetleaf, and nightshade.

Regulatory

- Facilitate the registration of pendimethalin (Prowl) on sugarbeets.
- Maintain herbicide registrations.

Education

- Educate the public about farm labor restraints, especially in the area of weed control, and the reliance on chemicals (i.e., farm labor is expensive and in short supply, so sometimes application of herbicides is the only weed control option).
- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.
- Educate users on the effect of pesticide application on endangered species.

Diseases

Beet Curly Top Virus
Beet curly top virus, commonly called simply "curly top," is an extremely destructive disease of sugarbeets. It is vectored by beet leafhoppers, which are the sole source of its transmission.

Damage:
Symptoms of curly top include dwarfed and distorted leaves and roots. Leaves may curl inward and/or become pimpled; the veins may become discolored, raised, roughened, and/or swollen. Roots are dwarfed; rootlets can be twisted and distorted. Phloem tissue becomes necrotic and phloem exudates appear on stems and leaves. Leaves can become chlorotic then necrotic; the entire plant can die.

IPM and Cultural Controls:
The primary means of control is the use of resistant varieties, which is discussed in the Planting section.

Chemical Controls:
There are no chemical controls for this virus. Its vector, the beet leafhopper, responds to a number of chemical controls, which are discussed in the Insect subsections of the various crop stage sections throughout the document.

Fusarium Yellows, *Fusarium* spp.

Damage:
The disease causes interveinal yellowing with older leaves affected first. As the disease progresses, younger leaves may yellow and older leaves may turn necrotic, generally remaining tan or light brown, and die. Some temporary wilting of the foliage may occur during the day. Roots may be stunted but usually show no external symptoms. Vascular discoloration occurs in the root. A different special form of the pathogen (*Fusarium oxysporum* f.sp. *radicis-betae*) causes a rot of the taproot, particularly the tip, which may be accompanied by proliferation of roots (described in more detail in Fusarium root rot section). Fusarium yellows or root rot can result in reduced yield, reduced sugar, and reduced juice purity. Recent studies suggest that Fusarium-infected sugarbeets have a higher respiration rate, which may affect storage.

IPM and Cultural Controls:
Irrigation level and timing can be used in some areas to reduce the damage from the wilt stage of the disease. Any kind of water stress is avoided, as either excessive or insufficient water can increase severity. *Fusarium* species can cause damping-off and affect stand as well, particularly if the soil is warm. Management of sugarbeet cyst nematode also is important, since co-infection will increase disease severity. Growers avoid mechanical and insect feeding injury. Varietal resistance was discussed in the Planting section.

Chemical Controls:
There are no chemical controls for this pest.

Fusarium Root Rot, *Fusarium* spp.
This is not a new disease, although it may be new to some areas. Fusarium root rot caused by *Fusarium oxysporum* f. sp. *radicis-betae* has been known since the 1980s, and root rot of sugarbeet caused by other species such as *Fusarium solani* or *Fusarium culmorum* has been known since at least the 1950s or 60s. In addition, Fusarium yellows can lead to a rot that starts with necrotic vascular tissue and, under severe disease pressure, spreads outward from the affected vascular tissue. In most areas, these root rots have been considered only a minor problem, but there have been increasing reports of *Fusarium*-induced disease (root rot and yellows) in many growing areas in the last few years. One factor may be that people have not recognized the symptoms caused by *Fusarium* spp., and in some cases it has been mistaken for other diseases or problems. Shortened rotations and a lack of rotational crops that can break the infection cycle are also factors in the increased incidence.

Damage:
Fusarium oxysporum f. sp. *radicis-betae* causes foliar symptoms of wilting, yellowing, and scorching of leaves. The root rot is generally dark and primarily affects the tip of the tap root and the secondary roots. *Fusarium culmorum* root rot is light to dark brown, often with a darker margin. According to researchers in areas where this is common, superficial white mycelium develop on the surface of infected roots and this may later turn pink when sporulation occurs. Foliar symptoms may or may not occur, depending on the severity of the rot. This rot often starts in the crown or where the beet has been injured. The root rot caused by *Fusarium solani* also is a dark rot. It has been found to occur on any part of the root. Damage from this disease can continue until harvest.

IPM and Cultural Controls:
Longer rotations can be helpful in managing Fusarium root rots. Avoiding dry beans in the rotation is also useful, as they are an alternate host for *Fusarium* spp.

Chemical Controls:
There are no chemical controls for this disease.

Powdery Mildew, *Erysiphe polygoni* (syn. *Erysiphe betae*)
Powdery mildew is the most important foliar disease of sugarbeets in Idaho and eastern Oregon and is an annual disease problem in many production areas of the western United States. It is an obligate parasite (i.e., it requires a living host for development) and infects only *Beta* spp. Microscopic spores are carried to the sugarbeet plant by air currents. The spores on the sugarbeet leaf multiply and, under ideal conditions, a powdery film can be visible in four to five days following infection. Primary inoculum probably originates from winter-grown sugarbeets in the southwestern United States or in sugarbeets grown for seed in the Northwest. Powdery mildew is well adapted to the environmental conditions of semi-arid regions with warm, dry climates and large diurnal fluctuations of temperature and relative humidity.

Powdery mildew is primarily propagated vegetatively (i.e., via conidiospores that are genetically equal to the parent). However, when sexually reproduced, there is a possibility for genetic recombinations. New strains from sexual (perfect stage) reproduction can occur or develop more rapidly. Ascocarps are the fruiting bodies of powdery mildew and are evidence that the sexual (perfect) stage is present. They used to be called cleistothecia, but this terminology is in flux now. They are minute, hard, round structures that form within the mildew patches. Immature ascocarps are yellow or orange, becoming dark brown to black as they mature. The perfect stage became widespread starting in 2001 in Idaho and Colorado, and since then it has been found in Montana and Wyoming. Since the perfect stage became widespread, powdery mildew appears to be more severe every year.

Damage:
Yield and sugar loss from powdery mildew can be as high as 35% if not controlled. The first symptoms of the disease are small, disperse, white colonies appearing on the older leaves. Often the initial colonies first appear on the underside of the leaves. As the disease progresses, younger leaves become infected and the plant takes on a dusty white appearance. The disease can cover entire leaves, and severely infected leaves may become yellowed, then purplish-brown.

IPM and Cultural Controls:
Partially resistant varieties are used and fields are monitored so that treatments are used when economic threshold levels appear imminent. Unfortunately, resistance is often incorrectly equated with immunity, and growers may incur unnecessary losses by failing to treat a resistant variety when it should be. With a resistant variety, disease development will usually be slower and not reach the same level of severity as with susceptible varieties. Furthermore, resistance is incomplete. Powdery mildew resistance does not determine a growers' variety selection; resistance to other diseases (e.g., beet curly top) drives the decision. Specific data for treating a powdery mildew-resistant variety have not been developed. The IPM practice is to monitor powdery mildew development and treat just before or as initial infections occur. If it is found in the area, chances are good it will spread to the crop.

Chemical Controls:
Because powdery mildew has the ability to increase rapidly, the concept of reaching a disease threshold before treating is of little practical value. Early detection is essential for good control; it is far more effective to treat at first appearance of the disease, or preferably just prior to its appearance, than to wait until the disease is widespread. The date of powdery mildew appearance is rather predictable in most sugarbeet growing areas in southern Idaho, and experienced growers and fieldmen are usually prepared and know when to look for it. In southwestern Idaho, for example, the disease first appears approximately July 1, but in some years it appears the last week of June. The earlier the disease appears, the more severe it will be. Traditionally the disease occurs approximately two weeks later in the western portion of Twin Falls County. Traveling to the east, the first appearance is progressively later. The disease usually appears in

Colorado and southern Wyoming in mid to late August, but can appear as early as mid-July in some parts of Colorado.

Sulfur (liquid formulations, various trade names) is applied through sprinklers (chemigation) or by aircraft at a higher rate. Applications are repeated at two- to four-week intervals if needed. Sulfur dust is applied by aircraft and provides superior control to the liquid formulations.

The strobilurin fungicides such as Trifloxystrobin (Gem) and pyraclostrobin (Headline) are registered for powdery mildew on sugarbeets, but because of potential resistance to these fungicides, no strobilurin fungicide is used more than once during the season, and they are tank mixed with sulfur. Azoxystrobin (Amistar, Quadris) is also registered for powdery mildew control, but it is not recommended because of poor efficacy.

Benzamidazole fungicides such as thiophanate-methyl (Topsin M) are also registered for powdery mildew control, but they, too, have resistance issues. They are tank-mixed with a non-benzimidazole fungicide—usually sulfur—and are not applied more than once during the season.

Tetraconazole (Eminent), a triazole fungicide, can be used for powdery mildew or Cercospora leaf spot. It was recently registered (April 15, 2005) by EPA, but the only states in which it is registered are those that had previously used it as a Section 18 registration (Colorado, Montana. and Wyoming) for Cercospora leaf spot. Idaho growers worked with the Idaho State Department of Agriculture to get a Section 24c registration to use tetraconazole in Idaho for powdery mildew and Cercospora leaf spot, but the 24c was revoked shortly after it was granted because the traizole fungicides are being reviewed by EPA and the sugarbeet acres on which tetraconazole would be applied in Idaho had not been added to the risk cup. It is intended Eminent will be registered (either as a full label, or a 24c) in states not currently on the label in the future, once the risk assessment for the triazoles is complete. Myclobutanil (Laredo), another triazole fungicide, was used as a Section 18 for two years in Idaho. EPA discontinued Section 18s for triazoles when new fungicides were registered. However, another class of fungicides is needed for powdery mildew control in order to maintain the present uses of benzamidazoles and strobilurins.

Rhizoctonia Crown and Root Rot, *Rhizoctonia solani* AG 2-2
Rhizoctonia crown and root rot caused by the fungus *Rhizoctonia solani* AG 2-2 is one of the most damaging sugarbeet diseases worldwide. Rhizoctonia is found in all states represented by this document. Losses are highest in warm, irrigated production areas where sugarbeets are cropped intensively.

Research shows that most infections occur through the crown from sclerotia deposited there primarily during cultivation and that application of effective fungicides to the crown prior to infection will provide good control. Prediction of crown infection has been difficult and various researchers have reached different conclusions as to when fungicide protection is needed. Recent research has shown that temperatures > 70 to 77°F at the 4-inch soil depth are required for infection and disease development.

R. solani anastomosis group AG 2-2 as well as *R. solani* AG-4 can also cause damping-off.

Damage:
Leaves of individual plants or groups of plants wilt during the heat of the day, but recover partially in cool periods. Leaves may retain their color for a time but eventually turn yellow and die. After severe daytime wilting, often the leaf petiole base darkens and the crown rots. Petioles remain attached to the crown and their base will have dark lesions. Severely infected roots are russet-brown or dark brown to black. Rot may be restricted to dark circular areas on the root. The root may be cracked or intact; it appears to be rotted, but inside considerable tissue can appear firm and healthy.

IPM and Cultural Controls:
In this stage of growth, controlling the deposition of soil into plant crowns during cultivation can help reduce disease severity. Resistant varieties were discussed in the Planting section.

Chemical Control**:**
The strobilurin fungicides azoxystrobin (Amistar), trifloxystrobin (Gem), or pyraclostrobin (Headline) are labeled for control. They can be applied at the 4- to 8-leaf stage. Application is made before soil temperature at the 4-inch depth exceeds 70 to 77°F Research has shown that post-emergence applications are more effective than in-furrow (at-planting) treatment and that azoxystrobin provides better control than the other strobilurin fungicides**.**

Rhizomania, Beet Necrotic Yellow Vein Virus (BNYVV), *Polymyxa betae*
Rhizomania is considered the most serious disease of sugarbeets worldwide. It was first detected in Idaho and Wyoming in 1992, and is now also a serious issue in Colorado and Oregon. It has recently been found in Montana, and is considered present in all sugarbeet-growing areas of the United States. This disease is caused by a virus, Beet necrotic yellow vein virus (BNYVV), which is transmitted by the fungus *Polymyxa betae*, commonly found in soil.

Damage:
The most obvious symptom is a mass of fine, hairy secondary roots that consist of a mixture of dead and healthy roots. Early-season infection may result in severely stunted, fleshy roots. Leaf symptoms are most often a general chlorosis that may reveal infested areas in the field. Yellowed and necrotic veins, from which the disease gets its name, can be diagnostic of Rhizomania, but these symptoms are rarely seen. BNYVV was detected in only 27 fields (670 acres) out of 354 fields sampled (14,740 acres) in 1992, the first year it was diagnosed in Idaho. Since that time the disease has spread considerably. Many growers have experienced severe economic loss, and several have had complete losses.

We now estimate that approximately 50% of the Amalgamated Sugar Company growing area of Idaho and eastern Oregon is affected—nearly 100,000 acres.

IPM and Cultural Controls:
During this stage of growth, water management is key to managing this disease; soil wetter than -40 centibars will encourage fungal development, as will compacted soils with reduced drainage. Proper weed management throughout the rotation can also be important to Rhizomania management. Resistant varieties were discussed in the Planting section.

Chemical Controls:
No chemical controls are registered for this disease at this stage of growth.

Seedling Diseases
Aphanomyces Damping-off and Black Root Rot, Phoma Black Leg, Pythium Damping-off, Rhizoctonia Damping-off, Fusarium Damping-off

Aphanomyces Damping-off and Black Root Rot
Aphanomyces cochioides is a relatively common soil-inhabiting fungus causing damping-off and root rot problems worldwide. It is favored by wet soil conditions and soil temperatures above 60°F. Damping-off is nearly entirely post emergent and besides killing seedlings it causes root rot of varying severity depending on soil moisture conditions, populations of the fungus in the soil, and susceptibility of the variety. Soil sampling procedures can predict disease potential. This disease is mostly an issue in Montana and Wyoming.

Damage:
Black root is the seedling stage, characterized by grayish, water-soaked lesions near the soil line. These lesions often turn black and infection can extend up to the cotyledons, causing cotyledons to become black and thread-like. On mature sugarbeets, the foliage wilts, turns dull green, and may eventually become yellowed or take on a scorched appearance. On roots, yellowish-brown water-soaked lesions become dark brown to black. Infection usually starts at the root tip. Disease severity and intensity depends largely on available soil moisture and temperature.

IPM and Cultural Controls:
Unnecessary irrigation and plant stress are avoided. Weed hosts, especially common lambsquarters and redroot pigweed, are carefully managed throughout the growing season. Resistant varieties were discussed in the Planting section.

Chemical Controls:
No chemical controls are used at this stage.

Phoma Black Leg
Damage:
It causes a serious post-emergence damping-off when infected seeds are planted.

Chemical Controls:
No chemical controls are used at this stage.

Pythium Damping-off, Pythium Ultimum
Damage:
With post-emergence damping-off, seedling plants may turn yellow, wilt, and die. Often the stem will appear pinched and rotted at the soil line, resulting in plants that fall over. If wet conditions persist, Pythium can cause root rots throughout the growing season. These rots are generally wetter than those caused by *Rhizoctonia solani*.

IPM and Cultural Controls:
Appropriate irrigation, which includes avoiding excessive water application, can reduce problems as can cultural practices to improve drainage.

Chemical Controls:
No chemical controls are used at this stage.

Rhizoctonia Damping-off
Rhizoctonia solani AG 4 and AG 2-2 are both involved in post-emergence damping-off. They are favored by conditions that slow emergence and seedling growth. Generally once plants have 4 or more true leaves Rhizoctonia damping-off is not as common.

IPM and Cultural Controls:
Growers also avoid cultivating soil such that soil is deposited into the plant crown. Good fertility is maintained and over-irrigation is avoided.

Chemical Controls:
No chemical controls are applied at this stage.

Fusarium Damping-off
This usually occurs in warmer soils (particularly with replants). Several species can cause damping-off. In Colorado, *Fusarium acuminatum*, *F. avenaceum*, *F. oxysporum*, *F. solani*, and *F. verticillioides* (syn. *F. moniliforme*) all have been demonstrated to cause seedling damping-off or rot.

Chemical Controls:
No chemical controls are applied at this stage.

Critical Needs for Management of Diseases in Western U.S. Sugarbeets at Emergence to Row Closure

Research

- Develop a growing degree-day model to aid in Rhizoctonia control measures.
- Develop rapid soil detection methods for rhizomania.
- Research changes in host resistance at different crop stages.

- Develop practical diagnostic tools for diseases.
- Understand the role of the perfect (sexual) stage of powdery mildew.
- Establish the anastomosis groups and subgroups of *Rhizoctonia* found in the Intermountain West and their distribution.
- Establish which strains of beet curly top virus are present in the Intermountain West and their distribution.

Regulatory

- Facilitate registration of triazole fungicides in Idaho for resistance management.
- Maintain pesticide registrations.
- Extend the registration of tetraconazole (Eminent) for powdery mildew control to states not currently on the label (e.g., Idaho and Oregon).

Education

- Update irrigation scheduling publications to reflect new research on powdery mildew infection under different irrigation regimes.
- Educate users on the effect of pesticide application on endangered species.
- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.

Insects

Most insecticide applications in the Treasure Valley are made in conjunction with powdery mildew treatments after lay-by. (Lay-by is defined as the last pesticide application made before row closure.) Chlorpyrifos (Lorsban), phorate (Thimet), zeta-cypermethrin (Mustang), or esfenvalerate (Asana) can be tank mixed with the powdery mildew compound. Growers spray for powdery mildew twice, so with the second application, chlorpyrifos (Lorsban) can be used again. Chlorpyrifos (Lorsban) only provides 21 days of control, so its application is sometimes repeated with the second application of powdery mildew controls.

Most of the damage from insect pests can be seen at this crop stage. Not all insect pests merit treatment every year; most do not. Pests that rarely require treatment include loopers, armyworms, spider mites, and webworms. Insecticide treatments directed at more serious, consistent pests such as the sugarbeet root maggot and cutworms may provide control for minor pests as well.

Armyworms and Loopers, *Spodoptera praefica, S. exigua, Melanchra picta, Autographa californica,* others

Armyworms are considered a major problem in the western half of Idaho. Two species are prevalent: the western yellowstriped armyworm (*Spodoptera praefica*) and the beet armyworm (*S. exigua*). A related leaf-feeding larva, the zebra caterpillar (*Melanchra* *picta*), is widely distributed but only rarely reaches damaging levels. Western yellowstriped armyworms have wide, velvety black stripes along their backs with many narrower, bright yellow stripes along their sides. They are approximately 1-1/2 inches when mature. Beet armyworms are dull green caterpillars with a dark, broad stripe along each side and many smaller, light, wavy lines down their backs. They are approximately 1-1/4 inches when mature. Armyworms are in the same family of moths (Noctuidae) as cutworms but the former larvae generally are slightly larger, are more brightly colored, and actively feed on plants during the day.

Mature alfalfa looper (*Autographa californica*) larvae are up to 1-1/2 inches long, light to dark green, with a thin white stripe along each side. These pests only rarely occur outside of Idaho.

Damage:

These pests are leaf feeders. Damage appears as skeletonized leaves with only leaf veins and petioles remaining. When armyworm infestations become dense and crowded, the larvae crawl en mass from field to field; sugarbeets adjoining infested alfalfa hay fields or cereals may be completely defoliated by armyworm larvae that disperse from these crops when hay is cut or a small grain crop is harvested. Although generally less damaging than armyworms, loopers can completely defoliate the beet plant as well, creating some economic losses if left uncontrolled. Looper damage occurs in the Treasure and Magic valleys and occasionally in Montana and northern Wyoming. Damage tends to occur later in the growing season. In most cases, loopers are controlled with the same treatments as armyworms.

IPM and Cultural Controls:

IPM practices are employed by monitoring populations and treating only when populations justify treatment. Older plants can tolerate considerable defoliation without any economic loss of root yield or sucrose content.

Biological Controls:

Armyworms commonly are attacked by parasitic wasps and flies that can help keep infestations in check.

Beauveria bassiana, live spores of an insect-killing fungus, is a registered control for armyworms and loopers. PHI is zero days. Three to 7 days after first spray is typically required for an infected insect to die and 7 to 10 days usually are required to see a reduction in the pest population. Hence, treatment must begin preventatively at the first appearance of the pest in anticipation that densities will reach economic thresholds. It needs to be applied at 5- to 10-day intervals for as long as pest pressure persists. Slow killing action and the need for repeated applications limit practical use in sugarbeet.

Some preliminary field work has been done in Idaho with inundative releases of commercially available *Trichogramma* wasps, but not enough is known yet to make practical recommendations about their use in sugarbeets

Chemical Controls:
No formal economic thresholds exist for armyworm or looper insecticide treatment decisions in sugarbeets. In most cases, since both loopers and armyworms are moth larvae, they may be controlled with the same treatments. Data does exist from California on treatment thresholds for these insects, and growers follow their general recommendations. When it appears that possibly 50% or greater defoliation is going to occur, treatments are usually made. No treatments are made for these pests in Colorado or southern Wyoming. Depending on infestation circumstances, treatments are applied from early crop emergence until after row closure.

- Carbaryl (Sevin) application is made to foliage when insects reach damaging levels. Application can be repeated up to 4 times if necessary.
- *Bacillus thuringiensis* spp. *kurstaki* (Dipel ES) application is made to foliage when insects reach economically damaging levels. It is most effective against small, newly hatched larvae. There is no contact action; larvae must eat treated leaves. Spreader-sticker is used. 0 days PHI. Growers are not apt to use this insecticide because it is very slow-acting.
- Chlorpyrifos (Lorsban)
- Esfenvalerate (Asana)
- Zeta-cypermethrin (Mustang)
- Methomyl (Lannate)

Blister Beetles, *Epicauta* spp., others
Gray, black, spotted, or striped ashgray and punctured blister beetles are 1/2- to 1-inch long, with conspicuous necks and soft, rounded wing covers that leave the tip of the abdomen exposed.

Damage:
Larvae are beneficial predators of grasshopper eggs. Beetle feeding, though highly localized, can defoliate plants to the midrib leaf vein. Economic infestations of these insects are rare, but isolated infestations may occur in years with or following high grasshopper populations. Blister beetle adults are quite mobile and may move into a field, cause localized feeding damage, and then quickly depart.

IPM and Cultural Controls:
Because blister beetles rarely reach damaging levels, and then typically only in relatively small spots within isolated fields, a simple but effective management approach is seasonal scouting and spot application of insecticides.

Chemical Controls:
No formal economic thresholds exist for blister beetle insecticide treatment decisions. They seldom are an economic problem. When the beetles present a problem they usually start working into a field from the border or borders, coming into it from previously inhabited brush or grass ground. When this happens, growers can often spray the borders of the field and contain the problem. Zeta-cypermethrin (Mustang) or esfenvalerate (Asana) are currently used in the Treasure Valley and La Grande areas.

Beet Leafhoppers, *Circulifer tenellus*
Beet leafhoppers are light yellow-green to gray-brown with wedge-shaped bodies approximately 1⁄8-inch long. They readily crawl as nymphs or jump and fly as adults. They are most important as the sole vector of curly top virus. The curly top virus survives the winter in the bodies of adult leafhoppers and then becomes a source of infection the following year. Not all leafhoppers found in sugarbeets are the true beet leafhopper.

Damage:
While beet leafhoppers do feed on and suck sap from sugarbeet plants, they seldom reach densities great enough to cause economic damage in this manner. It is their ability to vector the curly top virus that makes them a critical insect pest. Curly top is so devastating to sugarbeets as to have almost eliminated the industry prior to the development of virus-tolerant cultivars. Symptoms of the virus include dwarfed and distorted leaves and roots.

IPM and Cultural Controls:
Disease epidemiology and vector life-history characteristics make it difficult to manage curly top by insecticide applications for leafhopper. Virus host range includes at least 300 species of crop and weedy plants. Leafhoppers can acquire the virus after only a few minutes of feeding on infected plants; however, not all beet leafhoppers are viruliferous. The vector readily disperses hundreds of miles from rangeland overwintering and spring breeding habitats and can develop through three generations each year. Area-wide IPM approaches that reduce sources of pathogen and vector in overwintering sites before leafhoppers disperse to crops can contribute to curly top management, but the geographic scale required is beyond the resources of the industry.

In areas where the beet leafhopper and curly top virus are a problem, several cultural practices can reduce the potential for leafhopper buildup and damage potential to the crop. Areas around fields, machinery yards, and roads are kept free of host plants. In high-risk areas, insecticide can be added to herbicide sprays when treating weedy areas around sugarbeet fields.

Permanent breeding grounds for the beet leafhopper are areas with low annual precipitation (less than 10 inches), low humidity, and desert-type vegetation. Beet leafhoppers require a sequence of succulent hosts that they utilize through the winter and spring to survive on when field crop hosts are not available. It is important to monitor the beet leafhopper population to determine if control measures are justified. Sensitive tests have been developed for curly top detection, and it is now possible to identify curly top virus sources. Test results can be used to determine the potential role of virus sources in disease development and crop loss. Standardized collection methods must be used to accurately monitor beet leafhopper populations and determine sources of virus.

Leafhoppers can be collected with a sweep net. Sampling must be done only when air temperatures are 60°F or greater to insure adequate leafhopper activity. Determining the leafhopper density will help to establish the virus risk level in the area.

Chemical Controls:
The following insecticides are registered for leafhopper control but are rarely used for that specific purpose. Insecticides used for controlling other insects frequently control leafhoppers. Growers do not treat for leafhopper unless they are concerned about curly top. Growers in Colorado, Montana, and southern Wyoming can adequately control curly top with resistant varieties and do not treat for leafhoppers. Neither beet leafhoppers nor curly top are a problem in the Columbia Basin.

- Terbufos (Counter 15G)
- Aldicarb (Temik)
- Phorate (Thimet, Phorate)
- Esfenvalerate (Asana)

Crown Borer, *Hulstia undulatella*
The crown borer is considered a minor pest of sugarbeets; when it attacks beet crowns it generally causes minor injury. Crown borers overwinter as pupae in the soil. Adult moths emerge in the spring and lay eggs around the beet crowns or on the leaves and petioles. Two generations are produced per year, with the first usually being the most damaging.

Damage:
The most severe damage occurs near thinning time, when first-generation larvae cut off leaves and kill young plants. At this time it is too late to replant a field that has been decimated by this pest. Surviving plants have superficial feeding scars around the crown.

IPM and Cultural Controls:
Crown borers have one reported natural insect parasite, a chalcid wasp. It is an effective parasite at low borer population levels but not effective in controlling high population levels.

Chemical Controls:
Growers in Nyssa, Oregon and Elmore County, Idaho (both in the Treasure Valley) treat for this pest using one the following:

- Terbufos (Counter), applied at-plant for sugarbeet root maggot, or
- Chlorpyrifos (Lorsban) applied post-emergence.

Cutworms, various spp.

Damage:
Cutworms can be divided somewhat artificially into two categories on the basis of feeding habits: subterranean species vs. climbing species. Both groups are nocturnal feeders. The subterranean cutworm species (pale western, black, glassy, redbacked, and granulate cutworms) primarily feed underground, cutting plants off below the soil line. The first sign of a problem may be wilting plants or many plants in a row cut off overnight. Climbing cutworm species (spotted, variegated, and army cutworms) feed aboveground, cutting plants off at or above the soil line. These species also climb into the center crown of older plants where they feed on the newest leaves and petioles. Seedlings are girdled at the soil line and stands may be significantly reduced in some cases.

IPM and Cultural Controls:
Even experts find it difficult to differentiate between various species of cutworm at the larval stage; it may be more practical to monitor activity of adult moths with pheromone traps. In practice, cutworm presence is determined by observation of feeding damage. Disking and effective weed management can reduce cutworm numbers.

Chemical Controls:
Early detection of cutworm feeding and damage is essential to a good control program. No formal economic thresholds exist for cutworm insecticide treatment decisions in sugarbeets, but fields are generally treated when 5% of plants are damaged or cut and larvae are less than 1 inch long. Cutworm treatment is necessary in all areas represented by this document. Insecticides are effective if applied in a timely manner and directed at the soil around the base of the crop plants. Cutworm applications are generally tank mixed with post-emergence herbicides.

- Esfenvalerate (Asana) is applied as necessary. It is applied with ground or air equipment. It is inexpensive and effective.
- Zeta cypermethrin (Mustang) is used.
- Chlorpyrifos (Lorsban 4-E)

Flea Beetles
Potato Flea Beetle, *Epitrix cucumeri*; **Three-spotted Flea Beetle,** *Disconycha triangularis;* **Pale Striped Flea Beetle,** *Systena blanda;* and **Tuber Flea Beetle,** *E. tuberis*
Adults are typically small, often shiny, and have large rear legs that allow them to jump like a flea when disturbed. Flea beetles overwinter in the adult stage hidden under leaves or dirt clods or in other protected sites. They become active during warm days in mid-spring but their period of emergence may stretch out over several weeks. Many flea beetles are strong fliers, seeking out emerging host plants using chemical clues. Adults feed for several weeks. Soon thereafter, females intersperse feeding with egg laying. They lay eggs in soil cracks around the base of the plants. The minute, worm-like larvae then move to feed on small roots and root hairs. The larval stage is completed in approximately a month. The insects pupate and emerge from the soil as adults. There may be a second generation during the summer and, with a few species, a third generation. The flea beetle is sometimes a pest of newly emerging sugarbeets in the early stages of growth.

Damage:
Flea beetles primarily are pests in sugarbeet as leaf-feeding adult beetles rather than as root-feeding larvae. Adult feeding damage is easy to recognize by the numerous, small, round feeding holes (“shotholes”) in leaves. Feeding damage can reduce plant growth and even kill plants, depending upon the density of beetles present and the growth stage of the sugarbeet. Root damage by larval feeding usually is minor and control generally is not economical. Young plants and seedlings are particularly susceptible. Growth may be seriously retarded and plants even killed.

IPM and Cultural Controls:
Most management programs aim to control adult flea beetles early in the spring when seedlings are small and most susceptible to defoliation. Beetle generations that arise later in the growing season may cause some feeding damage, but sugarbeet plants generally compensate through increased summer growth.

Chemical Controls:
No formal economic thresholds exist for flea beetle insecticide treatment decisions. When adult populations are low and growing conditions are good, no chemical control may be necessary. Higher populations may require insecticides to prevent losses. Adult beetles can migrate or be windborne from one field to the next, so long-term control may require more than one insecticide application. Although flea beetles are common, injuries are often insignificant to plant health. On established plants, 10 to 20% or more of the leaf area must be destroyed before yield is impacted.

- Chlorpyrifos (Lorsban) is applied by spraying on foliage when insects are present.
- Carbaryl (Sevin) is applied by spraying on foliage when insects occur.
- Esfenvalerate (Asana) is preferable due to low cost; can be tank mixed with desmediphan + ethofumesate + phenmediphan (Progress) or other products for weed control.
- Aldicarb (Temik) is applied by banding directly over the plant row.
- Zeta-cypermethrin (Mustang)

Grasshoppers, various, including **Migratory Grasshopper.** *Melanoplus sanguinipes*, and **Red-Legged Grasshopper,** *M. femurrubrum*
Grasshoppers occur in many fields every year, especially in fields adjoining desert, rangeland, or Conservation Reserve Program (CRP) lands and other undisturbed (untilled) sites, but only periodically reach levels that justify control action. Eggs are deposited in the fall and overwinter in these sites. Hatching occurs during May and June, and nymphs begin feeding on weeds and other vegetation. As these areas dry up, grasshoppers move into sugarbeet fields and begin feeding on the sugarbeets. In years when vegetation dries up early in the season, grasshoppers are more likely to be an economic problem. Grasshopper outbreaks follow roughly a 22-year cycle in many parts of the west. During outbreak years, regional spray programs often are organized to treat grasshoppers in their overwintering habitat before they colonize crop fields.

Damage:
Damage is usually limited to field margins as the grasshoppers move out of adjoining hatching areas. Grasshoppers damage sugarbeets by consuming the leaves. Unusually severe infestations can result in grasshopper feeding into the newly emerged leaves and direct feeding damage to the growing point. This damage can occasionally result in death of the plant. In mid-summer, the increased mobility of adult grasshoppers coupled with the drying down of original food sources increases the damage potential to sugarbeet and other field crops.

In years with very warm temperatures during winter and early spring, a hatch of grasshoppers in early May can threaten young sugarbeet seedlings. Grasshopper nymphs move into sugarbeet fields and destroy young sugarbeets by consuming the cotyledons and the growing point of the small plants. If grasshopper densities are great, damage to these emerging fields can proceed rapidly and result in nearly complete stand loss, particularly near the borders.

IPM and Cultural Controls:
IPM is utilized in grasshopper control by monitoring populations and spraying only when economic threshold levels are reached. Extended cool (less than 65°F) and rainy weather during hatching can cause severe mortality of the young nymphs and can substantially reduce grasshopper populations.

Chemical Controls:
More than eight grasshoppers per square yard in the field margin or more than 20 per square yard in the border area would likely warrant control. Adult grasshoppers are much more difficult to control than the smaller nymphs, so in years when extremely high grasshopper numbers are present, early treatment of hatching areas before the grasshoppers become adults may reduce later impact. Growers sometimes treat field edges where grasshoppers are advancing rather than entire fields. Often only a side or part of the field containing the advancing grasshopper front is sprayed. Grasshoppers are not currently problematic in Region 6 (the Columbia Basin), but are found and treated in the other regions represented by this document.

- Diazinon (Diazinon) application is made to foliage when insects are present. Diazinon products registered on sugarbeets are being voluntarily cancelled by certain registrants in September, 2005.
- Carbaryl (Sevin)
- Esfenvalerate (Asana) can be applied to foliage to control grasshoppers
- Methyl Parathion (Methyl Parathion, Declare) is used for control of grasshoppers.
- Zeta-cypermenthrin (Mustang)

Leafminers, *Liriomyza huidobrensis, Pegomya betae, Psilopa levostoma,* others
Leafminers are shiny, black flies, 0.04 to 0.12 inch in length, with yellow markings. They overwinter in the soil in the pupal stage. Adult flies will emerge in May and seek out sugarbeets on which to lay their eggs. The adults are gray and smaller and thinner than a house fly. The larvae are white maggots and are always present in the mine inside the leaf. Females puncture the leaf to feed on plant sap and to lay their eggs within the leaf tissue. When the eggs hatch, larvae feed on the area between the upper and lower leaf surfaces. Larval development within the leaf lasts 7 to 10 days. Following this period, the maggots move to the soil and pupate. The pupal period lasts for 2 to 3 weeks, after which the flies emerge to begin a new generation. They usually do not cause serious damage, but have been severe enough to require treatment in some growing areas of Idaho and Oregon in recent years. Reasons for these increases are not known. Temperatures are reduced in fields under circle irrigation, however, allowing leafminers to remain in fields for an extended period of time—as much as 4 to 6 weeks longer. This pest has seldom

constituted a problem in Colorado, Montana, Washington, or Wyoming due to weather conditions that keep insect life cycles short. However, it has the potential to become an economically important pest in years with cooler temperatures.

Damage:
Eggs are laid on the underside of the leaves of small sugarbeets. After hatching, the larvae enter the leaf and feed between the upper and lower leaf. While the larvae are small, they create narrow, winding tunnels in the leaves that are visible as water-soaked or whitish areas. As the larvae increase in size and in feeding requirements, the feeding area appears as large irregular blotches on the leaves. These large leaf mines will dry up and darken, giving the plant a very ragged appearance. Affected leaves are rendered useless for photosynthesis.

IPM and Cultural Controls:
Growers monitor populations and treat only when the pest reaches economically damaging levels. Leafminers attack sugarbeets early in the season when leaf area is limited; however, the leaf area of a sugarbeet with these mines is seldom great enough to warrant treatment. The area of the mines will increase until the maggots move out of the leaf to pupate. At this time the sugarbeet plants begin to increase in size, and by the time the next generation of leafminers begins, the size of the sugarbeets limits the impact of the insect. An additional factor limiting leafminer damage is a potentially high rate of parasitization of the larvae near the end of the first generation.

Chemical Controls:
No formal economic thresholds exist for leafminer insecticide treatment decisions. Growers check the undersides of leaves starting early in the growing season to give them a good indication of whether or not the infestation will require treatment. The earlier the eggs appear, the more likely treatment will be necessary. If the plants have fewer than six true leaves and almost every plant has some eggs on it, then a treatment should be made. Another rule of thumb is that defoliation of 50% or more warrants treatment, unless the sugarbeets are small, in which case they would be treated before defoliation reaches this level.

- Chlorpyrifos (Lorsban)
- Aldicarb (Temik) is the preferred treatment due to effectiveness. It is generally not applied specifically for leafminers because it is too expensive.
- Asana (Esfenvalerate) can be tank mixed with herbicide.

Lygus Bugs, *Lygus* spp.
Lygus bugs are pale green to red-brown sap-sucking bugs, 1⁄4-inch long when mature. The wings of adults fold flat over the back to make a light-colored, V-shaped mark behind the thorax. Lygus overwinter in crop residue and protected areas. They emerge as temperatures warm in the spring. This is an occasional pest that does not occur every year.

Damage:
In sugarbeets, plant injury occurs as bugs puncture leaf surfaces with their beaks and suck the plant juice from new succulent leaves. Injured plants wilt more easily than healthy plants. Occasionally, lygus kill heart leaves and damage crown regions, so that multiple crowns are produced. Adults can readily move in and out of sugarbeet fields, and their movement often coincides with the cutting of hay.

IPM and Cultural Controls:
The host plant range for lygus is extensive, therefore there are many sources from which this pest can come to attack sugarbeet. Alfalfa (both hay and seed crops) is an especially good host. Awareness of prime hosts can play a role in treatment decisions. Destruction of crop residues and of all overwintering sites along banks, ditches, fence rows, and roadsides will reduce lygus bug populations.

Biological Control:
Beauveria bassiana (live spores of an insect-killing fungus) is a registered control for lygus bugs. Its PHI is zero days, and the product typically requires 7 to 10 days after first spray to see control. Treatment should begin at first appearance of pest. It is applied at 5- to 10-day intervals for as long as pest pressure persists. Growers do not have experience using this biological control.

Chemical Controls:
North Dakota State University has established a crude treatment threshold of a third of the plants infested with one or more lygus bugs.

Lygus bugs are currently not a problem in Region 6 (the Columbia Basin). Lygus bugs can be found during the season in sugarbeet fields in Colorado, Montana, and southern Wyoming, but are not a significant enough problem to warrant extensive treatment. It is found and treated in all other regions represented by this document. The following chemicals may control lygus:

- Chlorpyrifos (Lorsban)
- Zeta-cypermethrin (Mustang) can be applied with ground or air equipment.
- Esfenvalerate (Asana) is not registered for lygus bugs, but is effective at controlling them when it is directed at other insects.

Sugarbeet Root Aphid, *Pemphigus populivenae*
Sugarbeet root aphids are small, yellowish-green and broadly oval in shape. They feed entirely on roots, secreting a white, waxy material on the sugarbeet taproot, fibrous roots, and the surrounding soil that sometimes is mistaken by growers for mold growth. Several generations are produced in the root colonies. These winged aphids fly out of the sugarbeet fields and overwinter on narrow-leaved cottonwood trees along irrigation canals, in residential areas, and in the mountains. Some root aphids remain in the soil in the fall and overwinter. These aphids are capable of beginning new infestations on sugarbeets or other host weeds the following spring.

Given their cryptic habits but near universal occurrence in every sugarbeet field every year, the economic importance of sugarbeet root aphids likely has been underestimated across the west.

Damage:
Root aphids feed on the small secondary roots of sugarbeets. Their feeding interferes with plant growth by inhibiting nutrient and water uptake and transport. Severe infestations cause leaf yellowing and wilting and are often limited to spots in the field. This severe damage results in yield and quality losses. Symptoms include a field pattern of circular or elliptical patches consisting of chlorotic and wilty plants.

IPM and Cultural Controls:
The best option for managing the sugarbeet root aphid is the use of resistant varieties. Recent testing of sugarbeet varieties has shown that many varieties have excellent resistance to the aphid in the field, whereas susceptible varieties can be severely impacted by the presence of aphids. Most sugarbeet seed companies have lines with excellent resistance to the aphid. Testing has been done to determine resistance levels for regional varieties; however, not all varieties grown in the region have been evaluated. Long rotations (minimum of 3 years) and effective weed management (especially of common lambsquarters and redroot pigweed) are important preventative controls. Additional preventative controls include working infested fields immediately after harvest, disinfecting equipment before going into uninfested fields, and not using tailwater from infested fields on uninfested fields. Cultural controls also include avoiding water stress and minimizing the interval between irrigation cut-off and harvest since yield and quality losses are greatest in water-stressed sugarbeets.

Chemical Controls:
No formal economic thresholds exist for root aphid insecticide treatment decisions. Recent research in the High Plains Region (Colorado, Montana, Nebraska, and Wyoming) indicates that even moderate populations of root aphids, where no above-ground symptoms are evident, can result in significant sugar losses (up to 30 percent) on susceptible varieties. Additional stress, such as drought or disease, will increase the impact of the aphids. Sugarbeet root aphids are not currently an issue in the Columbia Basin. Growers in the other regions represented by this document report that root aphids are not treated because there are no effective controls. Terbufos (Counter 15G) can be applied post emergence for control of sugarbeet root aphid. However, it is difficult to apply Counter at this time of the year because it cannot be applied aerially.

Sugarbeet Root Maggot, *Tetanops myopaeformis*
This pest is considered the most serious sugarbeet insect in Idaho, eastern Oregon, and Colorado. It is also a problem in Montana. Adult flies are somewhat similar in size and appearance to the house fly (approximately 0.25-inch long). However, the body is shiny black with few hairs. Larvae are white, legless maggots that grow to approximately 0.25 to 0.33 inch in length. The head end is tapered to a point and the rear end is blunt. The pupae are tan to brown, elongate capsules approximately 0.31-inch long. Sugarbeet root maggots overwinter as full-grown larvae approximately 10 to 14 inches deep in the soil.

As temperatures rise in the spring, the larvae move close to the soil surface and pupate. Sugarbeet root maggots pupate in April and flies begin to emerge in early May. The flies move from last year's sugarbeet fields to the current fields soon after emergence. Flies readily disperse a kilometer or more, so field location (distance from overwintering sites) is an important factor that determines pest status. Fly activity in sugarbeet fields is greatly increased under warm and calm conditions. During cool or windy periods the flies remain in sheltered areas along field margins. Females lay eggs in the upper 0.25 to 0.5 inch of soil at the base of the sugarbeet plants. White, elongate eggs are laid in batches of a few to 40. Survival of eggs and early larval stages is greatly reduced in dry soil conditions. Larvae begin to feed on the sugarbeet roots and continue to feed for approximately 3 to 4 weeks. By late June to early July, feeding ceases, but the larvae remain in the soil around the sugarbeet roots. A single generation develops annually.

Spring-emerging adult flies lay eggs in soil next to young sugarbeet plants during May and June. Soilborne larvae subsequently feed on the taproot through mid-July, then diapause as nonfeeding, overwintering larvae.

Damage:
Root maggots feed with rasping mouth hooks that scar the surface of the sugarbeet root. Deeper scarring and malformed roots may result from heavier feeding. Heavy infestations of the sugarbeet root maggot can cause severe stand loss, particularly with small plants because the maggots feed on and sever the tap root. Most feeding damage occurs on young sugarbeets in late spring to early summer causing deeply scarred or severed taproots. Severe damage results in wilted or dead plants. Losses may also result from reduced plant vigor, and damaged plants may be more susceptible to root diseases. If not controlled, root maggot causes very serious economic losses each year. Even by following the best practices available to control this pest, its seriousness is such that without pesticide control when needed, sugar production in the most severely infested regions of Idaho and the Treasure Valley of Oregon would be cut in half. In the Magic Valley, 80% crop loss can be expected in the absence of treatment. Sugarbeet root maggot occurs in eastern Montana production areas and losses due to this pest can be significant but treatments are not warranted every year. Approximately 80% of the acres in Idaho are treated each year for sugarbeet root maggot. Yield losses result from seedling mortality and stand loss; diminished root systems that do not use water and nutrients effectively; reduced plant vigor and yield from damaged plants; and harvest losses when roto-beaters knock weakly anchored roots out of the row.

IPM and Cultural Controls:
IPM practices have been developed and are being followed in control of this pest. Sticky stake traps are placed in sugarbeet fields to monitor ovipositional flights of adult flies. Rather than preventively applying insecticides at planting time, growers instead can apply insecticides after plant emergence if traps signal that economic damage is likely. A degree-day program forecasts fly activity. However, fly populations have been known to build so rapidly that waiting until the economic threshold is reached to apply insecticides has resulted in intolerable crop losses. Therefore, upon early detection, treatment may be indicated. In Colorado, sometimes growers with light infestations will irrigate the field to

fill the soil profile. This causes the root maggots to feed above the water line and avoid severing the taproot

Chemical Controls:
This pest annually reaches economically damaging levels in many production regions. Although a few insecticides are registered for adult fly control, this tactic is not recommended. Adult root maggot flies are highly mobile; they continually colonize fields over long distances during a 6-week egg-laying period. Effective timing of insecticide applications, therefore, is not possible. Adult control would require repeated insecticide applications to kill flies before they laid eggs, but this has the potential negative side effects of selecting for pesticide resistant strains and triggering outbreaks of aphids and leaf-feeding caterpillars by eliminating their natural enemies. Furthermore, if adult controls are used, additional treatments for larvae will still be required. The timing of post-emergence insecticide applications directed at larval control is determined by monitoring local flight activity of adult root maggots with sticky traps. Larval control is most effective when insecticide application coincides with the time of peak seasonal fly capture on traps; earlier or especially later application is less effective. Peak capture signals that oviposition likewise has reached maximum seasonal activity and that larval feeding soon will begin. Some growers, especially in the Burley and Paul areas of Idaho (Magic Valley) make insecticide treatments before peak adult flight because growers there can reliably anticipate that trap captures will increase for several weeks, eventually exceeding threshold levels by 5- or 6-fold. Occasionally, on a localized basis, storms or disruptive weather patterns can kill enough flies or stretch out the emergence period such that insecticide treatment can be delayed or eliminated entirely.

Insecticide treatment for root maggot control is applied in a band over the row resulting in only one third of each treated field receiving pesticide. Root maggot is the major pest. When a treatment is directed at that pest, other pests may be controlled, but continued monitoring occurs to be sure the secondary pests are controlled. Additional treatments may be necessary.

- Aldicarb (Temik) is used in the Magic Valley (ID), Treasure Valley (ID, OR) and in Colorado, Montana, and Wyoming. Application is at first cultivation. No more than two post-emergence applications per crop are made. It is very effective for both adult fly and larval control. When treating for larvae, aldicarb (Temik) is the most efficacious control because of its solubility, which allows it to move deeper into the soil and control larvae that have descended to the root tip of the beet plants.
- Terbufos (Counter 15G) controls larvae and can be applied at first sign of fly emergence. It is mostly used in low-pressure areas.
- Phorate (Thimet, Phorate) controls larvae. It is mostly used in low-pressure areas.
- Carbofuran (Furadan) requires moisture for activation. Rain is needed in furrow-irrigated fields; in sprinkler-irrigated fields, growers follow treatment with light irrigation. It controls larvae. Applications are made 4 to 7 days after flies reach the economic threshold. Treatments are timed so that application begins after adult flies emerge. Carbofuran (Furadan) is used as a 24C label in Idaho and

Oregon, but it is not used in Colorado, Montana, or Wyoming. Furadan does not have a long residual.
- Zeta-cypermethrin (Mustang) is applied in furrow or in a 3- to 4-inch T-Band (band over open furrow). PHI 50 days. Used to kill adult flies, it is effective during peak emergence, especially in the high-pressure areas of maggot occurrence. It is banded over the row either alone or in a tank mix of herbicide and has shown great effectiveness in lowering maggot levels. Timing of application should be at peak flight with the intent of killing flies before they have had a chance to deposit eggs. It is a contact chemical that is used in a rescue situation when growers need an immediate kill. If there is low maggot pressure, some growers will use it as a primary treatment, again applying at peak flight.
- Esfenvalerate (Asana) (2ee) is used to control adult flies. In the past three years, growers have effectively utilized both Mustang and Asana as a peak fly flight application to control adult maggot flies in the Magic Valley. They are used in conjunction with a soil-applied insecticide to control the larvae and not as the sole treatment.

Two-spotted Spider Mites, *Tetranychus urticae*, others
Two-spotted spider mites, also known colloquially as red mites, overwinter as adults in protected places and under plant debris. In the spring, they migrate to the undersides of leaves and lay eggs. Both the young nymphs and adults feed on leaves. Numerous generations are produced each year. The two-spotted and red spider mites are sporadic problems in some locations when hot, dry, dusty conditions occur, particularly near field borders under rill irrigation. Mites are a sporadic problem in some locations in western Idaho, but are rarely a problem in the Upper Snake River Basin or in Colorado, Montana and Wyoming.

Damage:
Crop damage occurs in heavy infestations as plant leaves turn yellow and die.

IPM and Cultural Controls:
IPM is utilized by monitoring populations of both mites and predators and only treating if predator control is inadequate. Mites have numerous natural enemies including predatory mites that may keep populations in check, but chemicals applied to control other insect pests may also kill mite predators. The mites' host range is extensive and includes alfalfa, corn, dry beans, and potatoes. It has been reported that mites may prefer other hosts to sugarbeets. Sprinklers eliminate dust and thereby reduce mite problems.

Chemical Controls:
No formal economic thresholds exist for spider mite insecticide treatment decisions. Spider mites are not usually a serious enough problem to warrant treatment. Spider mites have the potential to be a problem in the Treasure Valley, but with the application of sulfur for powdery mildew, there has not been a problem for over 30 years. Depending on infestation circumstances, treatments are applied from crop emergence until after row closure. The following chemicals can be used when mite problems arise.

- Oxydemeton-methyl (Metasystox R) can be applied by chemigation.
- Phorate (Thimet)
- Sulfur (various) for powdery mildew control will also help with mites.

Webworms

Beet Webworm, *Loxostege sticticalis;* **Garden Webworm,** *Achyra rantalis,* and **Alfalfa Webworm,** *L. cereralis*

Webworms are problematic in some locations in Idaho; they are rarely a problem in Colorado, Montana, Washington, or Wyoming. Larvae are olive-green, up to 1-1⁄2 inches long, and marked with black dots and both dark and light stripes down the back and along sides. If disturbed, larvae hang from leaves by silk threads. Webworms overwinter as mature larvae or pupae in the soil. Adult moths emerge in May and begin laying eggs on sugarbeets. Eggs are laid singly or in small groups on the underside of the leaves. There are usually two generations of webworms. Larvae of the first generation feed in June and the second generation feeds in late July or August.

Damage:

Webworm larvae feed on the lower surface of the leaves. Early instars are not able to feed completely through the leaves resulting in a pitting on the lower leaf surface. Larval consumption rates in later instars increase dramatically through the leaves. Substantial defoliation can occur in a short time. This increase in defoliation is especially striking because the early instar feeding often goes unnoticed. Feeding initially appears as small transparent “windows” eaten from the undersides of leaves; later, it progresses to ragged, skeletonized, dirty, webbed leaves, especially midseason. Heavy infestations are usually localized, but in affected areas, plants may become almost completely defoliated resulting in substantial yield loss. After heavy infestations, only the midveins remain on the plant. Webworm larvae consume leaves rapidly; they can defoliate a beet field in a very short time. Heavy feeding can result in damage to the growing point.

IPM and Cultural Controls:

Weed control is extremely important since webworms prefer weedy fields; they deposit their eggs on such weeds as common lambsquarters and Russian thistle. Numerous predators and parasites have been reported preying upon webworms; a tachinid fly, in particular, parasitizes larvae. IPM is followed by monitoring populations and treating only as needed to prevent losses.

Chemical Controls:

With the development of new insecticides, webworms are no longer a major threat, although they are still potentially destructive. No formal economic thresholds exist for webworm insecticide treatment decisions. Treatment is considered if infestation levels average one to two webworm larvae on half the plants. Infestations are monitored closely, because webworms can defoliate plants rapidly.

- Esfenvalerate (Asana)
- Zeta-cypermethrin (Mustang)
- Chlorpyrifos (Lorsban 4E)
- Methomyl (Lannate)

- Carbaryl (Sevin)
- *Bacillus thuringiensis* spp. kurstaki (Dipel DF) application is made by spraying on foliage when insects appear. 0 days PHI. This product is not used by growers to control webworms because its action is too slow.
- Methyl parathion (Declare)

White Grubs, *Phyllophaga* spp.
White grubs are the robust, C-shaped larvae of June beetles, 1⁄8 to 1-1⁄4 inches in length, with a brown head capsule and prominent, jointed legs. The body is an overall dirty white, but the last abdominal segments are blue-black internally. White grubs, like wireworms, are widely distributed and live in the soil for several years. They have a wide host range and are among the most destructive of the soil insects. Adult beetles prefer pasture or grassland for egg deposition. The insect overwinters as eggs or larvae.

Damage:
Larval feeding can sever taproots early in the season and can cause surface cavities on taproots later during the season. Plants wilt and eventually die.

IPM and Cultural Controls:
Infestations are most likely when sugarbeets follow grassy pastures. Grasses are the preferred host plants both for oviposition and larval feeding. Some species require two or more years for egg-to-adult development, so old pasture can be infested with substantial populations of last-stage (large) grubs that are especially damaging to seedling sugarbeet plants. Plowing grasslands in the fall helps to destroy grubs. White grubs have many natural enemies including birds, skunks, and other insect parasites and predators. When planting sugarbeets following pasture or grassland, chemical treatment may be warranted.

Chemical Controls:
No chemicals are used to control white grubs at this crop stage. They are applied at planting.

Critical Needs for Management of Insects in Western U.S. Sugarbeets at Emergence to Row Closure

Research

- Research biological control methods for root maggots.
- Develop control measures for sugarbeet root aphid, since only varietal resistance is available.
- Research the use of registered biological controls.
- Research the efficacy of biological insecticides for control of leaf-eating caterpillars, spider mites, and leafminers.
- Develop a miticide for use on sugarbeets.
- Develop a replacement for diazinon (Diazinon).
- Develop a cost-effective control for leafminer.
- Research control measures for flea beetle larvae.

- Develop methods to monitor insecticide resistance for sugarbeet root maggot, especially when using pyrethroids.
- Research the effects of sugarbeet root aphid on the crop (i.e., quantify crop losses).
- Develop local, research-based economic thresholds for all insect pests aside from sugarbeet root maggot.
- Seek funding for applied entomologists.
- Develop an economic threshold for sugarbeet root aphid.

Regulatory
- Facilitate tolerance establishment and registration for triazamate (Aphistar) for sugarbeet root aphid.
- Maintain the registration of aldicarb (Temik) and terbufos (Counter).
- Add leafminer to carbofuran (Furadan) label.

Education
- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.
- Educate users on the effect of pesticide application on endangered species.

ROW CLOSURE TO HARVEST

Weeds

IPM and Cultural Controls:
Hand weeding is very common and is expensive both in labor costs and crop damage. Weeds may also be mowed down to the top of beet canopy.

Chemical Controls:
Glyphosate (Roundup) wick applications as described in the previous section are sometimes used in Idaho and Montana for weed escapes. Sethoxydim (Poast) (30 day PHI) and clethodim (Select) (40 day PHI) can be used to control grassy weeds at this stage.

Critical Needs for Management of Weeds in Western U.S. Sugarbeets at Row Closure to Harvest

Research
- Research improved dodder control methods.
- Evaluate other weed control methods such as mowing and candidate herbicides for wiper applications.

Regulatory

- Facilitate registration (Section 3 or 24C) for Roundup wiper use in all states.

Education

- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.

Diseases

Bacterial Vascular Necrosis and Rot, aka Erwinia Root Rot, *Erwinia carotovora* subsp. *betavasculorum*
This disease is generally more severe in warmer sugarbeet growing areas, such as Idaho, but can be found sporadically in other states of the intermountain west, such as Colorado, Montana, and Wyoming. Splashing water, insects, soil, and contaminated equipment may spread the pathogen. *E. carotovora* subsp. *betavasculorum* survives between sugarbeet crops in and on unharvested sugarbeets, soil, and weeds.

Damage:
Foliar symptoms of bacterial vascular necrosis are not always apparent, but dark black streaks running up petioles can develop. Gas produced by the bacterium may generate froth in the center of crowns. Root symptoms vary, ranging from soft rot to dry rot. Vascular bundles in roots become necrotic, and if cut and exposed to air they turn pink to reddish. Wilt can result if roots become severely affected, but plants do not die from the disease. Roots can become hollowed-out cavities. Yield losses of up to 40% have been reported.

IPM and Cultural Controls:
Workers and equipment remain out of the field when leaves are wet, to avoid spread of this disease. Plant injury during cultivation is prevented, because the bacteria cannot penetrate intact cell walls. Excessive nitrogen is avoided. The disease was more prevalent in the past, but infections decreased with the use of resistant varieties. It is increasing again, due to complacency in variety screening in recent years. Resistant varieties, another cultural control, are detailed in the Planting section.

Chemical Controls:
There are no chemical controls for this disease.

Beet Western Yellows
Beet western yellows virus (BWYV) is the most widely distributed of any of the beet viruses, and has an extensive host range of crops and weeds. The virus is transmitted by

at least eight species of aphids, the most important of which is green peach aphid (*Myzus persicae*). The virus is persistent in the vector for more than 50 days.

Damage:
Viral symptoms include mild chlorotic spotting of the interveinal areas, generally starting at the leaf tip. Veins generally remain green. As infected leaves age and the disease develops, yellowing becomes more intense and more tissue becomes yellow. Leaves become thickened and brittle. The chlorotic interveinal areas on older, severely infected leaves, often become infected with *Alternaria* spp., a low-grade secondary fungal pathogen.

IPM and Cultural Controls:
Because of the wide host range, rotation is ineffective. Resistant varieties are used in areas of the country where infection incidence is high. Because economic damage has not been assessed in the states covered by this report, resistant varieties adapted to this area have not been developed. Infection is usually first found in late July and in August, and little is known about loss from this disease.

Chemical Controls:
There are no chemical controls for this virus. Insecticides for control of this aphid vector control are not applied.

Cercospora Leaf Spot, *Cercospora beticola*
Cercospora leaf spot (CLS) is a foliar disease caused by the fungus *Cercospora beticola.* Management of CLS is critical to both growers and processors because this disease reduces harvestable tons, sugar content, and storability of harvested roots; it also decreases the amount of sugar extracted per ton due to increased impurities and loss to molasses. In Montana, Colorado, Wyoming, Oregon, and Idaho, losses over the past 6 years have ranged from 1 to 3 tons/A and 0.5 to 1.5% sugar. So far, it has been a minor pest in the Pacific Northwest states, but it is expected to become a major pest, given the right climatic conditions. In most years, between 500 and 1,000 acres are treated for CLS in Idaho. Storage and factory losses have been more difficult to measure but are probably near equal to field losses if this disease is not controlled.

Damage:
Spores are spread by wind and splashing rain, with wind transport generally less than 100 to 150 yards. Sporulation and infection are generally favored by warm (80 to 90°F) conditions where relative humidity in the leaf canopy is greater than 90% for more than 10 to 12 hours, and nighttime temperatures remain above 60°F. Infection and sporulation can occur at lower temperatures but require longer periods of relative humidity above 90% for infections to occur. High temperatures (over 95°F) may inhibit disease, and inhibition is very pronounced above 100°F.

Once the disease has infected the beet plant it causes necrotic spots on the leaves. The pathogen only causes visible symptoms on the leaves, but roots of affected plants do not store as well as roots from healthy plants. Initial symptoms appear as small, circular spots, 1/8- to 3/16-inch in diameter, with tan to gray centers and dark brown to reddish purple brown borders, beginning on the older leaves and progressing to younger leaves. In humid weather as spores of the fungus are actively being produced, spots may have a gray to steel blue, fuzzy appearance. As the disease progresses, leaf spots coalesce and kill large portions of the leaf. Severely diseased leaves wither and die, resulting in defoliation.

IPM and Cultural Controls:
Economically sound management of Cercospora leaf spot requires an integrated approach that incorporates crop rotation, planting varieties with at least an intermediate level of resistance, use of environmental monitoring to predict infection conditions, scouting, and timely application of effective fungicides. Growers use the following IPM program when the disease has caused losses:

- Maintain a minimum three-year crop rotation to reduce the inoculum and initial infection.
- Physically separate a new field from the prior year's field by > 100 to 200 yards. In the spring and early summer when temperatures exceed 60 to 65°F and the overwintering leaves are wet for long period of time (4 to 24 hours, depending on temperature) spores (conidia) are produced from fungal stroma in overwintered leaves and petioles. These spores are spread by wind or splashing water generally less than 100 to 150 yards.
- Reduce inoculum by fall plowing in order to bury infected plant material (before planting winter cover crops, if they are used). The *Cercospora beticola* fungus dies out rapidly once the leaves begin to decay, therefore tillage or other practices that hasten decay will reduce the potential for overwintering inoculum.
- Destroy sugarbeet foliar residues. In the narrow river valleys of Montana it can be difficult to separate the current year's planting sufficiently from the previous year's crop residues, therefore destruction of sugarbeet foliage residues is very critical.
- Reduce planting density where Cercospora is a known problem, allowing leaves to dry out more rapidly.
- Irrigate in such a way that sugarbeet leaves are dry by night.
- Manage weeds. Disease development each year is dependent on inoculum that survives the winter in infected leaves and petioles of the previous year sugarbeet crop or weeds such as winged pigweed (*Cycloloma atriplicifolium*), lambsquater, redroot pigweed, common mallow, wild buckwheat, and common unicorn plant (*Proboscidea louisianica)*.
- Use disease prediction models. The Cercospora leaf spot model developed at the University of Minnesota identifies infection periods and is used in Montana to predict CLS incidence. Other models have been developed. Generally, these disease prediction models are used wherever spraying for this disease is routine. Models have two integrally related components: percent disease severity and daily infection values (e.g., in Colorado, 72 hours at ≥72° F and ≥72% humidity). Weather data comes from temperature and humidity monitoring equipment placed in the canopy of a sugarbeet field. Losses are determined by the time of infection and infection intensity.
- Scout. Growers and fieldmen scout fields to determine the need for fungicide application. Initial scouting is done in fields bordering last years' sugarbeet fields and

in areas where plants dry slowly, such as areas protected from the wind or near water. Following initial detection the entire field is scouted weekly to determine the level of infection and the potential need for fungicide application.

Early disease detection and monitoring is essential to prevent economic loss. In early to mid-July an average of less than 1 leaf spot per leaf triggers a spray program, whereas by August 1, 1 to 5 spots per leaf indicate a problem and by mid August more than 5 leaf spots per leaf will be needed to justify fungicide application. In general, if disease levels are more than 75 leaf spots per leaf (3% leaf coverage) at harvest, significant economic loss has occurred.

Chemical Controls:
Although season-long protection is needed, the first spray is the most important in determining the efficacy of a spray program. Generally, poor control is due to waiting too long to spray, exceeding the recommended spray intervals, using lower than labeled rates or using fungicides to which the Cercospora fungus has developed resistance. Fungicide sprays are routinely used in Montana and parts of Wyoming. Occasionally in Colorado, Idaho, Oregon, and Washington, primarily in fields under sprinkler irrigation, Cercospora can become severe enough to warrant fungicide treatment. Some areas in Idaho are treated almost every year. Protective fungicides are applied only when disease is increasing and an average 0.5% (12 spots/leaf) of the leaf surface is infected. Fungicide sprays have increased net income by up to $350/A.

An effective fungicide treatment is essential for keeping the necrotic spots from enlarging and for preventing further infection and thus yield loss. While fungicides can prevent further leaf infections and spread of necrotic spots, the affected leaves will not produce as much photosynthate and thus sugar content will drop in the resulting crop. This 2% yield loss will translate into a three to five ton/acre decrease in sugar production.

Several fungicides are labeled for use on sugarbeets, including thiophanate-methyl (Topsin-M), tetraconazole (Eminent), trifloxystrobin (Gem), pyraclostrobin (Headline), azoxystrobin (Quadris), mancozeb (Dithane, Manzate, Penncozeb), maneb (Manex), triphenyltin hydroxide (SuperTin). Resistance to the benzimidazole fungicides is both widespread and common and these fungicides are not effective in some areas where use has been high in the past.

Research has shown that copper is less than 50% as effective as the other fungicides. Copper or EBDC products are applied on a 7- to 10-day spray interval and the other fungicides on a 14-day spray schedule. These spray intervals are carefully observed since new growth will need to be protected and the fungicides do break down.

Applications of thiophanate-methyl (Topsin M), benomyl (Benlate) tetraconazole (Eminent), or the strobilurins (Gem, Headline, Quadris) used alone are limited to no more than 1 application per season to minimize the potential for fungicide-resistant isolates of Cercospora to develop. If these fungicides are used in more than one application, they are mixed with another fungicide or used in an alternate spray program with other fungicides.

No resistance to tetraconazole (Eminent) or the strobilurin fungicides (Gem, Quadris, Headline) has been found, but tolerance to 1 to 10 ppm in increasing amounts has been seen. Tetraconazole (Eminent), a triazole fungicide, was recently registered (April 15, 2005) by EPA, but it is registered only in states that had previously used it as a Section 18 registration (Colorado, Montana, and Wyoming) for Cercospora leaf spot. Following its registration, Idaho growers, with the assistance of the State Department of Agriculture, obtained at Section 24c label to use tetraconazole in sugarbeets for powdery mildew and Cercospora leaf spot. However, this 24c was later revoked because the traizole fungicides are being reviewed by EPA and the sugarbeet acres on which tetraconazole would be applied in Idaho had not been added to the risk cup. It is intended that Eminent will be registered (either as a full label, or a Section 24c) in states not currently on the label,in the future, once the risk assessment for the triazoles is complete.

Generally, tetraconazole (Eminent), thiophanate-methyl (Topsin M), trifloxystrobin (Gem), pyraclostrobin (Headline), and azoxystrobin (Quadris) are used only in the first spray and other materials used in subsequent sprays. These systemic fungicides are desirable at the first spraying because they can eradicate infections that are 24 to 72 hours old.

Selection of fungicides can also depend on whether the beet tops are used as livestock feed. Only tops treated with Topsin M, Penncozeb, Manex, Eminent, Gem, Headline, or Quadris or copper (Champ, Kocide) can legally be fed.

Powdery Mildew, *Erysiphe polygoni*
Powdery mildew is still present and treated for at this crop stage.

Chemical Controls:
Research in Idaho indicates it is economically feasible to apply sulfur to fields developing initial powdery mildew infections up to 5-1/2 weeks before harvest (first of September).

Pythium and Phytopthora Root Rot, *Pythium aphanidermatum, Phytopthora drechsleri Pythium aphanidermatum,* and *Phytopthora drechsleri*
These rots can be problematic at this crop stage. Water management and proper drainage are the only methods of control. No varietal resistance is available.

Damage:
Brown to blackish wet rot begins on the lower taproot and progresses upward.

Chemical Controls:
No chemical controls are used for this disease at this time.

Rhizoctonia Root and Crown Rot
Water management is imperative to minimize this disease.

Scab, *Streptomyces scabies*

Caused by the filamentous bacterium *Streptomyces scabies,* scab is not economically important. It is common to see roots affected with surface lesions at harvest but the roots themselves seem normal in size and shape and growth.

Damage:
The disease is usually seen as brown scaly or corky superficial lesions, although warty outgrowths from the sugarbeet or lesions that penetrate into the root can be seen in some cases. Lesions are generally dry. Lesions can appear very similar to dry, scabby lesions caused by latent *Aphanomyces cochlioides* infections.

IPM and Cultural Controls:
Scab tends to show up in heavier soils and is usually associated with moisture and inadequate aeration. Therefore, better soil conditions can reduce disease incidence. No varieties with scab resistance are known.

Critical Needs for Management of Diseases in Western U.S. Sugarbeets at Row Closure to Harvest

Research

- Develop controls for Fusarium root rot, including varietal resistance.
- Develop biological strategies for disease control (biological control, biological fungicides).
- Understand the role of the perfect (sexual) stage of powdery mildew.
- Research the epidemiology of all diseases to understand how diseases spread.
- Develop resistant varieties for Erwinia control.
- Understand the effect of tail water on spreading diseases such as Erwinia.
- Research the efficacy of oilseed radish and other cover crops and green manures for root disease suppression.
- Investigate scab: biology, cause, spread.
- Investigate the relationship between weed presence and disease incidence.
- Research late-season applications for powdery mildew control.
- Research powdery mildew development under different irrigation methods.
- Investigate resistance management.

Regulatory

- Add resistance management as a justification for a Section 18.
- Maintain pesticide registrations.
- Extend the registration of tetraconazole (Eminent) for powdery mildew and Cercospora leaf spot control to other states not currently on the label (e.g., Idaho and Oregon).

Education

- Educate growers on the use of economic thresholds late in the season.
- Educate growers about identification of Fusarium root rots.
- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include

multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.
- Educate users on the effect of pesticide application on endangered species.

Insects

Bean Aphid, *Aphis fabae*
The most serious aphid on sugarbeets in the Regions 1, 2, and 3 (Magic Valley/ LaGrande, Treasure Valley, Upper Snake River Basin) is the bean aphid. It is not a serious problem every year, and infestations usually occur relatively late in the season as scattered hot spots or along edges rather than uniformly across the entire field. It is a dark-bodied aphid, 1⁄16-inch long. These aphids overwinter as eggs on *Euonymous* and *Viburnum* spp. ornamental shrubs in urban landscapes. The eggs hatch in the spring, producing stem mothers, which later give birth to female aphids, the first summer generation. These first-generation aphids fly to summer host plants and crops on which numerous generations of wingless female aphids are produced throughout the summer.

Damage:
During years with high populations, yields can be substantially reduced if the insect is not controlled. Colonies can produce massive amounts of honeydew, which causes a black, sooty mold to cover the leaves. In contrast to another aphid that infests sugarbeets in some parts of the country, the green peach aphid (*Myzus persicae*), bean aphids primarily cause direct feeding damage by sucking sap from plants rather than indirect damage by vectoring plant pathogens.

IPM and Cultural Controls:
IPM practices are followed by monitoring populations and only using insecticide treatments when predator control is inadequate.

Chemical Controls:
A diverse community of naturally occurring predaceous and parasitic insects potentially can contribute to aphid suppression. Foliar application of non-systemic, neurotoxic insecticides (whether directed for aphid control or targeted at another pest) is especially hazardous to these natural enemies. However, when soil-incorporated, systemic insecticides are used, hazard to canopy-dwelling natural enemies is minimized because they do not contact the insecticide; hazard is not reduced when systemic insecticides are applied over the plant canopy. If natural enemies are absent, insecticide applications are considered if bean aphids are on most leaves and if colonies cover 20 to 40 percent of leaf surface.

- Phorate (Thimet, Phorate) is applied only once per season, as a post-emergence treatment. Growers can no longer apply phorate aerially for bean aphid.
- Chlorpyrifos (Lorsban) is applied over foliage when economic thresholds are met.

Critical Needs for Management of Insects in Western U.S. Sugarbeets at Row Closure to Harvest

Research

- Research the tank mixes for new insect control agents and along with powdery mildew fungicides.
- Develop/refine the bean aphid economic threshold.

Regulatory

- Re-instate aerial applications of Phorate.
- Maintain pesticide registrations.

Education

- Educate growers about ongoing research through university researchers publishing end-of-year research reports. Such reports should include multidisciplinary information so that everybody who looks at the sugarbeets (e.g., university personnel, industry representatives, fertilizer dealers) has the same information available to them. Educate growers about the availability of these reports.
- Educate users on the effect of pesticide application on endangered species.

HARVEST

Harvest is that period of time beginning with the first harvest operation in the growers' field (defoliation) and ending when the sugarbeets are placed in storage piles at the receiving stations. There are two harvest periods, early harvest and regular, or late, harvest. Growers get paid more per unit during early harvest since yields are lower. Early harvest contracts are different every year and are determined by each sugarbeet processing facility. The harvest period usually begins in mid September to early October. Harvest is essentially complete by the 10th of November in all areas.

Defoliation

Defoliation is the process of removing the leaf and petiole material from the sugarbeet root. This is done mechanically using a defoliator, which generally covers either 6 or 12 rows of sugarbeets at a time. The machine consists of three rows of flails (older machines may have two rows of flails), which rotate vertically over the individual sugarbeet rows. Flails are made of either steel or a hard rubber-like material. The configuration of steel and rubber will vary by manufacturer and grower preference. It is common to either have the first row of flails made of steel followed by two rows of rubber flails, or to have all three rows rubber flails. Some rubber flails are equipped with metal studs similar to those found in snow tires.

Most defoliators have scalping units (i.e., discs that rotate horizontally or knives) following the three rows of flails. Some type of shoe is attached to determine the depth of the cut on the beet. The purpose of these units is to insure all petiole material is removed from the sugarbeet by slicing off a small portion of the crown material on the top of the sugarbeet root. The amount of crown material removed differs according to the preference of the contracting sugar company; varies from no crown removal to crown removal down to the lowest leaf scar on the sugarbeet root. All companies require complete removal of petiole material.

In some instances, where large amounts of weeds are present in the field, or where the sugarbeet tops are damaged by frost and are therefore difficult to defoliate, a grain stubble shredder may be used to remove much of the sugarbeet leaves and petioles as well as weeds prior to using the defoliator, making the defoliator much more effective.

Harvest

Following the defoliation process the sugarbeets are lifted from the ground and loaded into trucks by the sugarbeet harvester. This machine lifts the sugarbeets from the ground, deposits them in a cleaning area of the harvester where dirt and foreign material such as weeds and sugarbeet tops are removed, and then elevates them into the truck. The truck then transports them to the receiving station. Some harvesters have the capability of storing some sugarbeets on the machine itself, while others must have a truck present to operate. The most common harvesters harvest six rows of sugarbeets at a time. However, harvesters harvesting two, three, four, six, or eight rows are also in use. Most sugarbeet equipment is expensive and very specific to sugarbeets. Growers who plant in 30-inch rows commonly use 4-row harvesters, whereas fields planted in 22-inch rows are harvested with 6-row harvesters.

Harvest immediately follows defoliation; sugarbeets are not left in the ground for any length of time after defoliation. Doing so causes the sugarbeets to be more susceptible to warming or freezing, depending on the weather. Both conditions are detrimental to beet storage. Defoliated sugarbeets that are left in the ground for longer periods of time will also start to re-grow tops, which causes a decrease in sugar content and beet quality.

Piling

Sugarbeets are loaded onto trucks and hauled to sugar company receiving stations, which are located throughout the sugarbeet growing areas. Here the loaded trucks are weighed, then unloaded on the sugar company's sugarbeet piler. This machine elevates the sugarbeets, and then runs them over a cleaning area to remove dirt, remaining tops, and weeds. This material removed by the piler is weighed and credited back to the individual grower. Subsequently, the dirt—referred to as tare dirt—and foreign material is either hauled away by the grower, or by a common hauler hired by all growers at that receiving station.

After the sugarbeets are cleaned, samples of the sugarbeet loads are taken to determine the amount of dirt, sugarbeet tops, and weeds remaining with the sugarbeets. Samples are also tested for sugar content. All samples are identified by the grower's contract number. After going across the cleaning and sampling areas, the sugarbeets are then further elevated and deposited into the storage pile. The empty trucks are then weighed as they leave the piling ground. Gross and light weights of the truck, the weight of the dirt and other foreign material removed by the piler, and the results of the analysis made on the samples taken from the sugarbeet loads are the basis for the payment made to the grower for the sugarbeets.

Nematodes

Soilborne pests such as nematodes and diseases are present in tare dirt. Growers avoid infecting fields by not dumping tare dirt in sugarbeet fields. In fact, in Amalgamated growing areas, dumping tare dirt is strictly prohibited. Growers also clean any equipment moving between fields and other areas to avoid spreading nematodes around.

Critical Needs for Management of Nematodes in Western U.S. Sugarbeets at Harvest

Research
- Research composting of tare dirt; look at economics and survival of nematodes, rhizomania, and weed seeds.

Regulatory
- Regulate tare dirt disposal and composting.

Education
- Educate growers about how to compost tare dirt.

Weeds

Equipment sanitation is imperative for preventing weed dispersal. Weeds are mechanically removed from fields so that they do not end up in storage. As mentioned in the discussion on defoliation, above, growers with extreme amounts of weeds present at harvest may use a shredder on weeds and beet tops prior to defoliation.

Critical Needs for Management of Weeds in Western U.S. Sugarbeets at Harvest

Research
- Research the impact of mechanical weed shredding on the weed seed bank.

Regulatory

None listed.

Education
- Educate growers about the impacts of weeds in the beet piles (i.e., prevent weeds while they are in the field, to avoid problems in storage).

Diseases

Processing sugarbeet roots soon after harvest will reduce storage losses from root rot. It is recommended that roots with Phoma root rot be processed rapidly after they are harvested to reduce losses. There also are recommendations to process roots with Rhizoctonia root rot and Erwinia rot quickly, since these can spread and allow entrance of other pathogens.

Soilborne diseases such as rhizomania and pathogens including *Fusarium* spp. and *Rhizoctonia* spp. are present in tare dirt. Tare dirt is not brought back into fields.

Critical Needs for Management of Diseases in Western U.S. Sugarbeets at Harvest

Research

- Research the benefits and drawbacks of scalping sugarbeets (it causes open wounds during storage).
- Research the potential disease spread from the management of sugarbeet tops (feeding or field incorporation).
- Research the effect of composting tare dirt on pathogens.
- Research the influence of disease problems on the storability of sugarbeets.

Regulatory
None listed.

Education
None listed.

POST-HARVEST/STORAGE

The period of time that sugarbeets are kept in a pile until processing can range from a few days up to 180 days.

The short-term storage period for the Upper Snake River Valley and Magic Valley is approximately mid-September into the second week of October. Sugarbeets received into piling grounds are generally not stored for more than six days, because air temperatures can be too warm in this time period. The rate of harvest is "scheduled" to limit beet supply for the Mini-Cassia (Paul, Idaho) and Twin Falls (Twin Falls, Idaho) factories. Treasure Valley and Washington generally do not have a short-term storage period. Early sugarbeets harvested in the Western Sugar growing area are processed before regular harvest begins, so these sugarbeets are in short-term storage.

The long-term storage period for all areas of Amalgamated Sugar begins from the second week of October through the end of the beet-slicing campaign. End of campaign is approximately the first week of March for the Mini-Cassia and Twin Falls factories, the last week of January for the Nampa, Idaho factory, and approximately two weeks earlier for the Nyssa, Oregon factory. Length of campaign varies with the overall company yield and with the slice rates of the factories.

Sugarbeets are stored in piles at the companies' receiving stations. An average pile has a base width of 160', a height of 20', and a length of 900'. Sugarbeets received with minimal soil, weeds, beet leaves, and diseases will lose less sugar from root respiration and deterioration. Additionally, sugarbeets that are clean and disease-free when processed maximize factory efficiencies and minimize production costs.

It is important that beet root temperatures cool down. Roots will be at the temperature at which they were dug in the field and when put into a pile will first increase in temperature due to an increased respiration rate from damage (knocks, scrapes, gouges, and cuts) and then will decrease in temperature as affected by thermodynamic air movement of outside air into the pile. Daily air temperatures (maximum and minimum) throughout the storage period will have a profound affect on how well or poorly roots will store and maintain their quality.

Natural cooling of beet piles is driven by the temperature of outside air over time, but is influenced by the "cleanliness" of the sugarbeets going into the pile (free from soil, weeds, beet leaves and petioles, and diseases). Areas in a pile may not cool enough if air movement is hampered. These areas (a volume of sugarbeets) can actually increase in temperature due to higher root respiration rates. Roots in these areas can suffer severe loss of sugar content and can deteriorate from root-rotting organisms always present either in the adhering soil or on the root itself. Western Sugar is experimenting with leveling the tops of the piles to make them breathe better, therefore keeping them cooler and not trapping snow drift.

Weeds

Any weeds that make it into the beet pile are a problem. They restrict air movement through the pile, generate and trap heat, and contribute to storage rot.

Critical Needs for Management of Weeds in Western U.S. Sugarbeets at Post-harvest/Storage

Research

- Research the effect of Roundup wick applicators causing beet damage that carries over into storage.
- Research alternative mechanical weed separators to reduce beet damage.

Regulatory

None listed.

Education

None listed.

Diseases

No fungicides are registered for use on sugarbeets in storage but most storage rots begin with diseases in the field and are managed during the appropriate crop stage.

Penicillium and Botrytis rots are diseases that are not found in the field, but are major problems in storage. Phoma, one of the most important root rot diseases in storage, can occur as a seedling disease and/or as a root rot disease in the field. There are no controls for these diseases. Other fungal pathogens reported from storage rots include species of *Aspergillus* and *Rhizopus* (which may start in the field), as well as additional *Fusarium* spp. that are not a problem in the field.

Cercospora does not spread in the pile, and is therefore not considered a storage rot, but Cercospora-infected sugarbeets do not store well. The reason for this is not clear.

In some areas, lime has been applied to sugarbeets going into storage to increase the pH and inhibit some pathogens. This method is not widespread and efficacy has not been recorded.

Critical Needs for Management of Diseases in Western U.S. Sugarbeets at Post-harvest/Storage

Research

- Investigate the use of fungicides for sugarbeets in storage.
- Investigate factors predisposing sugarbeets to decay.
- Develop a fungicide to spray on crop 2 to 3 weeks before sugarbeets go into storage.
- Investigate a beet sprout inhibitor, similar to that used in onions.
- Research biological control of post-harvest rots.
- Develop varietal resistance to bacteria that break down sugarbeets in storage.
- Research the impact of diseased/frozen sugarbeets in storage, over time, on sugar extraction.
- Develop methods for early detection of decay in storage piles.

Regulatory

- Facilitate registration of thiabendazole (Mertect) and other compounds for sugarbeets going into storage.

Education

- Educate growers about the importance of not storing frozen or overheated sugarbeets.

Vertebrate Pests

Deer eat sugarbeets in the piles and present a physical impediment to accessing sugarbeet piles. They tend to be a greater problem later in the harvest campaign. No critical needs for vertebrate management were listed at this crop stage.

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Activity & Seasonal Pest Occurrence Table for Region 1

Magic Valley, ID and La Grande, OR

Cultural Activities

	J	F	M	A	M	J	J	A	S	O	N	D
Cover Crop Establishment								XXX*	XXX*			
Cover Crop Removal			XXX	XXX	XXX							
Soil Preparation		XXX	XXX	XXX	XXX			XXX	XXX	XXX	XXX	XXX
Soil Test for Nutrients		XXX	XXX	XXX					XXX	XXX		
Planting			3/08 - 5/31									
Cultivation					XXX	XXX						
Fertilization		XXX	XXX	XXX	XXX	XXX						
Irrigation				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
Harvest									09/15 - 11/5			
Row Closure						6/15 - 7/15						
Lay-By						XXX	XXX					
Green Manure/Trap Crop Planting								XXX*				
Green Manure/Trap Crop Removal										XXX*	XXX*	

Pest Management Activities

	J	F	M	A	M	J	J	A	S	O	N	D
Soil Sampling for Nematodes			XXX	XXX				XXX*	XXX*	XXX*		
Soil Fumigation			XXX					XXX*	XXX*	XXX*		
Scouting for Diseases			XXX	XXX	XXX	XXX	XXX	XXX†				
Scouting for Insects			XXX	XXX	XXX	XXX	XXX	XXX	XXX			
Scouting for Weeds			XXX	XXX	XXX	XXX	XXX					
Fungicide Application				XXX		XXX	XXX	XXX†				
Insecticide Application		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX			
Herbicide Application		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX*		
Hand Hoeing					XXX	XXX	XXX	XXX				
Mechanical Weed Mowing							XXX	XXX	XXX	XXX		

Seasonal Pest Occurrence

Nematodes		J	F	M	A	M	J	J	A	S	O	N	D
Stubby Root Nematode	Present‡		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated§	Not treated.											
Sugarbeet Cyst Nematode #	Present		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			XXX	XXX	XXX							
Root-Knot Nematode	Present		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated	Not treated.											
Weeds		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Barley, volunteer	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XXX						
Barnyardgrass	Present					XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XXX						
Bindweed, field	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	X						
Buckwheat	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				X	XXX	XX						

Seasonal Pest Occurrence, Region 1, cont.

Weeds, cont.		J	F	M	A	M	J	J	A	S	O	N	D
Cocklebur	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				X	XXX	XX						
Crabgrass	Present					XXX	XXX	XXX	XXX	XXX	XXX		
	Treated	Not treated.											
Dodder	Present						XXX	XXX	XXX	XXX	XXX		
	Treated					XXX	XXX	XXX	XXX				
Foxtail	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XX						
Knapweed, Russian	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XX						
Knotweed	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				X	XXX	X						
Kochia	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			X	XXX	XXX	X						
Lambsquarters, Common	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XX						
Mallow, Common	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	X						
Mustard	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	X						
Nightshade, Cutleaf	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XX						
Nightshade, Hairy	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XX						
Nutsedge, Yellow	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated									XXX*	XXX*	XXX*	
Oats, Wild	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XXX						
Pigweed	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XX						
Prickly Lettuce	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	X						
Purslane	Present					XXX	XXX	XXX	XXX	XXX	XXX		
	Treated					XXX	XXX						
Quackgrass	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			X	XXX	XXX	X						
Redstem Filaree	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XX	XXX	X						
Sandbur	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XX						
Smartweed	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XX						
Sowthistle	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	X						
Sunflower	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated					XXX	XXX						
Thistle, Canada	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				X	XXX	XX						

Seasonal Pest Occurrence, Region 1, cont.

Weeds, cont.		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Thistle, Russian	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	X						
Velvetleaf	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XXX						
Wheat, Volunteer	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			XXX	XXX	XXX							
Wild Proso Millet	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			XXX	XXX	XXX							
Diseases		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Aphanomyces		This disease does not occur in this region.											
Bacterial Vascular Necrosis (Erwinia)		This disease occurs only sporadically and at low levels; no action is taken by growers.											
Beet Curly Top Virus	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			XX	XXX	XXX	X						
Beet Western Yellows Virus		This disease does not occur in this region											
Cercospora Leaf Spot	Present						XXX	XXX	XXX	XXX	XXX		
	Treated	Not treated											
Fusarium Root Rot	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated	Not treated											
Fusarium Yellows		This disease occurs at low levels. Its importance and distribution are poorly understood.											
Powdery Mildew	Present						XXX	XXX	XXX	XXX	XXX		
	Treated							X	XXX	X			
Pythium Root Rot	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated#			XXX	XXX	XXX							
Rhizoctonia Root and Crown Rot	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			XX	XXX	XXX	XXX						
Rhizomania	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated	Seed selection is only treatment.											
Scab	Present								XXX	XXX	XXX		
	Treated	Not treated.											
Seedling Diseases (Rhizoctonia solani, Pythium ultimum, Phoma betae)	Present		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated**			XXX	XXX	XXX							
Insects		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Alfalfa Looper	Present					XXX	XXX	XXX					
	Treated						X	XXX	XXX				
Armyworms	Present							XXX	XXX	XXX			
	Treated							XXX	XXX				
Beet Leafhoppers	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			X	XXX	XXX							
Black Bean Aphid	Present					XXX	XXX	XXX	XXX	XXX	XXX		
	Treated					X	XXX	XXX	XXX	X			

Seasonal Pest Occurrence, Region 1, cont.

Insects, cont.		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Blister Beetles	Present					XXX	XXX						
	Treated					XX	X						
Crown Borer	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				X	XX							
Cutworms	Present			XXX	XXX	XXX							
	Treated				XXX	XXX							
Flea Beetles	Present			XXX	XXX	XXX	XXX	XXX					
	Treated	Not treated.											
Garden Symphalan	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated	Not treated.											
Grasshopper	Present					XXX	XXX	XXX	XXX	XXX	XXX		
	Treated					X	XXX	XXX	XXX				
Leafminers	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated					XXX	XXX	XXX					
Lygus Bugs	Present				XXX	XXX	XXX						
	Treated				X	XXX							
Spider Mites	Present							XXX	XXX				
	Treated							XXX	XXX				
Sugarbeet Root Aphid	Present					XXX	XXX	XXX	XXX	XXX	XXX		
	Treated	No effective treatment available.											
Sugarbeet Root Maggot	Present					XXX	XXX	XXX	XXX				
	Treated			X	XXX	XXX	XX						
Webworms	Present					XXX	XXX						
	Treated					XXX	XXX						
White Grubs	Present		XXX	XXX									
	Treated	Not treated.											
Wireworms	Present			XXX	XXX	XXX							
	Treated			X	XXX	X							
Vertebrate Pests		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Horned Larks, Crows, Pheasants	Present			XXX	XXX	XXX							
	Treated			XXX	XXX	XXX							
Voles	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			XXX	XXX	XXX							

* Previous crop year.

† Growers continue to scout for diseases until 30 days prior to harvest. If diseases are found, fungicide can be utilized until 30 days prior to harvest.

‡ Indicates periods when pests occur in fields; population densities may or may not reach treatable levels. This ***DOES*** indicate the mere presence of pests in a field.

§ When field activities are likely. This ***DOES NOT*** indicate the mere presence of pests in a field (e.g., perennial weeds and some insect and nematode pests may be found in fields all year, but management activities only occur as indicated in the table).

In the case where there are more than one species of nematode found in a region, and one is treated and the others are not treated, it is implied that the treatment directed at one nematode also manages the others, or that populations of the non-treated nematode are not high enough to warrant control on their own.

** Seed treatment only control used.

Activity & Seasonal Pest Occurrence Table for Region 2

Treasure Valley: Western Idaho and Eastern Oregon

Cultural Activities

	J	F	M	A	M	J	J	A	S	O	N	D
Cover Crop Establishment		X										
Cover Crop Removal			XXX									
Plant Green Manure								XXX*				
Plow Green Manure										XXX		
Soil Preparation			XXX	XXX				XXX*	XXX*	XXX*	XXX*	
Soil Test for Nutrients			XXX	XXX				XXX*	XXX*	XXX*		
Planting			3/10 - 5/5									
Cultivation				XXX	XXX	XXX						
Fertilization	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX*	XXX*	XXX*	XXX*	
Irrigation			XXX	XXX	XXX	XXX	XXX	XXX	XXX*	XXX*		
Harvest										10/5 - 11/10		
Row Closure						6/15 - 7/5						
Lay By					XXX	XXX						

Pest Management Activities

	J	F	M	A	M	J	J	A	S	O	N	D
Soil Sampling for Nematodes		XXX	XXX					XXX*	XXX*	XXX*	XXX*	
Soil Fumigation									XXX*	XXX*		
Scouting for Diseases			X	XXX	XXX	XXX	XXX	XXX	XXX			
Scouting for Insects				XXX	XXX	XXX	XXX	XXX	XXX			
Scouting for Weeds			XXX	XXX	XXX	XXX	XXX	XXX	XXX			
Fungicide Application				XXX		XXX	XXX	XXX	XXX	X		
Insecticide Application			XXX	XXX	XXX	XXX	XXX	XXX	XXX	X		
Herbicide Application		XXX	XXX	XXX	XXX	XXX	XXX	XXX		XXX*		
Hand Hoeing					XXX	XXX	XXX	XXX				

Seasonal Pest Occurrence

Nematodes		J	F	M	A	M	J	J	A	S	O	N	D
Stubby Root Nematode	Present†			XXX	XXX								
	Treated‡	No treatment.											
Sugarbeet Cyst Nematode #	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated			XXX	XXX				X	XXX	XXX	XXX	
Root-Knot Nematode	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated	No treatment.											
Weeds		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Barley, volunteer	Present			XXX	XXX	XXX	XXX						
	Treated					XXX	XXX						
Barnyardgrass	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated					XXX	XXX						
Bindweed, field	Present					XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX			X	XXX	XXX		
Buckwheat	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX							
Clover, sweet	Present				XXX	XXX	XXX						
	Treated				XXX	XXX							

Seasonal Pest Occurrence, Region 2, cont.

Weeds, cont.		J	F	M	A	M	J	J	A	S	O	N	D
Cocklebur	Present					XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX							
Crabgrass	Present					XXX	XXX	XXX	XXX	XXX	XXX		
	Treated					XXX	XXX						
Dodder	Present					XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			XX	XXX								
Foxtail	Present					XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX							
Knotweed	Present					XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX							
Kochia	Present		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			XXX	XXX	XXX	XX						
Lambsquarters, Common	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			XXX	XXX	XXX	XX						
Mallow, Common	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated	There are no effective treatments for this weed.											
Mustard	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated				XXX	XXX							
Nightshade, Hairy	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			XX	XXX	XXX	XXX						
Nutsedge, Yellow	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated						XXX	XXX	XX		XXX*		
Oats, Wild	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XX						
Pigweed	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XX						
Purslane	Present							XXX	XXX	XXX	XXX		
	Treated	There are no effective treatments for this weed.											
Quackgrass	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	
	Treated					XXX	XXX	XXX					
Sandbur	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XX						
Smartweed	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XX						
Sowthistle	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated				XXX	XXX	XX						
Sunflower	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XX						
Thistle, Canada	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated					XXX	XXX	XXX	XXX	XXX	XXX		
Thistle, Russian	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	
	Treated			XX	XXX	XXX							
Wheat, Volunteer	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated					XXX	XXX						
Wild Proso Millet	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated					XXX	XXX						

Seasonal Pest Occurrence, Region 2, cont.													
Insects, cont.		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Grasshopper	Present					XXX	XXX	XXX	XXX	XXX			
	Treated					XXX	XXX	XXX	XXX	XXX			
Leafminers	Present					XXX	XXX	XXX					
	Treated					XXX	XXX	XXX					
Lygus Bugs	Present				XXX	XXX	XXX	XXX	XXX				
	Treated				XXX	XXX							
Spider Mites	Present							XXX	XXX				
	Treated								XXX				
Sugarbeet Root Aphid	Present					XXX	XXX	XXX	XXX				
	Treated	No effective treatment available.											
Sugarbeet Root Maggot	Present				X	XXX	XXX						
	Treated			XX	XXX	XXX	XXX						
Webworms	Present						XXX	XXX	XXX				
	Treated							XXX	XXX				
White Grubs	Present				XXX	XXX							
	Treated	Not treated.											
Wireworms	Present			XXX	XXX	XXX							
	Treated			XXX	XXX	XXX							

* Previous crop year.

† Indicates periods when pests occur in fields; population densities may or may not reach treatable levels. This ***DOES*** indicate the mere presence of pests in a field.

‡ When field activities are likely. This ***DOES NOT*** indicate the mere presence of pests in a field (e.g., perennial weeds and some insect and nematode pests may be found in fields all year, but management activities only occur as indicated in the table).

§ All seeds bought by growers are pre-treated against seedling diseases. Some Amistar is applied at-planting, but only for extensive infestations.

In the case where there are more than one species of nematode found in a region, and one is treated and the others are not treated, it is implied that the treatment directed at one nematode also manages the others, or that populations of the non-treate

Activity & Seasonal Pest Occurrence Table for Region 3

Upper Snake River Valley, Eastern Idaho

Cultural Activities

	J	F	M	A	M	J	J	A	S	O	N	D
Cover Crop Establishment								XXX*	XXX*	X*		
Cover Crop Removal			small grains							green man'r		
Soil Preparation			X	XXX	X				XXX*	XXX*	XXX*	
Soil Test for Nutrients			XXX	XXX	XXX	XXX			XXX*	XXX*		
Planting			3/15 - 5/25									
Cultivation				XXX	XXX	XXX	XXX					
Fertilization			XXX	XXX	XXX	XXX			XXX*	XXX*		
Irrigation				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
Harvest									9/15 - 11/5			
Row Closure						6/15-7/4						
Lay By						XXX						

Pest Management Activities

	J	F	M	A	M	J	J	A	S	O	N	D
Soil Fumigation									XXX*	XXX*		
Scouting for Diseases					XXX	XXX	XXX	XXX	XXX			
Scouting for Insects				XXX	XXX	XXX	XXX	XXX	XXX			
Scouting for Weeds				XXX	XXX	XXX	XXX					
Fungicide Application					XXX†			XXX†	XXX†			
Insecticide Application				X	XXX	XXX	XXX	XXX	XXX			
Herbicide Application				XXX	XXX	XXX						
Hand Hoeing						XXX	XXX					

Seasonal Pest Occurrence

Nematodes		J	F	M	A	M	J	J	A	S	O	N	D
Stubby Root Nematode	Present‡					XXX	XXX	XXX					
	Treated§					XXX							
Weeds		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Barley, volunteer	Present			XXX	XXX	XXX							
	Treated				X	XXX	X						
Barnyardgrass	Present				XXX	XXX	XXX						
	Treated				X	XXX	XXX						
Bindweed, field	Present					XXX	XXX						
	Treated					XXX	XXX						
Buckwheat	Present				XXX	XXX							
	Treated				XX	XXX							
Cocklebur	Present					XXX	XXX						
	Treated					XXX	X						
Foxtail	Present				XXX	XXX	XXX						
	Treated				XX	XXX	X						
Knapweed, Russian	Present				XXX	XXX	XXX						
	Treated				XX	XXX	X						
Kochia	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX#
	Treated				XXX	XXX	XXX	X					

Seasonal Pest Occurrence, Region 3, cont.

Weeds, cont.		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Lambsquarters, Common	Present				XXX	XXX	XXX	XXX					
	Treated				XXX	XXX	XXX	X					
Mallow, Common	Present				XXX	XXX							
	Treated				XXX	XXX							
Mustard	Present				XXX	XXX	XXX						
	Treated				XXX	XXX	X						
Nightshade, Black	Present				XXX	XXX	XXX	XXX	XXX				
	Treated				XXX	XXX	XXX						
Nightshade, Hairy	Present				XXX	XXX	XXX	XXX	XXX				
	Treated				XXX	XXX	XXX						
Oats, Volunteer	Present			XXX	XXX								
	Treated				XXX								
Oats, Wild	Present			XXX	XXX	XXX							
	Treated				XXX	XXX							
Pigweed	Present				XXX	XXX	XXX	XXX					
	Treated				XXX	XXX	XXX	X					
Purslane	Present				XXX	XXX	XXX						
	Treated				X	XXX	XXX						
Quackgrass	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated			X	XXX	XXX	X						
Smartweed	Present				XXX	XXX	XXX						
	Treated				X	XXX	X						
Sowthistle	Present					XXX	XXX	XXX					
	Treated					XX	XXX	X					
Sunflower	Present						XXX	XXX	XXX				
	Treated						XXX	XXX					
Thistle, Canada	Present				XXX	XXX	XXX	XXX		XXX	XXX		
	Treated					XX	XXX	XX					
Thistle, Russian	Present				XXX	XXX	XXX	XXX		XXX	XXX		
	Treated				XXX	XXX	XXX						
Wheat, Volunteer	Present			XXX	XXX	XXX							
	Treated			X	XXX	XXX							
Diseases		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Beet Curly Top Virus	Present						XXX	XXX	XXX				
	Treated	Managed with resistant varieties.											
Beet Western Yellows Virus	Present							XXX	XXX				
	Treated	Not treated.											
Powdery Mildew	Present								XXX	XXX			
	Treated								XX	XXX			
Pythium Root Rot	Present				XXX	XXX							
	Trtd**			XXX	XXX	XXX							
Rhizoctonia Root and Crown Rot	Present					Root	Root	Crown	Crown				
	Treated					X	X						
Rhizomania	Present					XXX	XXX	XXX	XXX	XXX			
	Treated	Managed with resistant varieties.											

Seasonal Pest Occurrence, Region 3, cont.

Diseases, cont.		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Seedling Diseases (Rhizoctonia solani, Pythium ultimum, Phoma betae)	Present				XXX	XXX							
	Trtd**			XXX	XXX	XXX							
Insects		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Armyworms	Present					XXX	XXX	XXX	XXX	XXX			
	Treated						X	X					
Beet Leafhoppers	Present					XXX	XXX						
	Treated					XXX	X						
Black Bean Aphid	Present								XXX	XXX			
	Treated								XXX	XXX			
Cutworms	Present				XXX	XXX							
	Treated				XXX	XXX							
Flea Beetles	Present				XXX	XXX							
	Treated				XXX	XXX							
Garden Symphalan	Present					XXX							
	Treated					XX							
Grasshopper	Present						XXX	XXX	XXX				
	Treated						XXX	XX					
Leafminers	Present					XXX	XXX	XXX	XXX	XXX			
	Treated					XXX	XXX						
Lygus Bugs	Present				XXX	XXX							
	Treated				XX	X							
Sugarbeet Root Aphid	Present						XXX	XXX	XXX	XXX	XXX		
	Treated	No effective treatment available.											
Sugarbeet Root Maggot	Present					XXX	XXX	XXX					
	Treated					XXX	XXX	XXX					
White Grubs	Present				XXX	XXX							
	Treated				XX	X							
Wireworms	Present				XXX	XXX							
	Treated				XXX	X							

* Previous crop year.

† Early season fungicide application generally targets Rhizoctonia; later season applications target powdery mildew.

‡ Indicates periods when pests occur in fields; population densities may or may not reach treatable levels. This ***DOES*** indicate the mere presence of pests in a field.

§ When field activities are likely. This ***DOES NOT*** indicate the mere presence of pests in a field (e.g., perennial weeds and some insect and nematode pests may be found in fields all year, but management activities only occur as indicated in the table).

At this time, Kochia appears in sugarbeet piles.

** Seed treatment is the only control used.

Activity & Seasonal Pest Occurrence Table for Region 4

Montana, Northwestern Wyoming, and Western North Dakota

Cultural Activities

	J	F	M	A	M	J	J	A	S	O	N	D
Cover Crop Establishment (barley)			XXX	XXX								
Cover Crop Removal				X	XXX							
Soil Preparation			XXX	XXX					XXX*	XXX*	XXX*	
Soil Test for Nutrients			XXX	XXX				XX*	XXX*	XXX*	XXX*	
Planting				XXX	XX							
Cultivation					XXX	XXX						
Fertilization	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX*	XXX*	XXX*	XXX*	
Irrigation				XXX†	XXX	XXX	XXX	XXX	XXX	X*	XX*	
Harvest									XX	XXX	X	
Row Closure						X	X					
Lay By						XX	X					

Pest Management Activities

	J	F	M	A	M	J	J	A	S	O	N	D
Soil Sampling for Nematodes								XXX*	XXX*	XXX*	XXX*	
Soil Fumigation			XXX	XXX				XXX*	XXX*	XXX*	XXX*	
Scouting for Diseases				XXX	XXX	XXX	XXX	XXX	XXX	XX		
Scouting for Insects			X	XXX	XXX	XXX	XXX	XXX	XXX			
Scouting for Weeds			X	XXX	XXX	XXX	XXX	XXX				
Fungicide Application					XXX	XXX	XXX	XXX	XXX			
Insecticide Application			X	XXX	XXX	XXX	XXX	XXX				
Herbicide Application			X	XXX	XXX	XXX	XXX	XXX				
Hand Hoeing					XXX	XXX	XXX	XXX				

Seasonal Pest Occurrence

Nematodes		J	F	M	A	M	J	J	A	S	O	N	D
Sugarbeet Cyst Nematode	Present‡						XXX	XXX	XXX	XXX	XXX		
	Treated§			XXX	XXX	XXX	X		XXX*	XXX*	XXX*	XXX*	
Weeds		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Alfalfa, volunteer	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated				X	XXX	XXX	X	XXX*	XXX*	XXX*		
Barley, volunteer	Present			X	XXX	XXX	XXX		XXX*	XXX*	XXX*		
	Treated			X	XXX	XXX	XXX						
Barnyardgrass	Present					XXX	XXX	XXX	XXX	XXX			
	Treated					XXX	XXX	X					
Bindweed, field	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated				X	XXX	XXX	XX	XXX*	XXX*	XXX*		
Buckwheat	Present				XXX	XXX	XXX			XXX	XXX	XXX	
	Treated				XXX	XXX	XXX						
Cocklebur	Present					XXX	XXX	XXX					
	Treated					XXX	XXX	XXX					
Dodder	Present						XXX	XXX					
	Treated						XXX	XXX					

Seasonal Pest Occurrence, Region 4, cont.													
Weeds, cont.		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Foxtail	Present				XXX	XXX	XXX	XXX					
	Treated				XXX	XXX	XXX	X					
Knotweed	Present					XXX	XXX	XXX					
	Treated					XXX	XXX						
Kochia	Present			XXX	XXX	XXX	XXX	XXX					
	Treated			XXX	XXX	XXX	XXX	XXX					
Lambsquarters, Common	Present			XXX	XXX	XXX	XXX	XXX					
	Treated			XXX	XXX	XXX	XXX	XXX					
Mallow, Common	Present				XXX	XXX	XXX	XXX	XXX	XXX			
	Treated				XXX	XXX	XXX	XXX					
Milkweed	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated				XXX	XXX	XXX	XXX	XXX*	XXX*	XXX*		
Milkweed, showy	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated				XXX	XXX	XXX	XXX	XXX*	XXX*	XXX*		
Mustard	Present			XXX	XXX	XXX							
	Treated			XXX	XXX	XXX							
Nightshade, Black	Present				XXX	XXX	XXX	XXX					
	Treated				XXX	XXX	XXX	XXX					
Nightshade, Cutleaf	Present				XXX	XXX	XXX	XXX					
	Treated				XXX	XXX	XXX	XXX					
Nightshade, Hairy	Present				XXX	XXX	XXX	XXX					
	Treated				XXX	XXX	XXX	XXX					
Oats, Wild	Present			XXX	XXX	XXX	XXX						
	Treated			XXX	XXX	XXX	XXX						
Pigweed	Present				X	XXX	XXX	XXX					
	Treated				X	XXX	XXX	XXX					
Purslane	Present						XXX	XXX	XXX				
	Treated						XXX	XXX					
Quackgrass	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated			XXX	XXX	XXX	XXX	XXX	XXX*	XXX*	XXX*		
Sandbur	Present					X	XXX	XXX	XXX				
	Treated					X	XXX	XXX					
Smartweed	Present				X	XXX	XXX	XXX					
	Treated				X	XXX	XXX	XXX					
Sowthistle	Present					XXX	XXX	XXX					
	Treated					XXX	XXX	XXX					
Sunflower	Present				XXX	XXX	XXX						
	Treated				XXX	XXX	XXX						
Thistle, Canada	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated				XXX	XXX	XXX	XXX	XXX*	XXX*	XXX*		
Thistle, Russian	Present				XXX	XXX	XXX	XXX					
	Treated				XXX	XXX	XXX	XXX					
Wheat, Volunteer	Present			XXX	XXX	XXX			XXX*	XXX*	XXX*		
	Treated				XXX	XXX	XXX						

Seasonal Pest Occurrence, Region 4, cont.													
Diseases		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Aphanomyces	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	X							
Bacterial Vascular Necrosis	Present									XXX	XXX		
	Treated	Not treated.											
Beet Curly Top Virus	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated	Managed with resistant varieties											
Cercospora Leaf Spot	Present							XXX	XXX	XXX	XXX		
	Treated							XXX	XXX	X			
Fusarium Root Rot	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated	Can be managed with resistant varieties if necessary; no other treatment used.											
Fusarium Yellows	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated	Can be managed with resistant varieties if necessary; no other treatment used.											
Powdery Mildew	Present							XXX	XXX	XXX	XXX		
	Treated							XXX	XXX	X			
Pythium Root Rot	Present				XXX	XXX							
	Treated				XXX	X							
Rhizoctonia Root and Crown	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated					XXX	XXX	X					
Rhizomania	Present						XXX	XXX	XXX	XXX	XXX		
	Treated	Managed with resistant varieties.											
Scab	Present							XXX	XXX	XXX	XXX		
	Treated	Not treated.											
Seedling Diseases (Rhizoctonia solani, Pythium ultimum, Phoma betae)	Present				XXX	XXX							
	Treated				XXX	X							
Insects		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Alfalfa Looper	Present					X	XXX	XXX					
	Treated					X	XXX	XXX					
Armyworms	Present								XXX				
	Treated								XXX				
Beet Leafhoppers	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XXX						
Cutworms	Present				XXX	XXX							
	Treated				XXX	XXX							
Flea Beetles	Present				XXX	XXX	XXX						
	Treated				XXX	XXX	XXX						
Garden Symphalan	Present				XXX	XXX	X						
	Treated				XXX	XXX	X						
Grasshopper	Present							XXX	XXX	XXX			
	Treated							XXX	XXX				
Leafminers	Present						XXX	XXX					
	Treated						XXX	XXX					

Seasonal Pest Occurrence, Region 4, cont.													
Insects, cont.		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Lygus Bugs	Present					XXX	XXX	XXX					
	Treated					XXX	XXX	XXX					
Spider Mites	Present								XXX	XXX			
	Treated								XXX	XXX			
Sugarbeet Root Aphid	Present						XXX	XXX	XXX	XXX			
	Treated												
Sugarbeet Root Maggot	Present					XXX	XXX	XXX					
	Treated				XXX	XXX	XXX						
Webworms	Present					X	XXX	XXX	XXX	XXX			
	Treated					X	XXX	XXX	XXX	XXX			
White Grubs	Present				XXX	XXX	XXX						
	Treated				XXX	X							
Wireworms	Present				XXX	XXX							
	Treated				XXX	X							

* Previous year.

† Wyoming only.

‡ Indicates periods when pests occur in fields; population densities may or may not reach treatable levels. This ***DOES*** indicate the mere presence of pests in a field.

§ When field activities are likely. This ***DOES NOT*** indicate the mere presence of pests in a field (e.g., perennial weeds and some insect and nematode pests may be found in fields all year, but management activities only occur as indicated in the table).

Activity & Seasonal Pest Occurrence Table for Region 5

Colorado, Western Nebraska, and Southeastern Wyoming

Cultural Activities

	J	F	M	A	M	J	J	A	S	O	N	D
Cover Crop Establishment			XXX	XXX					XXX	XXX		
Cover Crop Removal					XXX	XXX						
Soil Preparation			XXX	XXX	XXX			XXX*	XXX*	XXX*	XXX*	
Soil Test for Nutrients		XXX	XXX	XXX				XXX*	XXX*	XXX*	XXX*	
Planting†			X	XXX	X							
Cultivation					XXX	XXX						
Fertilization		XXX	XXX	XXX	XXX	XXX	XXX	XXX*	XXX*			
Irrigation				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
Harvest									X	XXX	XXX	
Row Closure						XXX	XXX					
Lay-by					XXX	XXX	X					

Pest Management Activities

	J	F	M	A	M	J	J	A	S	O	N	D
Soil Sampling for Nematod		XXX	XXX	XXX				XXX*	XXX*	XXX*	XXX*	
Soil Fumigation		XXX	XXX						XXX*	XXX*		
Scouting for Diseases			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
Scouting for Insects			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
Scouting for Weeds				XXX	XXX	XXX	XXX	XXX				
Fungicide Application					XXX	XXX	XXX	XXX	XXX			
Insecticide Application				XXX	XXX	XXX	XXX	XXX				
Herbicide Application			XXX	XXX	XXX	XXX	XXX	XXX				
Hand Hoeing					XXX	XXX	XXX					

Seasonal Pest Occurrence

Nematodes		J	F	M	A	M	J	J	A	S	O	N	D
False Root-Knot Nematode	Present‡						XXX	XXX	XXX	XXX	XXX		
	Treated§	No treatment.											
Sugarbeet Cyst Nematode #	Present						XXX	XXX	XXX	XXX	XXX		
	Treated		XXX	XXX						XXX*	XXX*		
Root-Knot Nematode	Present						XXX	XXX	XXX	XXX	XXX		
	Treated	No treatment.											

Weeds		J	F	M	A	M	J	J	A	S	O	N	D
Barley, volunteer	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated					XXX	XXX						
Barnyardgrass	Present					XXX	XXX	XXX	XXX				
	Treated					XXX	XXX	XXX					
Bindweed, field	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated	This weed is best controlled in rotational crops and by hand hoeing.											
Buckwheat	Present				XXX	XXX	XXX						
	Treated					XXX	XXX						
Cocklebur	Present				XXX	XXX	XXX	XXX					
	Treated					XXX	XXX						
Crabgrass	Present				XXX	XXX							
	Treated					XXX							

Seasonal Pest Occurrence, Region 5, cont.

Weeds, cont.		J	F	M	A	M	J	J	A	S	O	N	D
Foxtail	Present				XXX	XXX	XXX	XXX					
	Treated					XXX	XXX	XXX					
Knotweed	Present				XXX	XXX	XXX						
	Treated	Not a problematic weed, so not treated.											
Kochia	Present			XXX	XXX	XXX	XXX	XXX					
	Treated			X	XXX	XXX	XXX	XXX					
Lambsquarters, Common	Present			XXX	XXX	XXX	XXX	XXX					
	Treated			X	XXX	XXX	XXX	XXX					
Mallow, Common	Present				XXX	XXX	XXX	XXX	XXX	XXX			
	Treated				XXX	XXX	XXX	XXX					
Mallow, Venice	Present				XXX	XXX	XXX	XXX					
	Treated				XXX	XXX	XXX	XXX					
Mustard	Present			XXX	XXX	XXX	XXX						
	Treated			X	XXX	XXX							
Nightshade, Black	Present				XXX	XXX	XXX	XXX					
	Treated				XXX	XXX	XXX	XXX					
Nightshade, Hairy	Present				XXX	XXX	XXX	XXX					
	Treated				XXX	XXX	XXX	XXX					
Oats, Volunteer	Present				XXX	XXX	XXX	XXX					
	Treated					XXX	XXX						
Oats, Wild	Present				XXX	XXX	XXX	XXX					
	Treated				XXX	XXX	XXX	XXX					
Pigweed	Present					XXX	XXX	XXX	XXX				
	Treated					XXX	XXX	XXX					
Purslane	Present					XX	XXX	XXX					
	Treated	Not a problematic weed, so not treated.											
Quackgrass	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated			XXX	XXX	XXX	XXX	XXX	XXX*	XXX*	XXX*		
Sandbur	Present				XXX	XXX	XXX	XXX					
	Treated					XXX	XXX	XXX					
Smartweed	Present					XXX	XXX	XXX					
	Treated					XXX	XXX						
Sowthistle	Present					XXX	XXX	XXX					
	Treated					XXX	XXX						
Spurge, Toothed	Present					XXX	XXX	XXX					
	Treated					XXX	XXX						
Sunflower	Present				XXX	XXX	XXX	XXX					
	Treated					XXX	XXX						
Thistle, Canada	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated				XXX	XXX	XXX	X					
Thistle, Russian	Present				XXX	XXX	XXX	XXX					
	Treated			X	XXX	XXX	XXX						
Wheat, Volunteer	Present			XXX	XXX	XXX		XXX*	XXX*	XXX*	XXX*		
	Treated					XXX	XXX						
Velvetleaf	Present				XXX	XXX	XXX	XXX	XXX	XXX			
	Treated				XXX	XXX	XXX	XXX					

Seasonal Pest Occurrence, Region 5, cont.

Diseases		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Aphanomyces	Present				XXX	XXX			XXX	XXX			
	Treated				XXX								
Bacterial Vascular Necrosis	Present									XXX	XXX		
	Treated	Not treated.											
Beet Curly Top Virus	Present				XXX	XXX	XXX	XXX					
	Treated	Managed with resistant varieties.											
Cercospora Leaf Spot	Present							XXX	XXX	XXX			
	Treated							XXX	XXX	XXX			
Fusarium Root Rot	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated	Can be managed with resistant varieties if necessary; no other treatment used.											
Fusarium Yellows	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated	Can be managed with resistant varieties if necessary; no other treatment used.											
Powdery Mildew	Present							X	XXX	XXX			
	Treated							X	XXX	XXX			
Pythium Root Rot	Present				XXX	XXX							
	Treated				XXX	X							
Rhizoctonia Root/Crown Rot	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated						XXX	XXX					
Rhizomania	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated	Managed with resistant varieties.											
Scab	Present							XXX	XXX	XXX			
	Treated	Not treated.											
Seedling Diseases (Rhizoctonia solani, Pythium ultimum, Phoma betae)	Present				XXX	XXX							
	Treated				XXX	X							
Insects		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Armyworms	Present								XXX				
	Treated	Not treated.											
Beet Leafhoppers	Present				XXX	XXX							
	Treated	Managed with resistant varieties.											
Cutworms	Present				XXX	XXX	XXX						
	Treated				XXX	XXX							
Flea Beetles	Present				XXX	XXX	XXX						
	Treated					XXX	XXX						
Flea Beetles Larvae	Present				XXX	XXX							
	Treated				XXX	XXX							
Garden Symphalan	Present				XXX	XXX							
	Treated	Not treated.											
Grasshopper	Present				XXX	XXX	XXX	XXX	XXX	XXX			
	Treated					X	XXX	XXX					
Leafminers	Present						XXX	XXX					
	Treated						XXX						
Lygus Bugs	Present					XXX	XXX	XXX					
	Treated	Not treated.											
Spider Mites	Present							XXX	XXX	XXX			
	Treated	Not treated.											

Seasonal Pest Occurrence, Region 5, cont.

Insects, cont.		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Sugarbeet Root Aphid	Present						XXX	XXX	XXX	XXX			
	Treated	Not treated.											
Sugarbeet Root Maggot	Present						XXX	XXX	XXX	XXX	XXX		
	Treated					X	XXX						
Webworms	Present						XXX	XXX	XXX	XXX			
	Treated						XXX						
White Grubs	Present				XXX	XXX	XXX						
	Treated				XXX								
Wireworms	Present				XXX	XXX							
	Treated				XXX								

* Previous crop year.

† April 1 is the insurance date.

‡ Indicates periods when pests occur in fields; population densities may or may not reach treatable levels. This ***DOES*** indicate the mere presence of pests in a field.

§ When field activities are likely. This ***DOES NOT*** indicate the mere presence of pests in a field (e.g., perennial weeds and some insect and nematode pests may be found in fields all year, but management activities only occur as indicated in the table).

\# In the case where more than one species of nematode is found in a region, and one is treated and the others are not treated, it is implied that the treatment directed at one nematode also manages the others, or that populations of the non-treated nematode are not high enough to warrant control on their own.

Activity & Seasonal Pest Occurrence Table for Region 6

South Columbia Basin: Benton County, WA and Umatilla County, OR

Cultural Activities

	J	F	M	A	M	J	J	A	S	O	N	D
Cover Crop Establishment	Not used at this time; when beets were grown in the upper basin, some were used.											
Cover Crop Removal												
Soil Preparation	XXX	XXX	XXX								XXX*	XXX*
Soil Test for Nutrients	XXX	XXX	XXX								XXX*	XXX*
Planting			X	XXX	X†							
Cultivation				XXX	XXX	XXX						
Fertilization		XXX	XXX		XXX	XXX	X				XXX*	XXX*
Irrigation			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	
Harvest									X	XXX	X	
Row Closure						10th						
Lay By						1-5th						

Pest Management Activities

	J	F	M	A	M	J	J	A	S	O	N	D
Soil Fumigation										XXX*	XXX*	
Scouting for Diseases				XXX	XXX	XXX	XXX	XXX	XXX			
Scouting for Insects				XXX	XXX	XXX	XXX	XXX	XXX			
Scouting for Weeds			XXX	XXX	XXX	XXX	XXX	XXX				
Fungicide Application‡			X	XXX	X	X	XXX	XXX	X			
Insecticide Application‡						XXX	XXX	XXX				
Herbicide Application§			X	XXX	XXX	XXX	XXX	XXX				
Hand Hoeing						XXX	XXX	XXX				

Seasonal Pest Occurrence

Weeds		J	F	M	A	M	J	J	A	S	O	N	D
Barnyardgrass	Present#				XXX	XXX	XXX	XXX					
	Treated**				XXX	XXX	XXX						
Buckwheat	Present					XXX	XXX						
	Treated				XXX	XXX	XXX						
Crabgrass	Present					XXX	XXX	XXX	XXX				
	Treated				XXX	XXX	XXX						
Dodder	Present					XXX	XXX	XXX	XXX				
	Treated				XXX	XXX	XXX						
Foxtail	Present				XXX	XXX	XXX	XXX	XXX				
	Treated				XXX	XXX	XXX						
Kochia	Present			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XXX						
Lambsquarters, Common	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XXX						
Mallow, Common	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated				XXX	XXX	XXX						
Mustard	Present			XXX	XXX	XXX							
	Treated				XXX	XXX	XXX						
Nightshade, Black	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XXX						

Seasonal Pest Occurrence, Region 6, cont.													
Weeds, cont.		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Nightshade, Hairy	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XXX						
Pigweed	Present				XXX	XXX	XXX	XXX	XXX	XXX	XXX		
	Treated				XXX	XXX	XXX						
Sandbur	Present					XXX	XXX	XXX	XXX	XXX			
	Treated				XXX	XXX	XXX						
Thistle, Russian	Present		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX			
	Treated				XXX	XXX	XXX						
Wheat, Volunteer	Present	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
	Treated				XXX	XXX	XXX						
Diseases		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Cercospora Leaf Spot	Present							XXX	XXX	XXX			
	Treated							XXX	XXX	XXX	X		
Powdery Mildew	Present							XXX	XXX	XXX			
	Treated						X	XXX	XXX	XXX			
Seedling Diseases (Rhizoctonia solani, Pythium ultimum, Phoma betae)	Present				XXX	XXX							
	Treated			X	XXX	XXX							
Insects		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Armyworms	Present						XXX	XXX					
	Treated						XXX	XXX					
Cutworms	Present						XXX	XXX					
	Treated					X	XXX	XXX					
Leafminers	Present							XXX	XXX				
	Treated							XXX	XXX				
Spider Mites	Present						XXX	XXX					
	Treated						XXX	XXX					
Vertebrate Pests		**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Birds††	Present				XXX								
	Treated												
Rodents††	Present				XXX								
	Treated			X									

* Activity occurs the fall before planting.

† Very few beets are planted this late; most planted between April 1 - 15.

‡ Fungicide and insecticide treatments are made at the time the pest is noted, except for seedling diseases, which are controlled with an at-planting fungicide treatment.

§ Preemergence treatment at planting to control weeds that germinate later. Those that are missed or are tolerant of treatment are treated beginning at their cotyledon stage. Any missed will persist all season unless removed by hand.

# Indicates periods when pests occur in fields; population densities may or may not reach treatable levels. This ***DOES*** indicate the mere presence of pests in a field.

** When field activities are likely. This ***DOES NOT*** indicate the mere presence of pests in a field (e.g., perennial weeds and some insect and nematode pests may be found in fields all year, but management activities only occur as indicated in the table).

†† These pests present until the beets emerge.

Efficacy Ratings for Nematode Management Tools in Sugarbeets

Rating Scale: **E** = Excellent (90-100%) control; **G** = Good (80-90%) control; **F** = Fair (70-80%) control; **P** = Poor (<70%) control. **L** = Limited information, **NA** = Not Available.

	Sugarbeet Cyst Nematode	**Root-Knot Nematode**	**Stubby-Root Nematode**	**False Root-Knot Nematode**	**Comments**
Registered Nematicides					
1,3-dichloropropene (Telone II)	E	G	G	G	
aldicarb (Temik)	G	G	E	G	Population dependent.
IPM and Cultural Controls					
Crop Rotation	F	F	L	L	
Irrigation Scheduling	P	P	P	P	
Plant Resistant Varieties	N/A	N/A	N/A	N/A	Being developed for cyst nematode.
Rotate to Green Manures and Trap Crops	F	F	L	L	Temp, water availability.
Tillage	P	P	P	P	
Weed Management	F	F	L	L	

NOTE: All pesticides rated in this table are registered for use on sugarbeets (with the possible exception of "pipeline materials"), but each pest rated is not necessarily on each pesticide label for which it is rated. The pests may be controlled incidentally, or through the provisions of the 2ee label. University of Idaho policy does not recommend the use of a pesticide for which both the site and the pest are not on the label.

Efficacy Ratings for Weed Management Tools in Sugarbeets

Rating Scale: E = Excellent (90-100%) control; **G** = Good (80-90%) control; **F** = Fair (70-80%) control; **P** = Poor (<70%) control.

	Barley, volunteer	Barnyardgrass	Bindweed., field	Buckwheat	Cocklebur	Crabgrass	Dodder	Foxtail	Knapweed, Russian	Knotweed	Kochia	Lambsquarters	Mallow	Mustard	Nightshade, black	Nightshade, hairy	Nutsedge, yellow	Oats, volunteer	Oats, wild	Pigweed	Purslane	Quackgrass	Sandbur	Smartweed	Sowthistle	Sunflower	Thistle, Canada	Thistle, Russian	Wheat, volunteer	**Comments**
Registered Herbicides																														
clethodim (Select)	G	E	P	P	P	E	P	E	P	P	P	P	P	P	P	P	P	G	G/E	P	P	G	E	P	P	P	P	P	G	2 applications required to control Quackgrass.
clopyralid (Stinger, Clopyr Ag)	P	P	P	E	E	P	P	P	G	F	P	F	P	P	F/G	F/G	P	P	P	P	P	P	P	G	G	E	E	P	P	
cycloate (Ro-Neet)	F	G	P	P	P	G	P	G	P	P	P	**G**	P	P	G	G	F	F	F	G/E	G	F	G	P	P	P	P	P	F	
dimethinamid (Outlook)	P	E	P	P	P	G	P	E	P	F	F-G	F-G	F-P	P	G	E	F-G	F	F	E	F-G	P	G	P	F	P	P	F	P	
EPTC layby (Eptam)	P	G	P	F	P	G	P	G	P	G	F	G	P	P	F-P	G	F	P	F/G	F/G	G	F	G	P	F	P	P	P	F	
ethofumesate (Nortron SC, Etho SC)	F	G	P	F/G	P	F/G	F	G	P	F	G	G/E	P	G	G	F/G	F	F	F	G/E	F/G	P	P	F/G	G	P	P	F/G	F	
glyphosate (various)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	
paraquat (Gramoxone)	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	F/G	
phenmedipham + desmedipham (Betamix)	P	P/F	P	F/G	F	P	P	F	P	F	F	E	P	G	F/G	G/E	P	P	P	G/E	G	P	P	P	E	F	P	F	P	
phenmedipham + desmedipham + ethofumesate (Progress)	P	P/F	P	F/G	F/G	L	P	F	P	F/G	F/G	E	P	G/E	E	G/E	P	P	P	G/E	G/E	P	L	P/F	E	G	P	F	P	
pyrazon (Pyramin)	P	P	P	P	P	P	P	P	P	P	P	G	P	G	F/G	F/G	P	P	P	G/E	F/G	P	P	G	P	P	P	P/F	P	
quizalofop (Assure II)	G	E	P	P	P	E	P	E	P	P	P	P	P	P	P	P	P	G/E	G/E	P	P	G	G	P	P	P	P	P	G	2 applications required to control Quackgrass.
s-metolachlor (Dual Magnum)	P	G/E	P	P	P	P	G	P	G	P	P/F	F	F	P	L	F	F/G	P	P	G	G	P	G	P	P	P	P	P	P	
sethoxydim (Poast)	P-F	E	P	P	P	F	P	E	P	P	P	P	P	P	P	P	P	P/F	G/E	P	P	F	L	P	P	P	L	P	P/F	
trifluralin (various)	P	G	P	F	P	G	P	G	P	G	F	F-G	P	P	P	P	P	P	F	G	G	P	G	P/F	P	P	P	F/G	F	
triflusulfuron-methyl (UpBeet)	P	P	P	G	F	P	P	P	P	G	G	G	F/G	G	G	F/G	P	P	P	G/E	F	P	P	G	G	P	P	P	P	Controls these weeds when mixed with Betamix.

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Efficacy Ratings for Disease Management Tools in Sugarbeets

Rating Scale: E = Excellent (90-100%) control; **G** = Good (80-90%) control; **F** = Fair (70-80%) control; **P** = Poor (<70%) control. **NE** = Not Effective, **L** = Limited information, **NA** = Not Available, **NU** = Not Used.

	Aphanomyces Black Root Rot	**Bacterial Necrosis/ Rot (Erwinia Root Rot)**	**Beet Curly Top Virus**	**Beet Western Yellows Virus**	**Cercospora Leaf Spot**	**Fusarium Root Rot**	**Fusarium Yellows**	**Pytopthora Root Rot and Pythium Root**	**Rhizoctonia Crown and Root Rot**	**Rhizomania**	**Scab**	**Powdery Mildew**	**Seedling Disease**	**Storage Rots (Bacterial and Fungal)**	**Comments**
Registered Fungicides															
azoxystrobin (Amistar, Quadris)					F/G				G/E			P			
copper (Champ, Kocide)					P							P			
copper + mancozeb (ManKocide)					F/G							P			
hymexazole (Tachigaren)	F												F-G		
mancozeb (Dithane, Penncozeb)					F/G							P			
maneb (Manzate)					F/G							P			
metalaxyl (Allegiance, Apron)													G		Pythium only.
metam potassium (K-Pam)									L	NE					
metam sodium (Vapam)									L	NE					
myclobutanil (Laredo)															
potassium bicarbonate (Kaligreen)												L			
pyraclostrobin (Headline)					E				F/G			E			
sulfur (various)												F			
thiophanate-methyl (Topsin-M)					F/G				P			G			Resistance with Cercospora.
thiram (Thiram)												P	G		
TPTH (SuperTin)					G/E							P			
trifloxystrobin (Gem)					E				F/G			E			
Soil Fumigants															
1,3-dichloropropene (Telone II)										NU; G					Not used; cost prohibitive.
Biological Controls															
Burkolderia cepacia (Deny)								L	L			L	L		
Trichoderma harzianum (T-22 Planter Box)								L	L			L	L		
Cultural Controls															
Amount of Irrigation	F	P	NE	NE	P	P	P	P	P	P	L	NU	G	L	
Avoid Excessive Nitrogen	NE	P	NE	L	NU	L	L	L	L	NE	L	NU	P/F	L	
Avoid Plant Injury	NE	P	NE	NE	NU	P	P	L	L	NE	L	NU	NU	L	
Crop Rotation	NE	L	NE	NE	F/G	F	P	L	G	P	P	NU	L	L	
Irrigation Timing	P	P	NE	NE	NU	P	P	L	P	P	L	NU	G	L	
Irrigation Type	L	L	NE	NE	P	L	L	L	L	P	L	F	F	L	
Plant Resistant Varieties	F	G/E	G/E	L	F/G	NA	L	NA	P/F	G/E	NA	P	F	L	
Planting Date	F	NU	P	L	NU	L	L	L	L	P	L	NU	G	L	
Rotate to Green Manures	P	L	NE	NE	L	L	L	L	L	L	L	NU	L	L	
Tillage/Cultivation	P	L	P	NE	P	L	L	L	F/G	P	L	NU	F	L	
Weed Management	NE	L	NE	NE	F	P	P	L	P	P-F	L	NU	L	L	

NOTE: All pesticides rated in this table are registered for use on sugarbeets (with the possible exception of "pipeline materials"), but each pest rated is not necessarily on each pesticide label for which it is rated. The pests may be controlled incidentally, or through the provisions of the 2ee label. University of Idaho policy does not recommend the use of a pesticide for which both the site and the pest are not on the label.

Efficacy Ratings for Insect and Mite Management Tools in Sugarbeets

Rating Scale: **E** = Excellent (90-100%) control; **G** = Good (80-90%) control; **F** = Fair (70-80%) control; **P** = Poor (<70%) control. **NE** = Not Effective, **L** = Limited information, **NA** = Not Available, **NU** = Not Used.

	Alfalfa Looper	Armyworms	Beet Leafhoppers	Bean Aphid	Blister Beetles	Crown Borer	Cutworms	Flea Beetles	Garden Symphylan	Grasshoppers	Leafminers	Lygus Bugs	Spider Mites	Sugarbeet Root Aphid	Sugarbeet Root Maggot (larvae)	Sugarbeet Root Maggot (adult)	Webworms	White Grubs	Wireworms	Comments
Registered Insecticides																				
aldicarb (Temik)	P	P	G/E	G/E		P	P	G/E	L	P	E	E	G/E	L	E	G	L	L	P	
carbaryl (Sevin)	G	G	G	G		F	F	G	L	G/E	P	F/G	P	L	P		G	L	P	
carbofuran (Furadan)															F/G					
chlorpyrifos (Lorsban)	G	G/E		G			G/E	G/E							G/E				P	
diazinon (Diazinon)																				
esfenvalerate (Asana)	E	G	E				E	E		E						E	E			
imidacloprid (Gaucho)	P	P	F/G	L		L	P	G/E	L	L	L	F/G	P	L	P		P	L	G/E	Seed treatment. Rate depends on species.
malathion (Malathion)										G										
methomyl (Lannate)		E		G																
methyl parathion (Methyl Parathion, Declare)																				
naled (Dibrom)										G										
oxydemeton-methyl (MSR)																				
phorate (Phorate, Thimet)	P	P					P								G*			F	F	* In season.
terbufos (Counter 15G)							P				L		L	F	E			G	G/E	
zeta-cypermethrin (Mustang)																G				
Biological Insecticides																				
azadirachtin (Azatin, Aza-Direct)	NU	NU	NU	NU	NU	NU	NU	NU		NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	No efficacy data.
Bacillus thurigeinsis spp. *aizawai* (Agree, Ketch, XenTari)	F,L	F,L					P,L										F,L			
Bacillus thurigeinsis spp. kurstaki (DiPel ES and many others)	F	F					P,L										F,L			
Beauveria bassiana	NU	NU		NU																
spinosad (Entrust, SpinTor, Success)																				

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Efficacy Ratings for Insect and Mite Management Tools in Sugarbeets, cont.

Rating Scale: **E** = Excellent (90-100%) control; **G** = Good (80-90%) control; **F** = Fair (70-80%) control; **P** = Poor (<70%) control. **NE** = Not Effective, **L** = Limited information, **NA** = Not Available, **NU** = Not Used.

	Alfalfa Looper	Armyworms	Beet Leafhoppers	Bean Aphid	Blister Beetles	Crown Borer	Cutworms	Flea Beetles	Garden Symphylan	Grasshoppers	Leafminers	Lygus Bugs	Spider Mites	Sugarbeet Root Aphid	Sugarbeet Root Maggot (larvae)	Sugarbeet Root Maggot (adult)	Webworms	White Grubs	Wireworms	Comments
Other Low-risk Products																				
horticultural oil				NU									NU							No efficacy data.
kaolin (Surround)			NU					NU		NU			NU							No efficacy data.
IPM and Cultural Controls																				
Crop Rotation	NE	NE	NE	NE	NE	P	NE	NE	P	NE	NE	NE	NE	P/F	NE		NE	NE	P	NE designates pests that readily disperse "long" distances.
Irrigation Scheduling	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	F	L		NE	NE	NE	
Natural Enemies	F/P	F/P	L	F/P	L	F/P	F/P	L	L	L	F/P	L	F/P	L	L		L	F/P	L	
Plant Resistant Varieties	NA	NA	G	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	G/E	NA		NA	NA	NA	
Tillage	NE	NE	NE	NE	NE	P	P	NE	P	NE	NE	NE	NE	F	NE		NE	NE	P	
Weed Management	NE	NE	F/P*	NE	NE	NE	NE	P	P	PE	P	P	P	F	NE		F	NE	NE	*Requires area-wide approach.

Toxicity Ratings on Beneficials in Western Sugarbeets

Key to Beneficials: **BEB**=Bigeyed bugs, **DB**=Damsel bug, **LW**=Lacewings (*Chrysopa* spp.), **LB**=Lady beetles (*Hippodamia convergens*), **MPB**=Minute pirate bugs (*Orius* spp.), **PM**=Predatory mites (*Acari: Phytoseiidae*), **PN**=Predatory nematodes, **PW**=Parasitic wasps (Ichneumonidae, Braconidae, Chalcidae families), **S**=spiders (Erigone aletris, E. blaesa, and E. dentosa (Arachnida: Araneae)), **SF**= Syrphid flies, **TF**=Tachinid flies, and **TSS**=Two-spotted stinkbug.

Rating Scale: E = Excellent survivability, G = Good survivability, F = Fair survivability, P = Poor survivability, and ND = No Data.

	Beneficials												
Management Tool	**BEB**	**DB**	**LW**	**LB**	**MPB**	**PM**	**PN**	**PW**	**S**	**SF**	**TF**	**TSS**	**Comments**
Insecticides													
aldicarb (Temik)	P	P			F-P				E				
carbaryl (Sevin)	G	G	G	G	G								
carbofuran (Furadan)	F-P	F-P	F-P	F-P	F-P				F-P				
chlorpyrifos (Lorsban)	F-P	F-P	P	F-P	F-P	F-P	P	P	P	P	P		
diazinon (Diazinon)	F	F	F	F	F	F	ND	G	F	P	ND		
esfenvalerate (Asana)	F?	F?			P?				P?				
imidacloprid (Gaucho)	F	F			E				E				Seed treatment.
malathion (Malathion)	F	F	F	P	F	P	F	F	F-P	P	F		
methomyl (Lannate)	F-P	F-P	P	P	P	P	P	ND	F	P	P		
methyl parathion (Methyl Parathion)	P	P	P	P	P	P	P	P	P	P	P	P	
naled (Dibrom)	P	P	P	P	P	P							
oxymedeton-methyl (MSR)	F-P	F-P	F-P	F-P	F-P	P	P	P	P	P	P		
phorate (Phorate, Thimet)	F	G-F			G-F				F				
spinosad (Success)	F	F	F	F	F	F	ND	F	F	F	F		
terbufos (Counter 15G)													
zeta-cypermethrin (Mustang)	F-P	F-P	F-P	F-P	F-P	F-P	ND	F-P	F	F-P	F-P		
Biological Insecticides													
azadirachtin (Azatin, Aza-Direct)	E	E	E	E	E	E	ND	E	E	E	E		
Bacillus thurigeinsis spp. *aizawai* (Agree, Ketch, XenTari)													
Bacillus thurigeinsis spp. *kurstaki* (DiPel ES and many others)	E	E			E				E				
Beauveria bassiana													

Key to Beneficials: **BEB**=Bigeyed bugs, **DB**=Damsel bug, **LW**=Lacewings (*Chrysopa* spp.), **LB**=Lady beetles (*Hippodamia convergens*), **MPB**=Minute pirate bugs (*Orius* spp.), **PM**=Predatory mites (*Acari: Phytoseiidae*), **PN**=Predatory nematodes, **PW**=Parasitic wasps (Ichneumonidae, Braconidae, Chalcidae families), **S**=spiders (Erigone aletris, E. blaesa, and E. dentosa (Arachnida: Araneae)), **SF**= Syrphid flies, **TF**=Tachinid flies, and **TSS**=Two-spotted stinkbug.

Rating Scale: E = Excellent survivability, G = Good survivability, F = Fair survivability, P = Poor survivability, and ND = No Data.

	Beneficials												
Management Tool	**BEB**	**DB**	**LW**	**LB**	**MPB**	**PM**	**PN**	**PW**	**S**	**SF**	**TF**	**TSS**	**Comments**
Other Low-risk Insecticides													
horticultural oil	F	F	G	G	F	F	ND	G	G	ND	ND		
kaolin (Surround)	ND	ND	ND	ND	ND	G	ND	ND	G	ND	ND		
Fungicides													
azoxystrobin (Amistar, Quadris)													ND for all
copper (Champ, Kocide)	ND	ND	ND	ND	ND	G	ND	ND	ND	ND	ND		
copper + mancozeb (ManKocide)													ND for all
hymexazole (Tachigaren)													ND; seed treatment
mancozeb (Dithane, Penncozeb)	ND	ND	ND	ND	ND	F	ND	ND	ND	ND	ND		
maneb (Manzate)													ND for all
metalaxyl (Allegicance, Apron)													ND for all
metam sodium (VAPAM)							P						Not toxic to foliage-borne beneficials
myclobutanil (Laredo)	ND	ND	ND	E	ND	E	ND	ND	ND	ND	ND		
potassium bicarbonate (Kaligreen)													ND for all
pyraclostrobin (Headline)													ND for all
sulfur (various)	G	G	G	G	G	F-P							
thiophanate-methyl (Topsin-M)													ND for all
thiram (Thiram)													ND for all
TPTH (SuperTin)													
trifloxystrobin (Gem)	ND	ND	ND	E	ND	E	ND	ND	ND	ND	ND		
Biological Fungicides													
Burkolderia cepacia (Deny)													
Trichoderma harzianum (T-22 Planter Box)													

<u>Key to Beneficials</u>: BEB=Bigeyed bugs, **DB**=Damsel bug, **LW**=Lacewings (*Chrysopa* spp.), **LB**=Lady beetles (*Hippodamia convergens*), **MPB**=Minute pirate bugs (*Orius* spp.), **PM**=Predatory mites (*Acari: Phytoseiidae*), **PN**=Predatory nematodes, **PW**=Parasitic wasps (Ichneumonidae, Braconidae, Chalcidae families), **S**=spiders (Erigone aletris, E. blaesa, and E. dentosa (Arachnida: Araneae)), **SF**= Syrphid flies, **TF**=Tachinid flies, and **TSS**=Two-spotted stinkbug.

<u>Rating Scale</u>: E = Excellent survivability, G = Good survivability, F = Fair survivability, P = Poor survivability, and ND = No Data.

	Beneficials												
Management Tool	**BEB**	**DB**	**LW**	**LB**	**MPB**	**PM**	**PN**	**PW**	**S**	**SF**	**TF**	**TSS**	**Comments**
Herbicides													
clethodim (Select)													ND for all
clopyralid (Stinger)													ND for all
cycloate (Ro-Neet)													
dimethinamid-P (Outlook)													
EPTC layby (Eptam)													
ethofumesate (Nortron SC, Etho SC)													
glyphosate (various)	F	ND	ND	ND	ND	P	ND	G	ND	ND	ND		
phenmedipham + desmedipham (Betamix)													
phenmedipham + desmedipham + ethofumesate (Progress)													
paraquat (Gramoxone)	ND	ND	ND	ND	ND	P	ND	ND	ND	ND	ND		
pyrazon (Pyramin)													
quizalofop (Assure II)													
sethoxydim (Poast)													ND for all
s-metolachlor (Dual Magnum)													ND for all
triflusulfuron-methyl (UpBeet)													
trifluralin (various)	ND	ND	ND	ND	ND	ND	ND	F-P	ND	ND	ND		
Nematicides													
aldicarb (Temik)	P	P			F-P				E				
1,3-dichloropropene (Telone II)							P						Not toxic to foliage-borne beneficials

<u>Key to Beneficials</u>: BEB=Bigeyed bugs, **DB**=Damsel bug, **LW**=Lacewings (*Chrysopa* spp.), **LB**=Lady beetles (*Hippodamia convergens*), **MPB**=Minute pirate bugs (*Orius* spp.), **PM**=Predatory mites (*Acari: Phytoseiidae*), **PN**=Predatory nematodes, **PW**=Parasitic wasps (Ichneumonidae, Braconidae, Chalcidae families), **S**=spiders (Erigone aletris, E. blaesa, and E. dentosa (Arachnida: Araneae)), **SF**= Syrphid flies, **TF**=Tachinid flies, and **TSS**=Two-spotted stinkbug.

<u>Rating Scale</u>: E = Excellent survivability, G = Good survivability, F = Fair survivability, P = Poor survivability, and ND = No Data.

	Beneficials												
Management Tool	**BEB**	**DB**	**LW**	**LB**	**MPB**	**PM**	**PN**	**PW**	**S**	**SF**	**TF**	**TSS**	**Comments**
Cultural Controls													
Avoid Excessive Nitrogen													Neutral
Avoid Plant Injury													
Crop Rotation													Variable ecological impacts on polyphagous natural enemies; largely neutral
Irrigation Scheduling													Neutral
Irrigation Amount													Neutral
Plant Green Manures and trap crops													
Plant Resistant Varieties													Neutral
Planting date													Neutral
Tillage													Short term disruption to soil dwellers
Weed Control around Field Borders													May remove habitat or alternative prey for some species
Weed Management													May remove habitat or alternative prey for some species