2008
Integrated Pest Management Guidelines for Insects and Mites in Idaho, Oregon and Washington Potatoes

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PURPOSE

Potato growers in Idaho, Oregon and Washington are facing new insect pests that pose significant management challenges. These pests, combined with historical potato insect pests, leave pest management decision makers with a complicated set of choices. The following document is our best set of recommendations as to how potato insect pests in Idaho, Oregon and Washington can be cost effectively controlled.

The practices outlined in this report may not be appropriate for all locations. We advise that you modify this program according to the specific needs of your location. Consult with your local extension or pest management specialist for more information.

A Generic Statement on Generic Insecticides

A number of insecticide groups, such as pyrethroids and neonicotinoids, are increasingly available as generic equivalent. In many cases, a generic insecticide is functionally identical in its activity as its brand name equivalent; in some cases, this may not be true. With the proliferation of generic products available for control of potato insect pests, it has become difficult to keep track of all of the products names for each active ingredient. For example, there are currently 40 products, up from 28 last year, containing imidacloprid registered on potatoes by 19 different companies in the Pacific Northwest and registrations for several more products are pending. Sometimes generic products are registered in our area but are not available. We are unable to include the names for all generic products for the active ingredients that are included in this report. Our policy focuses on the brand name or best known name for a product in our industry. It is up to the grower, his crop protection advisors and extension specialist to identify the product that best meet his or her needs.

Plant Back Restrictions

Most pesticides contain label language discussing restrictions on what crops can be planted following their application. It can be easy to over look these restrictions particularly when this language is situated far away on the label from the potato section. Potato growers have been placed in difficult situations by applying an insecticide or miticide and then realizing that they cannot plant alfalfa the same year or sweet corn the following year. The statement "read and follow the label" is probably said too many times, but there is no substitute for reading and following the label. Most labels change from year to year so reading the label last year may not suffice for this year. Crop advisors, manufacturer representatives and extension specialists can be valuable sources of information for label changes.

Pesticide Disclaimer

Some of the pesticides discussed in this publication were tested under an experimental use permit granted by WSDA and ODA. Application of a pesticide to a crop or site that is not on the label is a violation of pesticide law and may subject the applicator to civil penalties up to $7,500. In addition, such an application may also result in illegal residues that could subject the crop to seizure or embargo action by WSDA, ODA and/or the U.S. Food and Drug Administration. It is your responsibility to check the label before using the product to ensure lawful use and obtain all necessary permits in advance.

Resistance to Insecticides

Insect pest of potatoes have a long history of developing resistance to insecticides. Colorado potato beetle (CPB), green peach aphid, potato tuberworm and two spotted spider mite are notorious for developing resistance to products used for their control. **The Pacific Northwest is one of the few regions (along with Colorado) where potato insects have not developed resistance to insecticides.** *An important exception is CPB which has developed resistance to pyrethroid insecticides in certain regions of Idaho.*

The reason the PNW potato industry has avoided much of the resistance problems other regions have suffered from is varied; reasons include PNW growers rotate potato fields, practice resistance management tactics and there are a number of alternative hosts that serve as refuge.

One of the most important things that potato growers can do to avoid resistance is the rotation of classes of insecticides. Each class of insecticides has its unique mode of action and by rotating classes or modes of action, pest populations are exposed to differing causes of mortality decreasing the likelihood that a resistant population can develop. In order to aid growers in figuring out what product belongs to what class, all insecticides within a class have been assigned to a unique class. In this version of the Guidelines, we have added the group number for each insecticide. For example, neonicotinoid insecticides have the Group number 4A. Growers should not follow a Group 4A product with another insecticide from the same group.

Neonicotinoid Resistance Management. The two most significant insect pests of potatoes in the world, Colorado potato beetle and green peach aphid, have developed resistance to many insecticides used for their control. While the Pacific Northwest has largely escaped this problem, the development of insecticide resistance in these pests is still an issue for which the potato industry needs to be prepared. Once resistance to an insecticide is established in a population the utility of the product is largely lost. Avoidance of resistance or resistance management is the best means to preserve the effectiveness of potato insecticides. PNW potato growers have access to six planting time products, Admire Pro, Gaucho, Platinum, Cruiser, Venom and Belay and six foliar products, Assail, Provado, Leverage, Actara, Venom and Belay, that belong to the same class of chemistry, neonicotinoids. Due to certain characteristics of this pesticide class and the propensity of CPB and GPA to develop resistance, there exists the potential for development of resistance to the entire class if the products are not used carefully. CPB populations in locations in the Midwest and East Coast have already developed elevated levels of tolerance to neonicotinoid insecticides in potatoes potentially jeopardizing the use of this class of insecticides. It is critical that this situation be avoided in the Pacific Northwest.

A simple method exists that can help avoid the development of resistance to these valuable products. If Admire Pro or Platinum are applied in-furrow or as a side dress or if Gaucho, Cruiser and Cruiser Maxx are applied as a seed treatment, do not use Assail, Provado, Leverage or Actara in the same field in the same season. This will help prevent subsequent generations of the pests from being exposed to this chemistry.

A second resistance management tactic that can be used is to not treat all potato fields on one farm or in one localized area with products from the neonicotinoid class at one time. A grower could forgo treatment on one circle out of five, or if a field of early potatoes was not treated with a product from the class, then other fields could all be treated with products of the same class at planting.

Management of Wireworm

Wireworms (Figure 1) are the larval stage of click beetles and can cause damage to potatoes in two ways: feeding upon potato seed pieces and their emerging sprouts in spring, allowing secondary infection pathogens or more importantly damaging developing tubers by directly feeding on them during the growing season (Figure 2). This damage often results in downgrading or rejection of the potato crop by packing sheds and processors.

Figure 1. Wireworms from tuber infested at harvest.

Figure 2. Two types of damage caused by wireworms. The type on the left is more common. It occurs relatively early in the growing season, and the wounds are healed at harvest. The type on the right is less common, but more serious because wireworms are present in the tubers at harvest.

Wireworms tend to be most damaging in potatoes that follow corn or small grains and on ground just entering cultivation. Those causing the most damage in irrigated lands are the Pacific coast wireworm and the sugarbeet wireworm, although less important species such as the Columbia Basin wireworm and the western field wireworm may also be present. An invasive European wireworm has been detected in northwestern Washington, and could become a problem Wireworm larvae require 2 to 6 years to mature, overwintering at a depth of 12 to 24 or more inches in the soil, only to return near the surface in spring to resume feeding. Soil temperatures are important in wireworm development and control. Larvae start to move upward in the spring when soil temperatures at the 12-inch depth exceed 50 degrees F. Later in the season when temperatures reach 80 degrees F and above, the larvae tend to

move deeper than 6 inches. Movement downward in preparation for overwintering begins in early autumn or as soil temperatures at 1 foot drop below 60°F.

Wireworm presence or absence in a field should be determined before using control measures. The sequence of crops should be considered. For example, planting a susceptible crop such as potatoes immediately after red clover, pasture grasses or a grain crop is risky. Other than crop rotation with non host crops, there are no cultural and no biological control methods for wireworm. If one suspects wireworms are present in a field, chemical control is the only management option.

Telone is effective on wireworms that are present at the time of fumigation and within the zone of fumigation. Therefore, as a guideline, it is important that Telone is applied when soil temperature is 50 degrees (or higher) or if baiting/sampling indicates the presence of wireworms. For best results, late summer or fall applications should be made prior to the movement of wireworms down the soil profile and out of the fumigation zone.

Mocap (ethoprop, Group 1B) may be applied as a broadcast incorporated application or over the row at planting time. If the product is broadcast, it is critical that the material is deeply incorporated to a depth of at least 6 inches. Applications of 1 gallon of the 6 EC liquid formulation or 40 pounds of the 15% granular formulation are recommended. Ideally the incorporation should be in the 6 to 12 inch depth. An in furrow application should be applied as a band that is as wide as possible, ideally 12 inches wide. Applications of 2 quarts of the 6EC liquid formulation or 20 pounds of the 15% granular formulation are recommended for the band treatment. Narrow, in furrow bands are not recommended.

Regent 4 SC (fipronyl, Group 2B). The product is applied in furrow at 3.2 ounces per acre. The rate changes for row spacings over 36 inches in width. The product should be applied one time, in furrow in a 5 to 7 inch band. No T-banding over the top of a closed furrow is permitted. **Regent has some important crop rotation restrictions that will limit its importance to the Washington potato industry for the time being.** Do not plant any other rotational crops except (field corn, potato, leafy vegetables, root vegetables, legume vegetables, wheat or triticale) within 12 months following application. BASF is working to get these restrictions lifted, but for this season they are in place.

Planting Time Insecticide Treatments

Based on trials conducted in Idaho, Oregon and Washington, imidacloprid-based products (Admire Pro and Gaucho) and thiamethoxam-based products (Platinum and Cruiser) provide significantly better Colorado potato beetle and aphid control than alternatives. Imidacloprid and thiamethoxam (both neonicotinoid insecticides) applied at planting will provide 80 to 100 days of residual control. Aldicarb (Temik) applied at planting will provide approximately 70-75 days control. Other soil applied systemic insecticides such as phorate (Thimet, Phorate) and Furadan do not provide reliable Colorado potato beetle and GPA control beyond 50 days. Use of Temik will increase the likelihood that foliar application of insecticides mid to late season will be necessary. Use of Thimet and Furadan greatly increase the likelihood that foliar application of insecticides will be necessary. **Venom** is another neonicotinoid insecticide used at planting time recently registered by Valent for use on potatoes. At this time, it is not recommended for use in the Pacific Northwest.

Insecticide Seed Treatments

Tops MZ Gaucho (imidacloprid Group 4A). These dry seed treatments control aphid, Colorado potato beetle, flea beetle, potato leafhopper, and psyllids in a dust formulation. Gaucho may reduce wireworm damage in seed-pieces. Application rate is 0.75 lbs/cwt., or 20lbs/acre maximum. Do not apply any foliar neonicotinoid (Provado, Leverage or Actara, Assail, Belay, Venom) following this application.

Admire Pro (imidacloprid. Group 4A). Admire Pro is a liquid seed piece treatment offering control of all aphid species, Colorado potato beetle, flea beetle, potato leafhopper, and psyllids with the flexibility of ultra-low volume liquid seed-piece application. Admire Pro may reduce wireworm damage in seed-pieces. The application rate is 0.17 – 0.35 fl. oz./cwt. of seed-pieces (Note: Based on a 2000 lb/acre seeding rate, this rate range is equivalent to 3.5 -7.0 fl. oz./acre). Do not apply any foliar neonicotinoid (Provado, Leverage or Actara, Assail) following this application.

Cruiser 5FS (thiamethoxam. Group 4A). Cruiser is a seed applied neonicotinoid product recently registered for use on potatoes. Use Cruiser 5FS seed treatment to provide protection against injury from green peach aphid, potato aphid, Colorado potato beetles, flea beetles, and psyllids. Cruiser 5FS will also control wireworms that feed on the seed piece. The rate range is 0.11 to 0.16 fl oz per 100 lbs of tubers, depending on the seeding rate (consult label). Length of control will vary depending on the rate used, soil and environmental conditions, and insect pressure. Use approved application equipment (Spudgun or Milestone barrel treater). It is important to note that the application rate will vary by the number of sacks planted per acre with a maximum use rate of 0.125 lb ai/A. A new formulation of Cruiser, Cruiser Maxx, was recently registered. This formulation is a combination of Cruiser 5FS, Maxim 4FS and a drying agent. The drying agent dries the seed more quickly aiding in suberization. Do not apply any foliar neonicotinoid (Provado, Leverage or Actara, Assail) following this application.

Insecticide In-Furrow Treatments

Platinum (thiamethoxam. Group 4A). Platinum is a soil-applied insecticide providing long residual control in potatoes. Apply Platinum at 5.0 to 8.0 fluid ounces/acre (0.34 – 0.52 fluid oz./1,000 linear feet in 34 inch row spacing) in-furrow at planting in a 6-8 inch band with sufficient water for good coverage for the control of aphids, Colorado potato beetle, potato leafhoppers, flea beetles, and potato psyllid. Do not apply less than 5.0 fluid ounces/acre or more than 8.0 ounces/acre/season. Do not apply if any neonicotinoid (Group 4A: Cruiser, Cruiser MAXX, or Admire Pro) has been applied as a seed treatment. Do not apply neonicotinoids (Provado, Leverage or Actara) following this application. Alternatively, Platinum may be applied POST plant, pre-emergence as a broadcast application at 5.0 to 8.0 fluid ounces/acre and watered in with 0.10 -0.25 inches of water. All precautions listed above must be followed.

Temik 15G (aldicarb. Group 1A). Temik 15G is a soil applied granular insecticide/nematicide for control of major foliar insect pests in potatoes including aphids, Colorado potato beetle, leafhoppers (excluding beet leafhopper), flea beetles, and mites. Temik also controls lesion nematode while suppressing stubby root, Columbia rootknot and northern rootknot nematode. Reducing populations of these pests alleviate detrimental quality and yield problems that result from corky ringspot, net necrosis, and potato early dying. Application rate is 20 lbs/A. Place granules with seed pieces in the planting furrow or apply in a 6-inch band in front of the opening shoe and incorporate into the soil.

Tubers cannot be harvested until 150 days after application. Temik may not be used in furrow irrigated potatoes.

Admire Pro (imidacloprid. Group 4A). Admire Pro is a soil-applied insecticide providing long residual control of insect pests of potatoes. Admire Pro will control Colorado potato beetles, aphids, potato leafhoppers, wireworms (seed piece only), and psyllids. Dosage rates are 5.7 to 8.7 fl oz/A applied as an in-furrow spray at seeding or as a side dress to both sides of the hill after planting (treated areas of both hillsides should be covered with approximately 3 inches of soil).

Belay 16 WSG (clothiniadin, Group 4A). Apply Belay at 12 and 18 ounces in furrow or at cracking. Use 10 gallon of water per acre. Belay has an REI of 12 hours. Water immediately after application when cracking. Belay has no crop rotation restrictions.

Colorado Potato Beetle (CPB; Figures 3-5)

Cultural Control

Crop rotations: Crop rotations help in delaying or reducing CPB pressure. Adult beetles spend the winter buried 4 to10 inches deep in the soil and emerge in the spring just as the first volunteer potatoes appear. Recently emerged beetles either mate close to the overwintering sites or fly to new potato fields to find a mate. Colonizing beetles need to feed before starting to lay eggs. Therefore, rotating crops and planting the new potato fields as far from the last year's fields as possible will reduce the number of immigrant overwintering beetles into the new field. Although cereal crops favor wireworm populations as mentioned before, planting cereal grains after potatoes aids in reducing CPB migrations from overwintering sites to new fields.

Control of volunteers and weeds: Because overwintering adults need to feed before walking or flying into new fields, controlling volunteers and weeds such as nightshades is important, as they are an early food source for these emerging adults. This tactic does not provide complete control, but may reduce or delay population growth.

Figure 3. Colorado potato beetle adults.

Chemical Control

The use of systemic insecticides in early potatoes, presented in the previous section for aphid control, will also contribute to the control of early-season CPB populations. Do not use disruptive foliar products, such as pyrethroid insecticides, for control of CPB after June 15. **Pyrethroid insecticides kill beneficial organisms and may flare aphid numbers.** Foliar applied products available for CPB control include Assail, Success, Radiant, Agri-Mek, Penncap-M, Imidan, Provado, Leverage, Rimon and Actara.

Figure 4. CPB small larvae.

Success SC (spinosad. Group 5). For light larval populations, apply 3 to 4 fluid ounces of Success per acre by air, ground or chemigation. Time applications to target egg hatch or young larvae. For heavy larval populations, apply 5 to 6

fluid ounces of product per acre. Applications by chemigation at either rate should be made with 0.25 acre inches of water or less. If the plant is actively growing, applying 3 or 4 fluid ounces of product per acre in sequence may be more effective than applying 6 fluid ounces singularly. Acidic (< 6 pH) spray solutions may shorten the residual activity of Success and should be avoided. The pH of spray solution should be checked prior to adding Success into the tank and adjusted, if necessary. Acidifying products such as boron should be avoided. In addition, prior to adding Success to a tank it is recommended to conduct a compatibility test.

Figure 5. CPB larvae and foliar damage.

Radiant SC (spinetoram. Group 5). Apply 6 to 8 fluid ounces of Radiant per acre by air, ground or chemigation. Time applications to target egg hatch or young larvae. For heavy larval populations, repeat applications may be necessary but follow resistance management guidelines. Applications by chemigation at either rate should be made with 0.25 acre inches of water or less. Acidic (< 6 pH) spray solutions should be avoided. The pH of spray solution should be checked prior to adding Radiant into the tank and adjusted, if necessary. Acidifying products such as boron should be avoided. In addition, prior to adding Radiant to a tank it is recommended to conduct a compatibility test.

Agri-Mek (abamectin. Group 6). Apply 8 to 16 ounces of Agri-Mek by air with 5 gallons of water per acre. Avoid the use of Agri-Mek with any product containing sticker/binder-type adjuvants (e.g. Bravo Weather Stik, Bravo Ultrex or Dithane Rainshield). The addition of a nonionic surfactant or organosilicone-based surfactant, at the manufacturer's recommended rate is suggested for optimum control.

Imidan 70W (phosmet. Group 1B). Apply 1.33 pounds of product per acre by air or ground. Imidan is very sensitive to chemical hydrolysis in the presence of alkaline or neutral pH. Half-life for technical phosmet is only 33 minutes at pH 8.3, and 10 hours at pH 7, but increases steeply to approximately 4 to 13 days, respectively, between pH of 5.5 to 4.5. For optimum stability and residual, adjust tank mixture pH to between 3.5 and 5.0 using a suitable buffer that will maintain proper pH entirely through the course of application. Test kits for checking water pH are available from Gowan Company. For optimum control, apply early when CPB population is primarily in larval stage. If a second application is needed, apply no sooner than a 10-day schedule. Use adequate volume for good coverage; 5 gallons per acre by air; 20-40 gallons per acre by ground.

Provado 1.6 Flowable (imidacloprid. Group 4A). Apply 3.75 oz/acre; 7 days of residual activity should be expected. It is important to obtain complete coverage. Addition of a silicone or MSO type

surfactant has shown to be helpful. Applications can be made by air or ground. Do not apply Provado, Leverage or Actara if Admire Pro, Platinum, Gaucho or Cruiser have been applied as a seed or in furrow treatment.

Actara (thiamethoxam. Group 4A). Apply 1.5 ounces/acre by either ground or by air. A total of 6.0 ounces may be applied per season. Apply Actara in a minimum of 10 gallons of water when application by ground and a minimum of 5 gallons when applying by air. When applying Actara by ground or air use an oil blend adjuvant. For chemigation, use from 0.10-0.25 inches of water. Avoid the use of Actara with any product containing sticker/binder-type adjuvants (e.g. Bravo Weather Stik, Bravo Ultrex or Dithane Rainshield. Examples of appropriate adjuvants include crop oil concentrates (COC) (e.g. Herbimax), methylated seed oils (MSO) (e.g. Dynamic), ethylated seed oils (ESO) (e.g. Hasten) and organosilicone (OS) blends (e.g. Aerodynamic). Do not apply this product if the field has been treated this year with Admire Pro, Gaucho, Cruiser or Platinum.

Leverage (imidacloprid and cyfluthrin Group 3, 4A). Leverage may be applied by aerial, ground or chemigation equipment at 3.0-3.75 fl oz/A. Use the 3.0 fl oz rate for ground applications only. Aerial applications should be made in a minimum of 5 gallons per acre with 10 gallons per acre recommended. The addition of a silicone or MSO type surfactant may aid in control. Do not apply this product if the field has been treated this year with Admire Pro, Gaucho, Cruiser or Platinum.

Brigadier (imidacloprid and bifenthrin Group 3, 4A). Brigadier may be applied by ground, air or chemigation at 4.8 to 6.14 fl oz/A. There is a 21-day PHI, applications should not be made closer than 7 days apart and there is a season maximum limit of 25.6 fl oz/A.

Rimon 0.83 EC (novaluron. Group 15). Rimon may be applied by air, chemigation or ground equipment at 9 to 12 fl oz/A. Applications should be made when the majority of CPB larvae are between egg hatch and second instar. Rimon is an insect growth regulator type insecticide which must be ingested by larvae or applied either over or under eggs to act as an ovicide, therefore, reapplication at 7 to 14 days is needed to protect new plant tissue during periods of active foliar growth. The product must be ingested to affect larval CPB. It will not control adult beetles. Do not make more than two applications per season. Do not apply to two successive generations in the same growing season. Use a minimum of 5 gallons per acre when applying by air; apply a minimum of 10 gallons per acre when applying by ground. Rimon has a 12 hour restricted entry interval and a 14 day pre harvest interval. Do not apply more than 24 ounces per acre per season.

Assail 70WP (acetamidiprid. Group 4A). Apply 0.6 to 1.7 ounces/acre by ground, air or chemigation for Colorado potato beetle control. Use the higher rate under conditions of heavy pest pressure, dense foliage and/or application by chemigation. Apply before larvae cause defoliation damage that would result in economic loss. A total of 6.8 ounces may be applied per season. Do not make more than 4 applications per season and do not apply more than once every 7 days. Do not apply less than 7 days prior to harvest (7 day PHI). Complete plant coverage, including the lower portion of the plant if pests are present in that area, is necessary for best results. Apply Assail in a minimum of 20 gallons of water by ground, 5 gallons by air and a maximum of 0.2 inch/acre by chemigation. When applying Assail by ground or air, use a crop oil adjuvant such as crop oil concentrates (COC), methylated seed oils (MSO), ethylated seed oil (ESO), or use an organo-silicone crop oil blend adjuvant. Do not irrigate within 12 hours of an Assail application. There are no rotational crop plant back restrictions for Assail. Do not apply this product if the field has been treated this year with any neonicotinoid (Admire Pro, Gaucho, Cruiser or Platinum).

Aphids (Figure 6-7) and Aphid Management

Figure 6. Green peach aphids on potato leaf.

Desiccation of Early Season Potatoes

Desiccation of early season potatoes can influence the formation and emigration of winged aphids. Use of acid desiccation is the recommended practice to reduce the likelihood of infesting other potato fields with aphid survivors from early season potatoes. Chemical desiccants, such as Reglone or Rely, can also be used to decrease the likelihood of aphids moving to other fields. Desiccation of potatoes by removal of irrigation results in slow dehydration of potatoes, which triggers wing formation in aphids and stimulus for flights. Desiccation of potatoes by ending irrigation should only be used as a last resort. If water management is used to desiccate the crop, it is critical that an effective aphicide such as Fulfill, Beleaf or Monitor be used.

Figure 7. Potato aphid on potato stem. This aphid can be red or green.

- Use only clean seed tubers with low or no disease content based on winter tests.
- If potato growers do not use a systemic insecticide at planting, it is even more important that foliar aphid insecticides be used later in the season.
- Fields should be scouted at 3 to 4 day intervals before aphid flights begin; a minimum of ten locations per 100 acre field should be checked. Scouting should begin based on University recommendations. For potatoes that are not to be stored begin application of foliar aphid insecticides should begin when 5 aphids per 100 leaves or 5 aphids/plant are detected. **For**

information on potato aphids in the Columbia Basin, contact the *Aphid Hotline* at *1 888 673 6273*. This hotline (updated every 10-14 days during the main growing season) provides current GPA flights and field status; it is based on surveys of GPA from Umatilla to Moses Lake. For significant additional information on aphid pests of potatoes in Washington, see the website *www.potato.prosser.wsu.edu*

- Control volunteer potatoes and potatoes growing in cull piles. (See section in early season potatoes for information on volunteer potato control.)
- Based on trials conducted in Idaho, Oregon and Washington, imidacloprid-based products (Admire Pro and Gaucho), thiamethoxam-based products (Platinum and Cruiser) and clothiniadin-based product (Belay) provide significantly better aphid control than alternatives. Imidacloprid, thiamethoxam and chothiniadin applied at planting will provide 80 to 100 days of residual control. Aldicarb (Temik) applied at planting will provide approximately 70 to 75 days control. Other soil applied systemic insecticides such as phorate (Thimet, Phorate) and Furadan do not provide reliable green peach aphid (GPA) control beyond 50 days. Use of Thimet will increase the likelihood that foliar application of insecticides mid to late season will be necessary. Use of Thimet and Furadan in a full season potato production system is of minimal value for pest management. Temik can provide value nematode control. The need for nematode control may increase the need for Temik.
- In years with high numbers of winged GPA, a management program that uses only foliar insecticides applied in response to scouting is insufficient to prevent PLRV transmission in late season Russet potatoes. This is because the high number of aphids can transmit potato leaf roll virus (PLRV) before 100% of aphids are killed.
- Following a soil or seed treatment applied insecticide a "no gap" program is required to reduce the extent of transmission of PLRV from infected plants to non-infected plants within a field. It is possible that even with a "no gap" intensive GPA control program some level of transmission from virus bearing aphids migrating into a field from early season potatoes or weedy hosts may occur. A no gap program includes use of a long-term residual insecticide applied at time of planting, application of an effective foliar aphid insecticide prior to the "break" and then sequential applications of foliar aphid insecticides at intervals no longer than their period of residual control.
- Research in Idaho indicates that hairy nightshade is an excellent aphid and virus host. The mere presence of this weed increases the amount of PLRV and Potato Virus Y (PVY) in the crop. Therefore, control of this weed is highly recommended.

It was previously thought that the primary means by which GPA survives the winter is in the egg stage on peach trees. We now know that if they are not subjected to temperatures cold enough to kill them, they can also overwinter on various perennial, biennial, and winter annual weeds, such as tumble mustard, flixweed, shepherd's-purse, chickweed, mallow, horseweed, pennycress and redstem filaree. While it is not entirely possible or practical to control aphids originating from these weeds, it is important to understand that early sources of aphid outbreaks can occur throughout most, if not all of the PNW potato growing regions as these weeds dry out.

Cultural Control

Reducing overwintering GPA populations on the primary host. In some Idaho areas, the number of GPA present in the spring to infest crops depends upon winter survival. The common means of

overwintering in most parts of Idaho is on the winter host in the egg stage. Peach trees are the most common winter hosts, although apricots and other species of *Prunus* are infested on rare occasions. Fields near commercial peach orchards or urban areas with backyard and abandoned peach trees, usually have higher populations than those in isolated areas. Therefore, removing and replacing peach and apricot trees and spraying insecticides on commercial peach orchards are effective ways to prevent aphid buildup in Idaho.

Eliminating GPA populations on bedding plants. Bedding plants in home gardens are a good source of aphids. Proof of this is that potato fields close to towns are the ones with the most GPA problems. Significant numbers of winged aphids can be produced in home gardens after plants have emerged. Aphids moving directly from home gardens to potato plantings often transport viruses since home garden potato plants often have a high rate of disease infection. Elimination of aphids on bedding plants is a very important part in the success of any integrated pest management program of GPA and viruses. Effective programs to control GPA on the winter host and on bedding plants will greatly reduce the need for applications of insecticides to potato crops.

Eliminating secondary hosts. Early aphid infestations commonly occur on a number of weeds including species of mustards, nightshade and ground cherries. Winged forms produced on these weeds later infest crop plants, including potatoes, and high numbers may appear during a short period when one or more species of weeds dry up or mature. Research from Idaho has shown that hairy nightshade is an excellent aphid host and also harbors potato viruses. Green peach aphids reproduce up to 50 percent higher on the weed than on potatoes.

Green peach aphids and other species of colonizing and non colonizing aphids can transmit potato viruses (PLRV and PVY) from hairy nightshade to potatoes at higher rates than from potatoes to potatoes. Therefore, nightshades should be kept well in check, especially in seed-growing areas where disease prevention is essential.

Chemical Control

Application of aphid insecticides should begin just prior to the time or expected time in decline in performance ("break") of the soil or seed treatment insecticides applied at planting or layby, OR as soon as non-winged aphids are detected, OR if significant aphid flights have been forecast for your area. To ensure prevention of PLRV transmission there should be no gaps in aphid protection of potatoes, regardless of the insecticide used, or whether applied in furrow, to the seed piece or to the foliage. Complete insect control from planting until aphid flights have ceased is the only means to manage PLRV in full season potatoes. Any gap in coverage may result in substantial virus transmission. It is important to remember that even with complete insecticidal coverage of a potato field some transmission of PLRV from winged aphids landing on potatoes is possible. In most years for most fields, applications of aphid insecticides should be completed by Labor Day. However, treatment may be warranted beyond Labor Day if there is significant late season rise in aphid numbers in areas where potatoes are still green, still actively growing and bulking. Though yields are not likely to be impacted, late season virus transmission by aphids can increase the risk of PLRV net necrosis in stored tubers (for details on late season aphid transmission of PLRV, see the website, www.potato.prosser.wsu.edu, *Net Necrosis Article*).

Foliar insecticides which are suggested for use in suppressing aphids in late-season potatoes include the following:

Belay 50 WDG (clothinadin. Group 4A) Apply Belay at the full label rate of 1 to 1.5 oz. In 2008, Belay can be applied by ground only in 10 to 20 gallons per acre. The product has a 14 day PHI, a 12 REI and a 14 day application interval. There is a season limitation of 3 application. Belay has no crop rotation restrictions. Do not use if neonic at planting.

Monitor (metamidophos. Group 1B). Apply Monitor at the full label rate of 2 pints of product just prior to the "break" in control of the soil applied insecticide or as soon as non-winged aphids are detected. Winged aphids bearing PLRV are capable of transmitting the virus within minutes of landing; therefore, application of insecticides solely based on detection of aphids in a field may not prevent transmission of PLRV. Applications of insecticides should continue until the likelihood of GPA occurrence has passed. Monitor should be applied according to the following intervals: 14-day intervals when canopy is open, 10-day intervals when canopy is completely closed over and 7-day intervals when canopy becomes compacted. The Monitor label permits a maximum of four applications. A minimum of five gallons of water should be used when applying Monitor by air. Do not apply Monitor via an irrigation system. [Application of Monitor through an irrigation system may be an appropriate choice for locations where aerial or ground applications are prohibited, such as portions of the Tri-Cities area in Washington.]

Fulfill (Pymetrozine. Group 9B). Apply Fulfill at the full label rate of 2.75 to 5.5 oz./A ounces per acre using a penetrating surfactant. Use the higher rate with heavier aphid populations. This produce should be applied just prior to the "break" in control of soil applied insecticide or at the very first detection of wingless aphids in the field (see GPA action threshold at the end of this section.) A minimum of five gallons of water should be used when applying Fulfill by air. Fulfill can be applied via irrigation systems. The Fulfill label permits a maximum of only two applications. When applying Fulfill by ground or air use an oil blend adjuvant. Always use a penetrating adjuvant when used with other products that contain sticker/binder-type adjuvants (e.g. Bravo Weather Stik, Bravo Ultrex or Dithane Rainshield. Examples of appropriate adjuvants include crop oil concentrates (COC) (e.g. Herbimax), methylated seed oils (MSO) (e.g. Dynamic), ethylated seed oils (ESO) (e.g. Hasten) and organosilicone (OS) blends (e.g. Aerodynamic). Note, there is no quick knock down of aphid populations with Fulfill; the product causes aphids to cease feeding, with actual death occurring in 3-5 days.

Actara (thiamethoxam Group 4A). Apply 3.0 ounces/acre by either ground or by air (24C registration). This product should be applied just prior to the "break" in control of the soil applied insecticide or at the very first detection of wingless aphids in the field (see GPA action threshold at the end of this section). A total of 6.0 ounces may be applied per season. Apply Actara in a minimum of 10 gallons of water when application by ground and a minimum of 5 gallon when applying by air. When applying Actara by ground or air use an oil blend adjuvant. For chemigation, use 0.10-0.25 inches of water. Avoid the use of Actara with any product containing sticker/binder-type adjuvants (e.g. Bravo Weather Stik, Bravo Ultrex or Dithane Rainshield. Examples of appropriate adjuvants include crop oil concentrates (COC) (e.g. Herbimax), methylated seed oils (MSO) (e.g. Dynamic), ethylated seed oils (ESO) (e.g. Hasten) and organosilicone (OS) blends (e.g. Aerodynamic). Do not apply this product if the field has been treated this year with Admire Pro, Gaucho, Cruiser, Cruiser Maxx or Platinum.

Beleaf (flonicamid Group 9C). Beleaf is a new insecticide that was registered for the 2007 growing season for use on potatoes. Apply Beleaf at 2.0 to 2.8 ounces per acre. The product may be applied by ground, air or chemigation for aphid control. This product will only control aphids. Apply no more than 3 applications per season. Beleaf has a 7 day pre harvest interval.

Assail 70WP (acetamiprid Group 4A). Apply 1.0 to 1.7 ounces/acre by ground, air or chemigation for aphid control in full season potatoes. Use the higher rate under conditions of heavy pest pressure, dense foliage and/or application by air or chemigation. Apply Assail when aphids are first detected. Repeat applications at 7-10 day intervals may be required if aphid pressure continues. A total of 6.8 ounces may be applied per season. Do not make more than 4 applications per season and do not apply more than once every 7 days. Do not apply less than 7 days prior to harvest (7 day PHI). Complete plant coverage, including the lower portion of the plant if pests are present in that area, is necessary for best results. Chemigation may provide the best coverage when the canopy is dense and closed. Apply Assail in a minimum of 20 gallons of water by ground, 5 gallons by air and a maximum of 0.2 inch/acre by chemigation. When applying Assail by ground or air use a crop oil adjuvant such as crop oil concentrates (COC), methylated seed oils (MSO) or ethylated seed oil (ESO), or use an organosilicone crop oil blend adjuvant. Avoid the use of Assail with any product containing sticker/binder-type adjuvants when aphid and leafhopper are the target pests. Do not irrigate within 12 hours of an Assail application. There are no rotational crop plant back restrictions for Assail. Do not apply this product if the field has been treated this year with Admire Pro, Gaucho, Cruiser or Platinum.

Mite Control in Potatoes

Virtually all economic infestations of mites (two-spotted spider mites, Figure 8) on potatoes occur in the Columbia Basin of Washington and Oregon. Occasionally mite outbreaks on potatoes occur in other regions of Oregon and in Idaho. Mite infestations should be managed in the same manner throughout the Pacific Northwest, however, the decision of whether and when to scout for mites on potatoes outside of the Columbia Basin must be based on local conditions and risk of mite outbreak. All potatoes in the Columbia Basin should be sampled for mites. Applications of miticides (Acramite, Comite and Oberon) should be made upon early detection of mites. All potatoes should be surveyed for the presence of mites and mite eggs starting July 15.

Figure 8. Two-spotted spider mite and eggs on potato leaf. The mite is less than 0.1 inch long.

Sampling for mites requires a close visual inspection of leaves from differing levels of the plants. Shaking suspected infested leaves above a piece of white paper helps to determine the presence of mites. They will dislodge from the leaves and the tiny spots moving on the paper (mites) are easy to see. Use of at least a 10x hand lens is important for detecting mites in low numbers. There are no registered miticides available that will provide full control or serve as rescue treatments once mite populations reach outbreak levels. Application of miticides should begin before populations reach 2 mites per leaf; this is close to the detection limit for the pest. Thorough coverage is essential for good control. Foliage should be dry at the time of application. Do not irrigate potatoes for 24 hours after application if possible.

In most cases, a single application of a miticide will suffice for a growing season; however, in about 10% of mite outbreaks a second application of a miticide is required. Retreatment with a different miticide should be considered as a resistance prevention strategy. Mites on potatoes have never been demonstrated increased tolerance to miticides; however, two spotted spider mite is well known for its ability to develop resistance and rotation of miticides is desirable.

Based on research supported by the Washington State Potato Commission inclusion of surfactants that improve coverage have been shown to significantly improve efficacy of miticides.

Acramite (bifenazate Group 25) is a newly registered miticide that may be applied by air, chemigation or ground. Acramite should be applied at 16 to 24 ounces per acre. Apply the higher rate to higher populations of mites. Use at least 20 gallons of water when applying by ground and at least 5 gallons of water when applying by air. Only one application can be applied per season. The preharvest interval is 14 days.

Oberon (spiromesifen Group 23) is a broad-spectrum miticide that may be applied by air, ground, or chemigation equipment. Good coverage of the foliage is necessary for optimal control. An adjuvant

may be used to improve coverage and control. For best results the treatment should be made when mite populations begin to build and before a damaging population becomes established. Oberon is most effective against the egg and nymphal stages of mites. Control should be directed at these stages. Oberon can be applied at 8-16 fluid ounces per acre. Apply when mites first appear and prior to leaf damage or discoloration. Apply in adequate water for uniform coverage with ground or aerial application equipment, or by chemigation as per the use label. If needed, repeat an application of Oberon at a 7- to 10-day interval. There is a limit of two applications per season. Applications of Oberon at the 8.0 oz rate are not recommended by air or chemigation except for situations where mite pressure is low or when applied sequentially as a split application following higher rates of Oberon as needed. Based on observations of field applications, applications via chemigation have been more effective than by air.

Comite (propargite Group 12C) is effective against the nymphal (6 legs) and adult (8 legs) stages of spider mites when applied by air, ground, or chemigation. The preferred method of application is by air or ground. Aerial applications of Comite should be applied in a minimum of 10 gallons of water. The addition of an adjuvant has been shown to improve coverage. Comite has a 14-day retreatment interval for Washington, Oregon, and Idaho.

Two-spotted spider mite resistance management. While the species of spider mite attacking PNW potatoes has demonstrated the ability to readily develop resistance to miticides, there appears to be no evidence of this problem developing in our area. However, with the availability of new miticides, potato growers should consider taking some basic steps that could prevent or delay onset of resistance in mites. If growers apply more than one miticide per season, consider applying a different miticide for the second application. All three miticides registered on potatoes have different modes of action and can be rotated with each other. While research has shown some differing levels of efficacy between the products, all three products have repeatedly been shown to provide commercially acceptable levels of control when applied early enough in the outbreak cycle.

Cutworm, Armyworm and Cabbage Looper Control in Potatoes

Little is known about the biology and management of worms in PNW potatoes (for pictures and other information, see the section below entitled "Secondary and Emerging Insect Pests"). The economic threshold for when to treat for worms is unknown. In the absence of a threshold, growers should consider the level of defoliation by worms to be approximately similar to that of Colorado potato beetles. CPB rates of development and feeding patterns are different from worms, so do not make predictions of expected damage using your knowledge of beetle outbreaks. Also, different worm species can infest potatoes, so your experience for one field may not be appropriate for another field unless the species, environment and other conditions are the same or similar. It is important to scout for living worms in your fields, rather than applying treatments in response to damage. Sometimes worms are absent by the time damage is noticed. Also, some species have nocturnal habits and may not be easily found during the day.

There are four insecticides recommended for control of worms in a potato integrated pest management program, Success, Rimon and Avaunt (indoxacarb) and Imidan. Applications should be targeted at the incidence of feeding or appearance of small larvae (1^{st} and 2^{nd} instars). Larger larvae may be more difficult to control and may require multiple applications at 7-day intervals.

Success SC (spinosad Group 5). For smaller sized worms (early instars), apply 4.5 fluid ounces of product per acre by air, ground or chemigation. Time applications to target egg hatch or young larvae. For larger (later instar) larval populations, apply 5 to 6 fluid ounces of product per acre. Applications by chemigation at either rate should be made with 0.25 acre-inches of water or less. If the plant is actively growing, applying 3 or 4 fluid ounces of product per acre in sequence may be more effective than applying 6 ounces singularly. Acidic (< 6 pH) spray solutions may shorten the residual activity of Success and should be avoided. The pH of spray solution should be checked prior to adding Success into the tank and adjusted, if necessary. Acidifying products such as boron should be avoided. In addition, prior to adding Success to a tank it is recommended to conduct a compatibility test.

Radiant SC (spinetoram Group 5). Apply 6 to 8 fluid ounces of Radiant per acre by air, ground or chemigation. Time applications to target egg hatch or young larvae. For heavy larval populations, repeat applications may be necessary but follow resistance management guidelines. Applications by chemigation at either rate should be made with 0.25 acre inches of water or less. Acidic (< 6 pH) spray solutions should be avoided. The pH of spray solution should be checked prior to adding Radiant into the tank and adjusted, if necessary. Acidifying products such as boron should be avoided. In addition, prior to adding Radiant to a tank it is recommended to conduct a compatibility test.

Avaunt (indoxacarb Group 22). Avaunt may be applied by air or ground equipment at 2.5 to 6.0 ounces per acre, with 3.0 ounces being the most common rate applied. The preharvest interval is 7 days and it has a restricted entry interval of 12 hours. A total of 24 ounces can be applied per season. Applications by air require a minimum of 5 gallons of water per acre.

Rimon 0.83 EC (novaluron Group 15). Rimon may be applied by air, chemigation or ground equipment at 9 to 12 fl oz/A. Applications should be made when the majority of larvae are between egg hatch and second instar. Rimon is an insect growth regulator type insecticide which must be ingested by larvae or applied either over or under eggs to act as an ovicide, therefore, reapplication at 7 to 14 days is needed to protect new plant tissue during periods of active foliar growth. In order for this product to affect larvae it must be ingested. Rimon has no effect on adults. Do not make more than two applications per season. Use a minimum of 5 gpa when applying by air; and a minimum of 10 gpa

when applying by ground. Rimon has a 12 hour restricted entry interval and a 14 day preharvest interval. Apply no more than 24 ounces per acre per season.

Imidan 70W (phosmet Group 1B). Imidan may be applied for control of loopers at 1.33 to 2.5 pounds per acre. Apply when worms are first detected and larvae are predominantly small. A rate of 2 to 2.5 pounds is recommended for use against loopers in potatoes. Apply by ground or air in a minimum of 2 gallons of water per acre. Obtain uniform coverage for best results. Do not apply more than two times per season when using the maximum rate of 2.5 pounds per acre per season, do not apply more than 6.66 pounds per season. This product may be applied through irrigation systems. At 1.33 pounds per acre, the preharvest interval is 7 days, at rates above 1.33 pounds, the preharvest interval is 21 days. This product is available for use under Section 24c of FIFRA, make sure you have a copy of 24c label with you when making the application.

Management of Beet Leafhopper and
Beet Leafhopper Transmitted Virescence Agent in Potatoes

BLTVA and Beet Leafhopper in Potatoes

A serious epidemic of a "potato yellows" disease, also called purple top, occurred in many potato fields throughout the Columbia Basin in 2002. The beet leafhopper-transmitted virescence agent (BLTVA), a bacteria-like organism called a phytoplasma, has been shown to be the cause of this disease. The only known vector for this disease is the beet leafhopper (BLH).

BLTVA can cause a wide range of symptoms in potatoes, including leaf curling and purpling, aerial tubers, chlorosis, and early senescence (Figures 9). Beet leafhopper is the most important vector of BLTVA in the Columbia Basin of Oregon and Washington. Most BLTVA infection occurs early in the season, during May and June, although some evidence suggests damaging infections in July. Beet leafhoppers live and reproduce mostly in weeds on nonirrigated ground. Favorite food plants include wild mustards, kochia, and Russian thistle. BLTVA is transmitted to potatoes every year but is extremely severe in years when beet leafhopper numbers are highest.

Figure 9. Two adjacent plants with purple top symptoms.

Monitoring with Yellow Sticky Traps
Because potatoes are not a preferred host of the beet leafhopper, in-field sampling is difficult. We recommend monitoring for leafhoppers using yellow sticky cards around field margins.

Supplies Needed. Trapping supplies include double-sided 4X6" yellow sticky cards, wooden stakes, large binder clips to secure the cards to the stakes, and a magnifying glass for counting BLH on the cards (Figure 10). The magnifying glass is essential to correctly identify BLH, and sometimes even picking leafhoppers out from all the other insects caught on a card requires a magnifier.

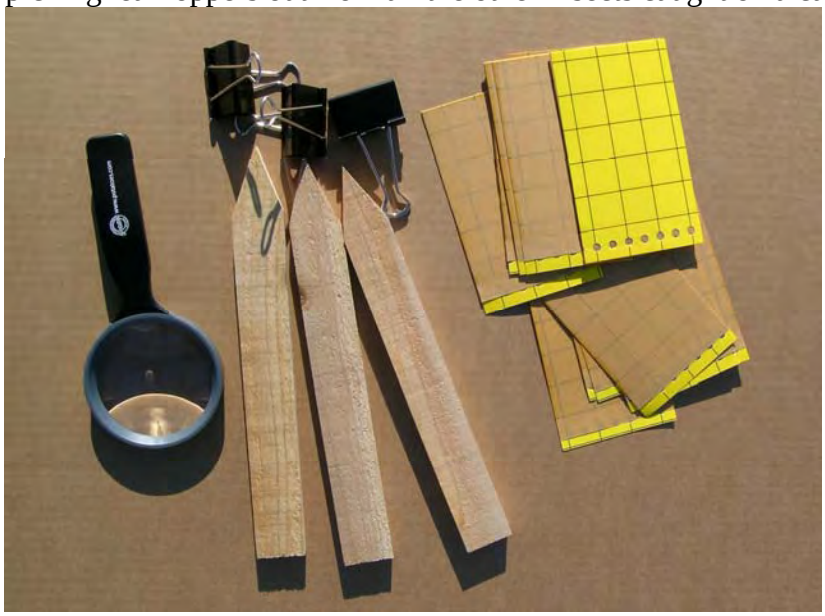


Figure 10. Supplies needed for BLH trapping.

How to Deploy Traps. Yellow sticky cards should be set up as shown in Figure 11. It is important to keep the traps low to the ground as shown because BLH move about very close to the ground. Even with a very low mount like shown in Figure 11, the bottom half of the trap will often catch almost all the BLH on the trap.

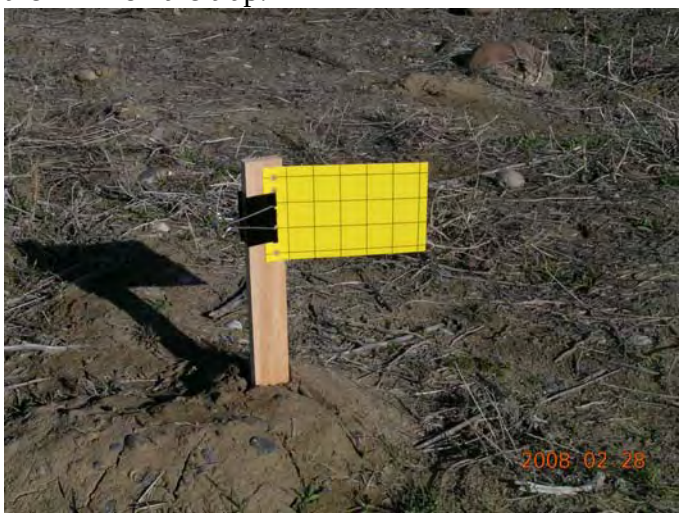


Figure 11. Proper mounting for yellow sticky card trap. Both sides of the trap should be used.

Where to Place Traps. Beet leafhoppers occur in almost all kinds of habitats we see near potato fields. There are, however, habitats that they prefer such as unirrigated low weedy vegetation composed of mustards and grasses (during early spring) or kochia and Russian thistle (during late spring, summer, and fall). When monitoring for BLH with yellow sticky traps, the traps should be placed outside potato fields in unirrigated weeds. When siting your traps, focus on the more disturbed areas around potato fields where annual weeds predominate. Perennial grass or native shrub habitats are not good places for BLH traps. Finally, at least two traps should be deployed per field. This is because BLH populations can be very spotty. More traps make it more likely that an infestation will be detected.

Checking the Traps. Traps should be checked every few days during the first 8 weeks after crop emergence. Traps should be changed once a week, or whenever they become covered in insects, dirt, feathers, fur, dead lizards and mice, etc.

Counting Beet Leafhoppers

Here is the tricky part. The first step is recognizing the leafhoppers from amongst all the insects that yellow sticky cards catch. Figure 3 shows many of the leafhopper species we catch near potato fields.

Figure 12. A multitude of leafhopper species. Leafhoppers are elongate and tapered from head to tail, hold their wings roof-like at rest, and vary in size from about 3 to 10 mm long. BLH are marked in the figure.

Figure 13 shows a sticky trap with many BLH, little dirt and debris, and few other insects. If only all sticky cards were this easy to count. Figure 14 shows a trap that will be much harder to count. Figure 15 demonstrates what a little magnification can do.

Figure 13. Good BLH catch.

Figure 14. Messy leafhopper trap.

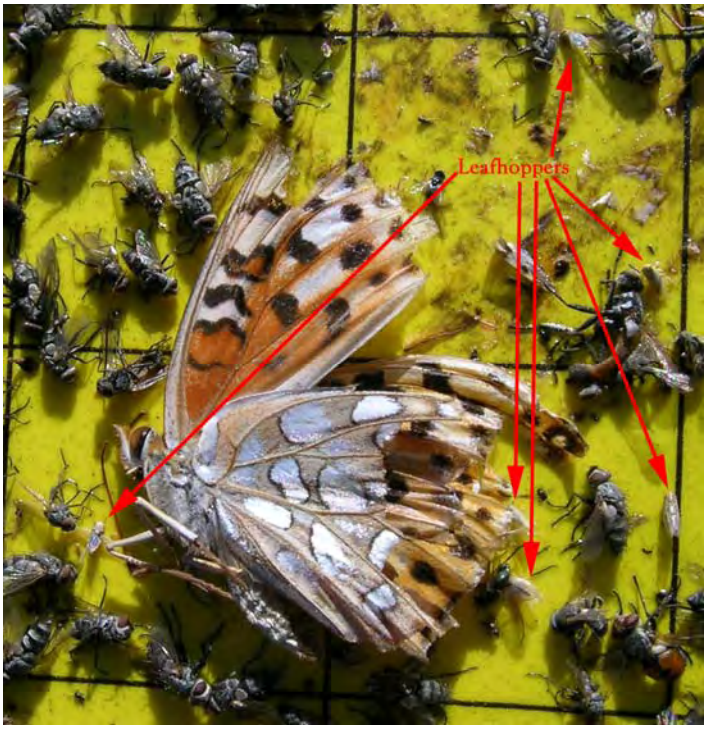


Figure 15. A piece of Figure 14 magnified a little, about what a magnifying glass will do.

Spotting the leafhoppers is easy in Figure 15, but which ones are BLH? It is definitely NOT safe to assume that all leafhoppers on sticky cards are BLH. The other species of leafhoppers shown in Figure 12 can be very common. Those other species do not transmit BLTVA to potatoes, or cause any problem for potatoes. Therefore, it is important to know when you are and are not looking at BLH.

Recognition features for beet leafhopper

1. Size. BLH is one of the smaller species on the cards. Most of the straw-colored specimens shown in Figure 4 are BLH. See Figure 16 for some pictures of BLH with other common species to get a feel for relative size.
2. Color. BLH are relatively pale, lacking strong pigmentation on the head and body. See Figure 8 for some information on BLH variation and comparison of pigmentation to other species.

3. Shape. Of the leafhoppers of similar length, BLH is relatively broad in the body. Another critical feature is the gently curved front of the head (as viewed from the top). Some other species have pointed heads, as you can see in Figure 8.

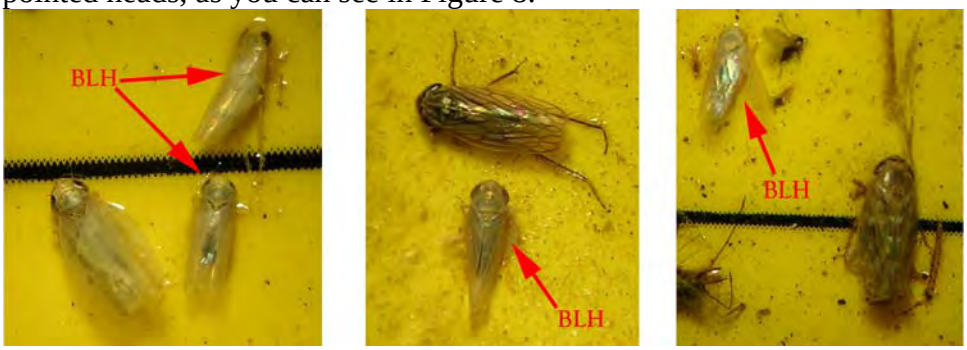


Figure 16. A few common leafhoppers compared to BLH.

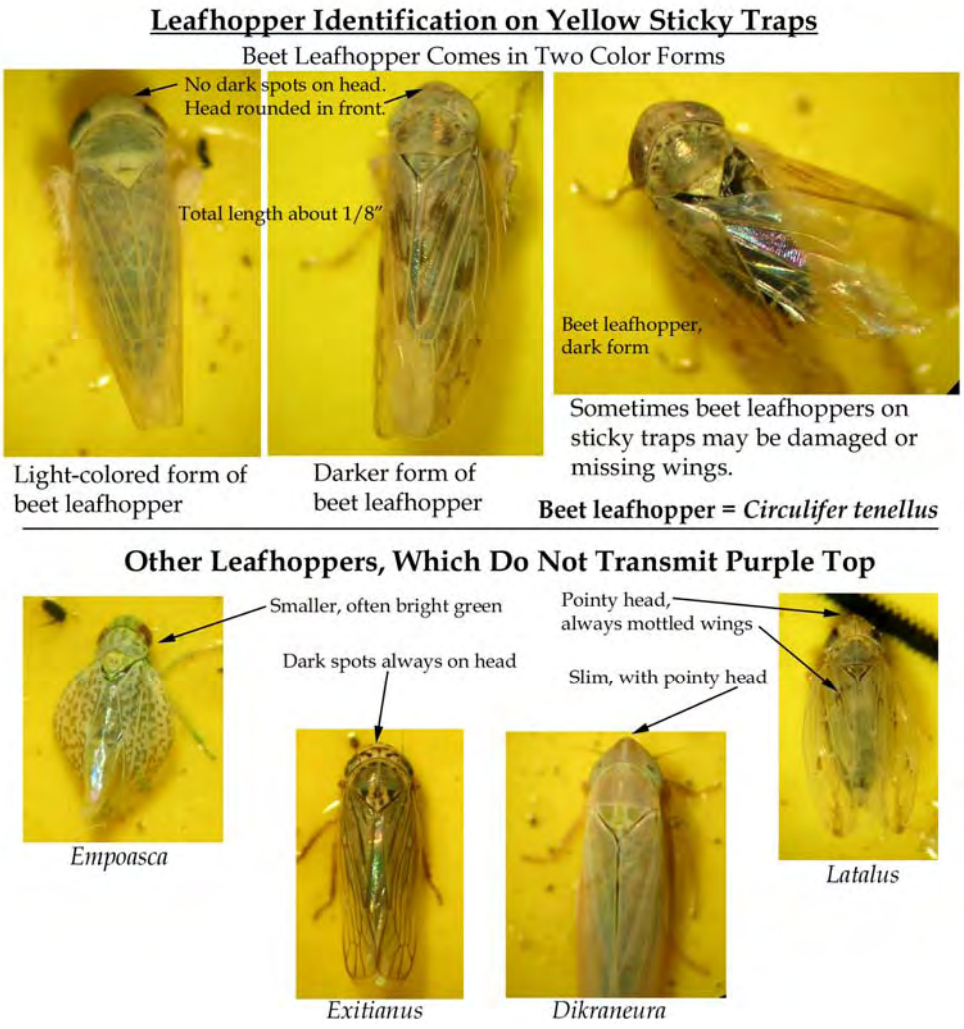


Figure 17. Information on the light and dark forms of BLH, and how they compare to some other common species.

How to Interpret BLH Trap Catch Numbers

Unfortunately, nobody knows how many BLH on sticky traps next to a potato field are enough to warrant treatment of that field. What we do know is that exposure to large populations of BLH during the first 8 weeks or so of plant growth is a bad thing. So all we can do today is offer guidance on what a "large population" is, as detected with yellow sticky cards. We have been conducting region-wide trapping of BLH for four years now, and we can turn to our data for some guidance. Our highest

number of BLH caught on a single trap in a week was 471. A more typical weekly catch during a peak of BLH activity is 100. A common scenario for a well-placed trap is to see very few (less than 10 per week) BLH until sometime in mid- or late May. A peak will quickly occur, rising from very low counts to 40 or 50 per week and then to about 100 per week, and then the third week will see very few BLH caught. It is this rapidly peaking flight that is important to detect.

As noted above, it is important to have more than one trap deployed per field, and to check them regularly. When the average catch rate increases toward the equivalent of 40-100 per week, that might be a good time to get worried. We very much hope to get more research done in coming years that will help us fine tune our monitoring for BLH.

Please feel free to contact Andy Jensen at the commission office with any questions about leafhoppers or purple top management.

Management of BLTVA in Potatoes

Minimal data on control of BLTVA-transmitting leafhoppers is available. We are largely relying on information from a single Washington based efficacy trial, on control of other species of leafhoppers, notably the potato leafhopper, in potatoes in the Midwest, what we know about controlling leafhoppers in other crops, and what we know generally about insecticides labeled for use on potatoes. There exists some anecdotal evidence that in-furrow use of some neonicotinoid based products may provide control of BLTVA. However, the only data available suggests that prophylactic use of insecticides is the only documented means to prevent transmission of BLTVA.

Research since 2002 has found that a significant percentage of the BLH in the Columbia Basin is infected with BLTVA. This means that risk from BLTVA infection increases in proportion to the number of beet leafhoppers. We hope to generate research information in coming years, which will help growers judge how serious their risk is. Relevant leafhopper sampling results are posted on the Washington Potato Commission's website at: www.potatoes.com/research.cfm and in http://oregonstate.edu/Dept/hermiston/TrapReports.php.

Cultural control.
There is still little research-based knowledge on cultural control techniques for purple top caused by BLTVA. We do know some things about beet leafhopper, though, that lead to a few suggestions. Favored hosts of beet leafhopper during later spring and summer are young kochia plants and Russian thistle. Preventing or eliminating large tracts of these weeds near potato fields will reduce beet leafhopper numbers in the area. And, because we know that large beet leafhopper populations lead to purple top outbreaks, this reduction in insect numbers should reduce purple top infection rates.

Insecticidal control.
An early 2004 article published in the Washington State Potato Commission's *Potato Progress* describes the most current opinions in managing leafhoppers and BLTVA in potatoes. This report was revised in 2005 based on 2004 research and field observations. A beet leafhopper (BLH) efficacy trial conducted in 2006 near Eltopia, WA found that 14 day applications of Asana, Actara, Penncap M and Assail significantly reduced BLH numbers and numerically reduced incidence of BLTVA.

Minimal data on control of BLTVA-transmitting leafhoppers are available. We are largely relying on information from a single Washington based efficacy trial, on control of other species of leafhoppers, notably the potato leafhopper, in potatoes in the Midwest, what we know about controlling leafhoppers in other crops, and what we know generally about insecticides labeled for use on potatoes. There exists some anecdotal evidence that in-furrow use of some neonicotinoid based products may provide control of BLTVA. However, the only data available suggests that prophylactic use of insecticides can prevent transmission of BLTVA.

Consider your overall insect program. Before selecting an insecticide for controlling leafhoppers, think about the impact your selection will have on the rest of your program. Some insecticides have season limits, and use of a product for leafhoppers early in the season may restrict usage later in the season. For example, there is a 4-application restriction (at the high rate) for Monitor. If Monitor is applied for beet leafhopper three times, only a single application will be available for the remainder of the year. Do not apply Assail, Actara, Belay, Provado, or Leverage for leafhoppers if you have already applied Admire Pro, Gaucho, Belay, Platinum or Cruiser at planting due to resistance management concerns. Pyrethroid insecticides such as Asana, Baythroid, Ambush and Pounce, or Leverage, which contains a pyrethroid, are tempting choices for control of leafhoppers due to good efficacy against leafhoppers, low price, and broad spectrum. Broad spectrum products such as pyrethroids also remove beneficial insects that keep pests such as aphids and mites under control. One to three applications of a pyrethroid can result in aphid and mite outbreaks. Asana, Baythroid, Ambush, Pounce, and Leverage have a role in potato insect management programs, but careful consideration should be given to their use for leafhopper control.

Residual Control. BLTVA can be transmitted by a vector that can be difficult to detect, making management of the insect and disease challenging. The greatest likelihood of success in preventing transmission of BLTVA is through the use of longer residual insecticides applied at the beginning of leafhopper flights and maintaining a residue of insecticides on potato foliage that is sufficient to kill leafhoppers. In general, an application should have a period of residual activity of 10 to 14 days, otherwise the number and expense of applications required to maintain control would become prohibitive. Depending on the duration of leafhopper flights and timing of applications, two applications providing 20 to 28 days of control may provide a sufficient interval of control. If plants are actively growing during this time, a contact insecticide, such as pyrethroids, Imidan and Sevin, will not provide control for foliage produced after application. For actively growing plants reduce the intervals of application for a contact insecticide. Because leafhoppers in other cropping systems are considered easy to control, it is tempting to use below labeled rates of insecticides; a not uncommon practice in the Midwest for non-disease transmitting leafhoppers. Reducing the rate of any insecticide will reduce the period of residual activity. Do not use below labeled rates of insecticides for control of leafhoppers potentially transmitting BLTVA.

Efficacy. Minimal insecticide screening against leafhoppers in potatoes has been conducted in the PNW; however, work in this area has been carried out in other crops and in other regions on other leafhopper species on potatoes. Based on these bodies of work, leafhoppers are generally considered to be relatively easy to control. Many of the insecticides listed in Table 1 will kill leafhoppers, but other considerations significantly reduce the utility of several of them. For reasons that are not clear, planting time insecticides do not appear to provide beet leafhopper control in potatoes. Based on 2006 and 2007 research, products from the neonicotinoid, pyrethroid, and organophosphate classes of insecticides have applied foliarly demonstrated efficacy against BLH.

Method of Application. In many situations growers choose chemigation to avoid the cost of application; however in this scenario use of chemigation with non-systemic products may result in substantially reduced insecticide levels on the foliage. Due to our lack of knowledge on effect of method of application on efficacy, do not apply insecticides for leafhopper in potatoes via chemigation unless you are confident the application will result in adequate deposition of insecticide residues on the foliage. Obtaining adequate coverage, particularly with contact insecticides, is extremely critical.

Planting Time Insecticides. Temik, Admire Pro, Gaucho, Thimet/Phorate, Platinum, Cruiser and Cruiser Maxx and Vydate applied at planting time, all have leafhopper on the label, although none specify beet leafhopper. Based on a review of BLTVA infested fields and a field trial conducted in 2004, planting time treatments did not appear to provide protection against the disease. This observation has at least two different explanations. One explanation is that BLTVA-transmitting leafhoppers probe and feed only briefly on potato, can transmit the disease during this period, and transmission may occur before the insect is killed by the systemic insecticide. A second explanation is that by the time of the season BLTVA transmission occurs, the level of insecticide is insufficient to provide control of the vectoring leafhopper. Growers should depend on a foliar insecticide program rather than planting time treatments to provide control of these leafhoppers.

Foliar Products with Limited or No Utility for Control of Leafhopper

M-Pede. This product is thought to have low efficacy; label states product should be used in combination with other insecticides.

Lannate, dimethoate, and malathion. These products will kill leafhopper but have relatively short periods of residual control. Other options exist that have similar efficacy but provide a longer period of control.

Foliar Products with Uncertain Utility for Control of Leafhoppers

Thiodan/Endosulfan, Sevin and Imidan. Due to lack of research, it is unclear of the relative efficacy and period of residual activity these products have against leafhoppers. Sevin is registered for use against leafhoppers in other crops such as sugarbeets, cereal grains and several root and tuber crops. Its efficacy against leafhoppers in potatoes is unknown.

Foliar Products with a Higher Potential for Use against Leafhoppers

Asana, Battalion Baythroid, Ambush, Brigrade, Mustang Max and Pounce. These products are highly effective against leafhoppers and can provide a longer period of residual control. Additionally, these products will control several other pest species. Use of these products is discouraged in most potato pest management scenarios due to their potential to cause aphid and mite outbreaks. In some situations, these products may be appropriate for control of BLTVA-transmitting leafhoppers in potatoes.

Provado and Actara. These products provide good efficacy against leafhoppers and have relatively longer periods of residual activity. Due to concerns with resistance management neither product should be used if a neonicotinoid insecticide such as Admire Pro, Gaucho, Platinum or Cruiser, has been used at planting time. Do not apply the 1.5 ounce rate of Actara more than four times. Do not apply Provado more than four times at the 3.75 oz rate.

Assail 70WP (acetamiprid). Assail provides effective control of beet leafhoppers and has been shown to reduce the incidence of BLTVA in potato plants. Apply 1.0 to 1.7 ounces/acre by ground, air or chemigation for beet leafhopper control. Control measures should start when leafhopper flights begin and fields must be protected for at least several weeks following crop emergence to help prevent transmission of BLTVA (causes purple top). A total of 6.8 ounces may be applied per season. Do not make more than 4 applications per season and do not apply more than once every 7 days. Do not apply less than 7 days prior to harvest (7 day PHI). Assail is a systemic insecticide and will move upward in the plant to protect new vegetative growth. Good coverage of the lower portion of the plant is necessary to control pests if present in that area. It is important to obtain complete coverage for best results. Apply Assail in a minimum of 20 gallons of water by ground, 5 gallons by air and a maximum of 0.2 inch/acre by chemigation. When applying Assail by ground or air, use a crop oil adjuvant such as crop oil concentrates (COC), methylated seed oils (MSO), ethylated seed oil (ESO), or use an organo-silicone crop oil blend adjuvant. Avoid the use of Assail with any product containing sticker/binder-type adjuvants when aphid and leafhopper are the target pests. Do not irrigate within 12 hours of an Assail application. There are no rotational crop plant back restrictions for Assail. For resistance management do not apply this product if the field has been treated this year with an at-plant neonicotinoid insecticide.

Leverage (imidacloprid and cyfluthrin. Group 3 and 4A). This is a prepackage mix containing imidacloprid (Provado) and cyfluthrin (Baythroid). Because it contains a pyrethroid insecticide, it is viewed similar to other pyrethroid insecticides. However, because it contains imidacloprid, it does provide a broader spectrum of control and is subject to the same limitations as Provado. Leverage is a very effective against leafhoppers.

Baythroid (cyfluthrin. Group 3). Research in 2007 demonstrated that four applications of Baythroid applied at 2.8 fluid ounces per acre provided excellent control of beet leafhopper and prevented transmission of BLTVA.

Mustang Max (zeta-cypermethrin, Group 3). Research in 2007 demonstrated that four applications of Mustang Max applied at 4 fluid ounces per acre provided excellent control of beet leafhopper and prevented transmission of BLTVA.

Monitor (metamidophos. Group 1B). Monitor provides excellent efficacy against leafhopper and has a relatively longer period of residual activity. There is a season limitation on the amount of Monitor that can be used - do not make more than 4 applications at the 2 pint rate or 5 applications at the 1.5 pint rate.

Furadan (carbofuran. Group 1A). Application of Furadan at 2 pints per acre has been documented to provide protection against BLH.

Penncap-M (methyl parathion (Group 1B). Penncap-M is effective against beet leafhoppers and has been shown to reduce the incidence of BLTVA (beet leafhopper transmitted virescens agent) in potato plants. Apply Penncap-M at 3 - 4 pints/acre by ground, air or chemigation. Penncap-M is not a systemic insecticide and will not protect new vegetative growth. It is important to obtain complete coverage for best results. Apply in a minimum 5 gallons of water by air and a maximum of 0.2 inch/acre by chemigation. Do not apply more than 24 pints/acre Penncap-M per year. Do not irrigate within 24 hours of application.

Vydate (oxamyl, Group 1B). Based on several anecdotal observations from the 2002 growing season, a program including 3 to 4 applications of Vydate applied in June and July controlled transmission of BLTVA, while adjacent fields without a Vydate program were highly symptomatic and tested positive for the phytoplasma. Based on knowledge of how this product works and experiences from the 2002 growing season, Vydate can be an important tool for control of BLTVA. Careful consideration must be given to timing of the early applications of the product. Applications should begin before or at the very beginning of leafhopper flights.

Potato Tuberworm Management Recommendations

Alan Schreiber, Agriculture Development Group, Inc.
Andy Jensen, Washington State Potato Commission
George Clough, Oregon State University
Sandy Debano, Oregon State University
Silvia Rondon, Oregon State University

These recommendations are intended for Washington and Oregon, but may have utility outside of this geographic area.

Potato tuberworm (PTW, Figure 18) was recognized as an insect pest of potatoes in the Columbia Basin in 2003. From 2003 through 2005, PTW expanded its range and severity. Probably due to the colder winters, PTW incidence and severity was much lower during the 2006 and 2007 growing seasons. It remains unclear how severe of a pest PTW will be in the Columbia Basin. It is highly likely that the species will be with us for the foreseeable future. It is likely to be more of a pest following winters of moderate severity and less of a pest following severe winters. It is likely to be more a pest in areas with higher minimum winter time temperatures such as the lower Columbia Basin. Probably the most important issue in tuberworm success in the spring is survival of volunteer potatoes in the field. Tuberworm needs a food source to survive warmer weather in spring prior to emergence of the new crop. Franklin, Benton, Walla counties of Washington and Umatilla and Morrow counties of Oregon are likely to be at the highest risk of PTW infestations.

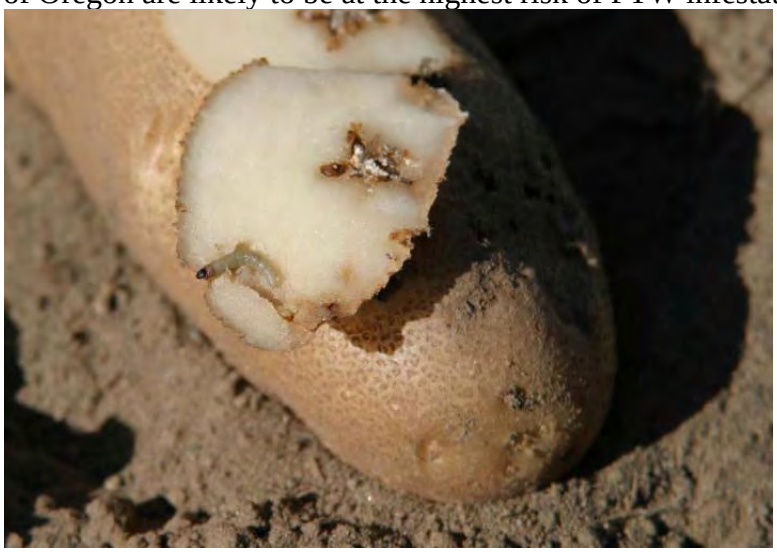


Figure 18. Tuberworm larva on damaged tuber.

Host Range. Although its host range includes a wide array of solanaceous crops such as tomatoes, peppers, eggplants, tobacco, and weeds such as nightshade, it has only been found on potatoes in the Pacific Northwest. PTW has been detected in all potato growing regions of Oregon and throughout the Columbia Basin of Washington. A limited number of adult PTW have been trapped in western Idaho. No tuber damage has been reported in Idaho.

There is much about the biology and management of PTW in the Pacific Northwest that is unknown. The following recommendations represent our best understanding of this pest in potatoes in Washington and Oregon (http://extension.oregonstate.edu/catalog/pdf/ pnw/pnw594.pdf). When possible, the recommendations are based on local research. For more information visit http://oregonstate.edu/potatoes/ipm/index.htm or contact Silvia Rondon, OSU-HAREC, PO BOX 105, Hermiston, OR 97838. Phone (541) 5678321. Email: silvia.rondon@oregonstate.edu

PTW is present throughout the growing season; however, early and mid season foliar infestations have been light to moderate. The species appears to have 3 generations a year and populations appear to build sharply later in the growing season (September and October). Control efforts should be directed toward populations during this time. If PTW populations appear to be building prior to this time, control measures may be necessary.

Non-Chemical Control Methods

Cull Piles and Volunteer Potatoes. PTW thrives on potatoes. Elimination of cull potatoes and piles and control of volunteer potatoes will reduce your exposure to PTW populations. Feeding cull potatoes to cattle will not eliminate risk from PTW unless potatoes are consumed immediately.

Irrigation. During mid to late season, apply irrigation water daily or often enough to keep the soil surface moist. Research in other areas of the world has shown that tuber infestations are greater when the soil is dry. Research conducted in Oregon in 2005 and 2006 showed that irrigating with 0.10 inches daily from vine kill to harvest decreased PTW damage and did not significantly increase tuber rot. It is thought that either the insect cannot reach the tubers as easily in wet soil or dry soil has cracks that result in more exposed tubers.

Desiccation. PTW females apparently prefer to lay eggs on potato foliage. When potato foliage starts to degrade and turn color, the risk of tuber infestation increases greatly. The period between desiccation and harvest is a time of increased risk of tuber infestation. Between 100% vine kill and harvest is the time of greatest risk of tuber infestation. Anything that will reduce the time between desiccation and harvest is thought to reduce the risk of tuber infestation. Selection of desiccant may influence PTW tuber infestation; however a 2005-2006 research project on PTW and desiccants in Oregon found that the rate of vine desiccation did not impact tuberworm damage, and the researchers concluded that the rate of vine-dying is not an important factor, as long as there are green vines in the field.

When should insecticides be applied for PTW? PTW tuber infestations increase as the amount of potato foliage in the canopy decreases. In other locations, particularly in California, control programs have targeted the interval leading up to desiccation and harvest. Control programs in Washington and Oregon that have focused on the period of 4 to 8 weeks prior to harvest have been successful in controlling PTW in potatoes. A 2005 study at OSU Hermiston that examined Monitor, Asana and Lannate applied at regular intervals starting at 1, 2, 3 and 4 weeks prior to desiccation found no difference in tuber infestation, suggesting that control of PTW just prior to desiccation and harvest is critical. Application of all insecticides in this trial controlled PTW compared to the untreated check. However, given the preliminary nature of this study, it is recommended that PTW control programs start no later than 4 weeks prior to desiccation/harvest until further research can be conducted on the subject.

Chemical Controls

Products that have been found to be effective for control of PTW in Washington and Oregon – based on one season of testing. All rates are in formulated product per acre. Unless otherwise noted, the products discussed in this section were found to reduce the incidence of PTW larvae in the foliage

to close to zero in a moderate pressure situation or significantly reduce larval populations in a high pressure situation. All treatments began approximately four to six weeks before desiccation.

Monitor. Monitor applied by ground and chemigation at 32 ounces (2 pints) was effective when applied at a 7 day interval.

Rimon 0.83EC. Rimon applied at 9 and 12 ounces provided effective control of PTW when applied at a 10 day interval by ground and chemigation.

Avaunt. Avaunt was effective when applied by ground and chemigation at 7 day intervals at 3 and 5 ounces. Avaunt applied by chemigation at desiccation and 7 days after desiccation was effective at reducing tuber infestation.

Agri-Mek. Agri-Mek was effective when applied by ground at 7 day intervals at 10 ounces.

Asana. Asana was effective at 4 and 8 ounces when applied by ground and chemigation at 7 to 10 day intervals. There is no indication that the higher rate is more effective.

Lannate. Lannate applied by ground and chemigation at 1 and 2 pints at 5 day intervals was effective at controlling PTW.

Imidan. Imidan at 1.3 and 2.5 pints applied by ground at 10-day intervals was effective against PTW.

Success. Success was effective at 6 ounces when applied by ground at a 7 day interval.

Furadan. Furadan was effective at a 7 day interval at 2 pints when applied by ground.

Leverage. Leverage applied by ground and chemigation at 10 day intervals at 3.75 ounces was effective against PTW.

Baythroid. Baythroid at 1.5 ounces was effective when applied by chemigation at 10-day intervals.

Hero. Hero was effective at an 8 ounces per acre at 10 day intervals when applied by ground

Assail. Based on the results of research trials in 2005, Assail is not recommended for PTW; however use of the product against other insect pests may reduce PTW populations.

Penncap M. Penncap M applied at 4 pints at 10 day intervals by ground was effective against PTW.

Dipel (Bacillus thuringiensis). Dipel at 1 pound per acre applied by ground in rotation with Entrust at 3 ounces per acre at 10-day intervals was effective in controlling PTW. Entrust was applied first and third and Dipel was applied second and fourth.

Battalion. Battalion applied at 12.8 ounces per acre at 10 day intervals by ground and chemigation was effective in controlling PTW.

Aza Direct. Aza Direct applied at 2 pints per acre at 10 day intervals by ground significantly reduced PTW populations.

Products Considered Ineffective Against PTW. No planting time treatments have been documented to be effective against PTW including Gaucho, Admire Pro, Cruiser, Platinum, Venom, Temik and Thimet/Phorate.

Foliar Insecticides Considered Ineffective Against PTW. Sevin, dimethoate, Fulfill, Beleaf, Acramite, Comite and Oberon have not demonstrated efficacy against PTW.

Products of Unknown Efficacy Against PTW. Research has not yet determined the efficacy of Thiodan against PTW.

Treatment Intervals and Rates of Application. Research conducted in 2005 included treatment intervals at 5, 7 and 10 days and products were tested at the higher end of the range of labeled rates in most cases. In many cases, the products were very effective against PTW. It is likely that products can be applied at wider intervals, at lower rates, or at both wider intervals and lower rates than were tested in 2005. Further research is needed to determine the most cost effective rates and timing intervals.

Spectrum of Control. It is likely that growers will have other insect pests present at the same time PTW is targeted. Other pests that require control at the same time as PTW can influence selection of an insecticide for PTW control. Following is a spectrum of control guide for PTW active insecticides. This information is taken from a variety of sources including product labels, discussion with agchem company representatives and my own research and knowledge (Alan Schreiber).

Effectiveness of PTW active products against other potato insect pests[1]

	Beet Leafhopper	Colorado Potato Beetle	Green Peach Aphid	Cabbage Looper	Thrips
Monitor	xxx	x	xxx	xxx	xx
Imidan	xxx	xxx		xx	
Penncap M	xxx	xx		xx	x
Furadan	xxx	xxx	xx		
Success		xxx		xx	x
Assail	xxx	xxx	xx		xx
Leverage	xxx	xxx	x	xxx	
Baythroid	xxx	xxx		xxx	
Asana	xxx	xxx		xxx	
Agri-Mek		xxx			
Lannate	xxx	x	x	x	
Avaunt				xxx	
Rimon		xxx		xxx	

1 An xxx means efficacy against the pest is high, a double x means efficacy is moderate, a single x means efficacy is present but may not be commercially acceptable. A lack of an x means no efficacy data exists. Other factors including cost, length of residual control, impact on secondary pests and beneficals and label restrictions may influence choice.

Important Use Restrictions – Pay Attention!

In recent years, growers have been targeting new insect pests of potatoes such as PTW, beet leafhopper and thrips. Because of these new pests, growers must choose their products carefully. All insecticides have restricted entry interval (REI), a preharvest interval (PHI) and a limit on the amount of product that can be used in a single season and plant back restrictions (see p. 4).

Rimon has a 12 day REI, Monitor has a 3-day REI. Prior to PTW, growers have not had to control insect pests near harvest time. Now selecting products near harvest is critical and significant differences exist in PHI among PTW active insecticides. Monitor, Agri-Mek and Furadan have 14-day PHIs, while other products have shorter PHIs such as Baythroid (0 day PHI), and Penncap M (5 day PHI).

PRODUCT	REI	PHI	SEASONAL USE LIMITS
MONITOR	72 hrs	14 days	8 pt/acre/season
RIMON	12 hr	14 days	2 apps/crop/season; 24 oz/season
AVAUNT	12 hr	7 days	24 oz/acre/season
AGRI-MEK	12 hr	14 days	32 oz/season for mites; 48 oz/season for leafminer
ASANA	12 hr	7 days	0..35 lb ai/season
LANNATE	48 hr	6 days	4.5 lb ai or 10 apps/season
IMIDAN	24 hr	7 days	6.66 lb/season
SUCCESS	4 hr	7 days	3 apps/30 day interval; 4 apps/crop/season; 21 oz/season
FURADAN	48 hr	14 days	2 apps/season
LEVERAGE	12 hr	7 days	15 oz/acre/season
BAYTHROID	12 hr	0 day	6 apps/season
ASSAIL 70WP	12 hr	7 days	6.8 oz/season; 4 apps/season
PENNCAP M	5 days	5 days	24 pt/season

When Imidan is used at the higher rate (1.33 to 2.5 lbs/ acre) the PHI increases to 21 days.

Economic Threshold. No economic threshold has been established for PTW in the Pacific Northwest.

Method of Application. All PTW insecticide research in 2005 in Washington and Oregon was conducted via ground or chemigation. Virtually all commercial PTW applications are made using air or chemigation applications. Significant additional work needs to be done to ascertain the best method of application for control of PTW. The majority of PTW larvae are in the top third of the foliage; however a portion of PTW exist in the middle and lower portion of potato foliage. Accordingly, as with many other insect pests, coverage is important. Some products may be more effective when applied by air or chemigation. Regardless of method of application, take appropriate steps to insure adequate coverage of foliage with insecticides.

Organic Potatoes. Growers of organic potatoes can expect a difficult time controlling PTW. One strategy is to harvest as early as possible to avoid the build-up of PTW infestations. Two organically acceptable chemical control options have been found effective against the insect pest.

Entrust. Entrust, the organic formulation of Success, was effective when applied at 6 ounces by ground at 10 day intervals.

Dipel (*Bacillus thuringiensis*). Dipel at 1 pound per acre applied by ground in rotation with Entrust at 3 ounces per acre at 10 day intervals was effective in controlling PTW. Entrust was applied first and third and Dipel was applied second and fourth.

Azadirect. Aza Direct applied at 2 pints per acre at 10 day intervals by ground significantly reduced PTW populations.

Pyrethroid Insecticides. Research by Alan Schreiber has conclusively demonstrated that application of pyrethroid insecticides mid and late season will flare aphids and mites in potatoes. Application of insecticides in May and the first half of June does not appear to result in aphid and mite infestations. Pyrethroids should not be applied for PTW after June 15 in the Columbia Basin of Washington and Oregon in order to prevent the flaring of aphids and mites. One exception to this rule is during the two weeks prior to harvest or desiccation. Two weeks prior to harvest or desiccation does not allow sufficient time to flare aphids or mites.

Resistance. PTW has a number of characteristics that have allowed it to develop resistance to insecticides. PTW has developed resistance to insecticides used for its control in several locations around the world. ***It is critical that growers prevent PTW from developing resistance in the PNW. To achieve this, the potato industry must incorporate resistance management into PTW control programs from the beginning.***

There are two key components to developing a resistance management program for PTW. First, growers must employ non-chemical control tactics for control of PTW, including irrigation, cultivation and proper hilling of potatoes. Second, growers must rotate insecticidal modes of action, in the same manner as growers currently rotate fungicides in late blight programs. The PNW potato industry is fortunate that we have a large number of insecticides that have demonstrated efficacy against PTW. These products can be separated into 8 different modes of action.

We recommend that growers incorporate three different modes of actions in a PTW management program. There is no order in which the products should be rotated. No group is recommended over other groups

PTW active insecticides grouped by mode of action

1) Organophosphates: Monitor, Imidan, Penncap M
2) Rimon
3) Avaunt
4) Agri-Mek
5) Pyrethroids: Asana, Leverage, Baythroid
6) Success, Entrust
7) Carbamates: Furadan, Lannate
8) Bacillus thuringiensis

If Assail is used during the course of a PTW control program it would count as a ninth and separate mode of action.

Chart for activity by life stage. This information is based on 2005 research data, information provided by registrations and our knowledge of the products listed.

Product	Egg	Larvae	Adult	Activity against larvae in leaf tissue
Monitor		**x**	**x**	**x**
Imidan			**x**	**x**
Penncap M		**x**	**x**	**x**
Rimon	**x**	**x**		
Avaunt	**x**	**x**		**x**
Agri-Mek		**x**		
Asana		**x**	**x**	
Leverage		**x**	**x**	
Baythroid		**x**	**x**	
Success, Entrust		**x**		
Furadan		**x**	**x**	**x**
Lannate		**x**	**x**	**x**
Bacillus thuringiensis		**x**		
Assail		**x**		

Pheromone Trapping
Prepared by Andy Jensen, WSPC, and Peter Landolt, USDA-ARS

All growers in areas even **potentially** affected by PTW should maintain at least one pheromone trap adjacent to each field starting April 15. This insect can have very localized infestations, and it is risky to conclude too much from traps that are miles away from your field(s).

Like hundreds of other moths, the adult female PTW releases a sex pheromone to attract males for mating. That pheromone has been identified and is sold for use in traps to detect or monitor changes in the presence of the moth. The pheromone is a blend of two chemicals: (E,Z)-4,7-tridecadienyl acetate and (E,E,Z)-4,7,10-tridecadienyl acetate. These chemicals are absorbed into rubber septa as the lures, which then slowly release the pheromone when placed in a trap. The attractiveness of the lure varies with the amount of pheromone put into the septum, and less so by the ratio of the two chemicals. The numbers of moths captured is also affected by the design of the trap. In order to compare experimental results between sites and years, it is best for researchers to consistently use the same lures and traps. In order to appropriately interpret trap catch data, it is best for growers to use lures and traps that are as similar as possible to those used by researchers.

The multi-year potato tuberworm monitoring project coordinated by Andy Jensen uses lures that are loaded with a 1:1 ratio of the two chemicals, with a total load per septum of 200 micrograms. These lures have been made at the USDA-ARS Laboratory near Yakima. These are put in Delta traps and are replaced after 4 weeks exposure in the field. When purchasing pheromone lures from a company, it is important to specify that you need the complete blend of the pheromone. Trece, for example, sells lures that only include one of the two pheromone chemicals, and they sell lures that include both chemicals. The lures with one chemical, referred to as their "California" lure, are expected to be considerably less attractive to the potato tuberworm than the two component lures, referred to as their "International" lure. We have been told by Cam Oeschlager of ChemTica in San Jose, Costa Rica that their potato tuberworm lures, sold through AgBio, include both chemicals.

Pheromone traps should be mounted within or very near the potato fields, close to the ground or canopy (about 12" high). We recommend using a re-usable plastic Delta trap with replaceable sticky liners. These liners should be monitored as often as possible, and replaced weekly. Pheromone lures should be changed every 4 weeks, and kept frozen prior to use. In the Columbia Basin of Washington and Oregon the tuberworm pheromone lure attracts many other species of moth that are not tuberworm and are not pests of potato. Persons uncertain about moth identification are encouraged to have an entomologist confirm the identification of their moths. See also the tuberworm information on the potato commission's website: www.potatoes.com/research.cfm. Moth trap catch information cannot be readily translated into risk of tuber damage, but it is clear that at lower population densities, greater moth catch indicates greater risk. Pheromone traps are especially useful for detecting initial infestations in an area.

We are conducting the regional tuberworm trapping network again this season. Watch the Washington Potato Commission website for the latest data: www.potatoes.com/research.cfm.

Scouting and Sampling for PTW

Prepared by Sandy DeBano, OSU

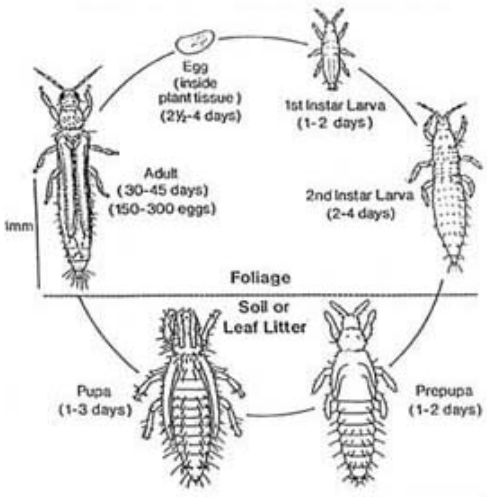
Several issues related to scouting have been examined in Oregon in 2005, including determining the length of time it takes to visually sample whole plants in the field for PTW foliar damage, the accuracy of those counts, and the number of plants that must be sampled to give a reliable estimate of foliar damage in a given area. A thorough examination of the foliage of a single potato plant takes approximately 2 minutes and detects less than 50% of the mines that can be found in a thorough examination in the laboratory. Most mines (56%) are found in the upper third of the plant canopy, suggesting that efficient scouting for foliar damage should focus on the top third of the plant. The number of mines on a plant is correlated with the number of larvae in a plant, but not strongly. This means that while number of mines gives a good indicator of the history of PTW infestation of a plant, it does not necessarily indicate the severity of larval infestation at a point in time. The study also found that reasonably precise estimates of foliar damage for areas of 23 ft x 30 ft can be made by sampling 9 plants. While this information may not be useful for scouting large fields until we understand the pattern of damage in large areas, it should be useful for researchers attempting to quantify foliar damage.

Secondary and Emerging Insect Pests

Andrew Jensen, Washington State Potato Commission
&
Alan Schreiber, Agriculture Development Group, Inc.

Potato growers deal with a very long list of potential pests and diseases. The primary insect pests of concern in Washington are green peach aphid (*Myzus persicae*), wireworm (primarily *Limonius* spp.), and Colorado potato beetle (*Leptinotarsa decemlineata*). There are however, many other herbivorous insects found in Washington potato fields, and some of these can reach damaging populations. Below we picture and briefly discuss several of these occasional and poorly known pests.

Thrips (mostly *Frankliniella occidentalis*)



Very little is known about thrips biology on potatoes in the Pacific Northwest. Thrips are minute, slender bodied insects (0.5-1.0 mm in length). Wings may be present or absent, and are unlike normal insect wings; thrips wings are essentially thin rods lined with long hairs. Thrips feed on potato leaves by rasping plant cells and sucking out their contents. Thrips feed on leaves and flowers, but are most commonly found on the underside of leaves. Use of a hand lens will aid in their detection and identification. Populations of thrips are low in the early spring and build up over time and can become very dense. Damage on potato leaves looks somewhat like mite damage – there are often small patches of damaged leaf tissue that are paler than surrounding healthy tissue. Thrips have a complex life cycle in which the last two immature stages are quiescent and non-feeding.

Thrips are difficult to control in a number of crops. Insecticides will not kill all of the population and due to short generation time, thrips numbers will rebound quickly. Some years are worse than others-partly due to overall insect management programs; thrips often seem to be less of a problem when growers have deployed a beet leafhopper control program in the first half of the season. The critical issue is that the cumulative damage done by thrips feeding on the leaves becomes a drag on plants' ability to photosynthesize. We currently have no science-based treatment threshold. We do know that waiting too long can lead to uncontrollably large populations.

Caterpillars (a.k.a. "worms" – several species mostly of Noctuidae)

Increasingly, Washington potato growers consider "worms" a major insect pest of potatoes. The term "worms" is used loosely to cover a group of species of moth larvae (caterpillars) found on potatoes. These include cutworms, loopers, armyworms (all belong to the family Noctuidae), and sometimes leaf tiers (Pyrallidae). There is less known about this group of insects than any other major pest of potatoes in the Pacific Northwest. We believe that shifts away from broad spectrum organophosphate and carbamate insecticides to the neonicotinoid and other narrower spectra of control classes of insecticides (e.g. Fulfill) has allowed these species to flourish. We have little or no information on the abundance, diversity, pattern of occurrence, host suitability, economic threshold or other basic information on these pests. However, growers routinely face scenarios where management decisions must be made for these species. These caterpillars are commonly targeted with insecticides without knowledge of the species involved or their true pest potential.

Alfalfa looper, adult and larva (Photos: OSU)

Cabbage looper, adult and larva (Photos: OSU)

Armyworm on arugula

Larva of a leaf tier on potato

Like all the insects discussed here, there is no science-based treatment threshold for these caterpillars. The bigger problem is we know very little about pest biology and we do not sample correctly for this pest. It is not unusual for a grower to treat based on the appearance of damage—when this happens it is highly likely that most of the damage has already occurred and the insect is probably either a large larva or has pupated. Large caterpillars are very difficult to control. When using insecticides, coverage is critical. Application by ground is best, chemigation is better, and aerial application can be questionable in terms of efficacy.

Lygus bugs (*Lygus* spp.)

Small sucking bugs, brown to green and less than ¼ inch long. They cause minor damage of unknown economic significance. Damage commonly consists of flagging of leaflets, leaves, or small stems. Chemical treatment for lygus bugs in potatoes probably is rarely needed, and should be undertaken with care. Alfalfa seed growers learned an important lesson about lygus control. Pyrethroid insecticides were their primary tool until lygus developed resistance and growers lost the use of that class of chemistry. Lygus can, however, reach very high populations in potatoes and may cause economic damage at those high levels.

Lygus adult.

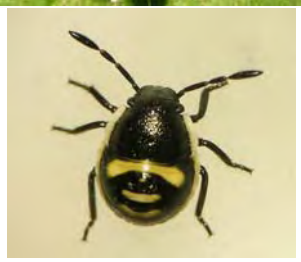
Immature lygus (a.k.a. nymph)

Example of leaf damage associated with lygus.

Lygus bug on potato leaf.

Stink bugs (e.g. *Chlorochroa* spp.)

Stink bugs that damage potatoes are usually large (about ½"), green, shield-shaped bugs. They feed by sucking plant sap. Stink bug damage is usually a flagging of leaflet, leaf, or stem. For example, feeding at the base of a leaf seems to cause the entire leaf to wilt. Stink bugs are pests of potatoes in isolated pockets in the Pacific Northwest. The widespread use of neonicotinoid insecticides (Admire and Gaucho, Platinum and Cruiser) has probably allowed stink bugs to become a problem. There is no known treatment threshold, but it is possible that 4 to 5 adults per plant could cause significant disruption to plant physiology. Stink bug problems are usually associated with fields next to unfarmed, desert land. Stink bugs migrate into the field mid and late season and they can build up in a potato field.



Chlorochroa stink bug eggs on a leaf, nymphs hatching, and a very young nymph.

Adult stink bugs are about ½ inch long and can be green, light green, or even brownish.

Blister beetles (e.g. *Epicauta* spp.)

An uncommon pest of potatoes is the blister beetle. There are many species of blister beetles, all with similar biology, but the most common species feeding on potatoes are *Epicauta* pictured here. Adults feed on the leaves, causing a ragged appearance. Adults are about ½ inch long, gray to black, narrow and elongate, with conspicuous heads and necks. Larval blister beetles live in the soil in uncultivated land, and are predators of grasshopper and bee eggs. Adults feed on the foliage of many different kinds of plants. The problem occurs near unfarmed land, usually associated with the year following a grasshopper outbreak. These beetles can cause complete defoliation of affected areas, but because they are extremely clumped within a field, little total damage normally results. Treatment of an entire field would rarely be appropriate.

White grubs (various beetles in Scarabeidae)

The white grubs are a group of common beetles also known as scarabs. As larvae these beetles live in the soil and feed on roots of many plants. When they are in potato fields they can also feed on developing tubers. Tuber feeding by white grubs usually causes broad, relatively shallow holes that are often healed over by harvest. They can, however, cause damage that is fresh at harvest, and even be present with the harvested tubers.

Comparative Efficacy of Insecticides

I, Alan Schreiber, have conducted a series of insecticide screening trials on potatoes in Washington for several years. As a result of these trials and my review of data from other trials and observations of use in the field, I have developed the following table that provides a comparative efficacy guide of for various insecticides registered for use on potatoes.

Insecticide Effectiveness In Potatoes

Prepared by Alan Schreiber, Agriculture Develoment Group, Inc.

Active Ingredient		Aphids	CPB	Cabbage looper	Spider mites	Wireworms	Thrips	PTW
1,3 dichloropropene	Telone	NE	NE	NE	NE	E	NE	NE
abamectin	Agri-Mek	VP	G	ND	ND	VP	ND	E
actamiprid	Assail	G	E	ND	ND	ND	G	F
aldicarb	Temik	E	E	F	ND	ND	ND	ND
azadirachtin	several	ND	F	ND	ND	ND	ND	ND
bifenazate	Acramite	NE	NE	NE	E	NE	NE	NE
bifenthrin	several	VP	E	G	G	ND	ND	E
carbaryl	Sevin	VP	G	ND	ND	VP	ND	VP
carbofuran	Furdan	G	G	ND	ND	ND	P	E
chloropicrin	several	VP	VP	VP	VP	ND	NE	ND
clothiniadin	Belay	E	E	NE	NE	NE	G	G
cryolite	Cryolite	VP	ND	ND	ND	VP	ND	ND
cyfluthrin	Baythroid	VP	E	E	VP	NE	G	E
deltamethrin	Battalion	VP	E	E	VP	NE	G	E
diazinon	several	F	G	F	VP	F	ND	ND
dimethoate	Dimethoate	G	P	ND	ND	VP	ND	ND
disulfoton	Di-Syston	G	P	ND	ND	ND	ND	ND
endosulfan	Thiodan	ND	ND	ND	ND	VP	ND	ND
esfenvalerate	Asana	VP	E	E	VP	VP	G	E
ethoprop	Mocap	VP	VP	VP	VP	G	NE	ND
fipronyl	Regent	NE	NE	NE	NE	E	NE	NE
imidacloprid	several	E	E	VP	VP	F	ND	ND
indoxacarb	Avaunt	VP	VP	E	VP	VP	ND	E
lambda cyhalothrin	Warrior	G	E	E	VP	NE	G	E
malathion	several	ND	ND	ND	ND	VP	ND	ND
metam potassium	K-pam	VP	VP	VP	VP	ND	NE	ND
metam sodium	Vapam	VP	VP	VP	VP	F	NE	ND
methamidophos	Monitor	E	F	G	VP	VP	G	E
methomyl	Lannate	G	G	G	ND	VP	ND	E
methyl parathion	Penncap-M	F	F	F	P	VP	G	E
novaluron	Rimon	VP	G	G	VP	VP	ND	E
oxamyl	Vydate	G	G	G	F	ND	ND	ND
permethrin	Ambush, Pounce	VP	E	E	VP	VP	ND	ND
phorate	Thimet, Phorate	E	E	ND	VP	VP	ND	ND
phosmet	Imidan	VP	G	G	VP	VP	ND	E
propargite	Comite	VP	VP	VP	G	VP	NE	VP
pymetrozine	Fulfill	E	VP	VP	VP	VP	NE	VP
spinosad	Success	VP	G	G, F	VP	VP	G	E
spiromesifen	Oberon	NE	NE	NE	NE	E	ND	VP
sulfur	several	ND	ND	ND	ND	ND	ND	ND
thiamethoxam	several	E	E	VP	VP	F	ND	ND
zeta cypermethrin	Mustang Max	VP	E	G	VP	NE	ND	E

E = Excellent, G = Good, F = Fair, P = Poor, VP = Very Poor or No Effect, ND = No Data

No Effect (NE) means the product has no effect on the pest

Attachment 1

Insecticides Registered on Potatoes in Washington and Oregon in 2008.

Following is a list of the 367 insecticides currently registered for use by commercial potato growers in Washington and Oregon. This list, with the possible exception of a few 24c state registrations should be virtually identical for Idaho. The list includes the active ingredient, product name, manufacturer name and the registration number if it is a 24c Special Local Needs (SLN). This list is current as of May 15, 2008.

INGREDIENT	PRODUCT NAME	SLN #	REGISTRANT NAME
ABAMECTIN (AVERMECTIN B1)	ABACUS AGRICULTURAL MITICIDE/INSECTICIDE		ROTAM NORTH AMERICA INC
ABAMECTIN (AVERMECTIN B1)	ABAMECTIC E-AG 0.15EC INSECTICIDE		ETIGRA
ABAMECTIN (AVERMECTIN B1)	ABBA 0.15EC		MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
ABAMECTIN (AVERMECTIN B1)	ABBA 0.15EC MITICIDE/INSECTICIDE		MAKHTESHIM-AGAN /FARMSAVER.COM LLC
ABAMECTIN (AVERMECTIN B1)	ABBA 0.15EC MITICIDE/INSECTICIDE		MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
ABAMECTIN (AVERMECTIN B1)	AGRI-MEK 0.15EC (MIN. 5 GAL/A - AERIAL APPL ON ASSORT CROPS)		SYNGENTA CROP PROTECTION INC.
ABAMECTIN (AVERMECTIN B1)	AGRI-MEK 0.15EC MITICIDE/INSECTICIDE		SYNGENTA CROP PROTECTION INC.
ABAMECTIN (AVERMECTIN B1)	CLINCH ANT BAIT		SYNGENTA CROP PROTECTION INC.
ABAMECTIN (AVERMECTIN B1)	EPI-MEK 0.15EC MITICIDE/INSECTICIDE		SYNGENTA CROP PROTECTION INC.
ABAMECTIN (AVERMECTIN B1)	REAPER 0.15EC MITICIDE/INSECTICIDE		UAP LOVELAND PRODUCTS
ABAMECTIN (AVERMECTIN B1)	TEMPRANO		CHEMTURA CORPORATION
ABAMECTIN (AVERMECTIN B1)	TIMECTIN 0.15EC AG INSECTICIDE/MITICIDE		TIDE INTERNATIONAL USA INC
ABAMECTIN (AVERMECTIN B1)	ZORO MITICIDE/INSECTICIDE		CHEMINOVA INC.
ACETAMIPRID	ASSAIL 30SG INSECT (POTATOES - CHEMIGATION DIR.)		CEREXAGRI INC
ACETAMIPRID	ASSAIL 30SG INSECT (POTATOES - CHEMIGATION DIR.)		CEREXAGRI-NISSO LLC
ACETAMIPRID	ASSAIL 30SG INSECT (TUBEROUS & CORM VEGETABLES)		CEREXAGRI INC
ACETAMIPRID	ASSAIL 30SG INSECT (TUBEROUS & CORM VEGETABLES)		CEREXAGRI-NISSO LLC
ACETAMIPRID	ASSAIL 30SG INSECTICIDE		NIPPON SODA CO. LTD.
ACETAMIPRID	ASSAIL 30SG INSECTICIDE		UNITED PHOSPHOROUS INC
ACETAMIPRID	ASSAIL 70WP INSECT (POTATOES - CHEMICATION DIR.)		CEREXAGRI-NISSO LLC

ACETAMIPRID	ASSAIL 70WP INSECT (POTATOES - CHEMIGATION DIR.)	CEREXAGRI INC
ACETAMIPRID	ASSAIL 70WP INSECT (TUBEROUS & CORM VEGETABLES)	CEREXAGRI INC
ACETAMIPRID	ASSAIL 70WP INSECTICIDE	CEREXAGRI INC
ACETAMIPRID	ASSAIL 70WP INSECTICIDE	CEREXAGRI-NISSO LLC
ACETAMIPRID	ASSAIL 70WP INSECTICIDE	NIPPON SODA CO. LTD.
ACETAMIPRID	ASSAIL 70WP INSECTICIDE	UNITED PHOSPHOROUS INC
ALDICARB (CARBAMATE)	TEMIK BRAND 15G ALDICARB PESTICIDE (B)	BAYER CROPSCIENCE LP
ALDICARB (CARBAMATE)	TEMIK BRAND 15G LOCK 'N LOAD ALDICARB PESTICIDE (B)	BAYER CROPSCIENCE LP
AZADIRACHTIN	AGRONEEM PLUS EMULSIFIABLE CONC./AG. HORT. & G-H USE -OMRI-	AGRO LOGISTIC SYSTEMS INC
AZADIRACHTIN	AZA-DIRECT BIOLOGICAL INSECTICIDE -OMRI-	GOWAN CO.
AZADIRACHTIN	AZAMAX BIOLOGICAL INSECTICIDE MITICIDE & NEMATICIDE -OMRI-	PARRY AMERICA
AZADIRACHTIN	AZATIN XL BIOLOGICAL INSECTICIDE	OHP INC.
AZADIRACHTIN	ECOZIN 3% EC BOTANICAL INSECTICIDE	AMVAC CHEMICAL CORP.
AZADIRACHTIN	GORDON'S PRO T&O AZATROL EC INSECTICIDE -OMRI-	PBI/GORDON CORPORATION
AZADIRACHTIN	NEEMIX 4.5 IGR -OMRI-	CERTIS USA LLC
BACILLUS THURINGIENSIS SSP. AIZAWAI	XENTARI DRY FLOWABLE /ORGANIC PRODUCTION	VALENT BIOSCIENCES CORP.
BACILLUS THURINGIENSIS SSP. AIZAWAI 91	AGREE WG BIOLOGICAL INSECTICIDE -OMRI-	CERTIS USA LLC
BACILLUS THURINGIENSIS SSP. KURSTAKI 1	BIOBIT HP BIO INSECTICIDE WETTABLE POWDER/ORGANIC PRODUCTION	VALENT BIOSCIENCES CORP.
BACILLUS THURINGIENSIS SSP. KURSTAKI 1	BONIDE DIPEL 150 DUST FOR VEGETABLES R-T-U	BONIDE PRODUCTS INC
BACILLUS THURINGIENSIS SSP. KURSTAKI 1	BT 320 SULFUR 25 DUST	WILBUR-ELLIS COMPANY
BACILLUS THURINGIENSIS SSP. KURSTAKI 1	DELIVER BIOLOGICAL INSECTICIDE/FRUIT NUTS VEGS &SOYBEAN-OMRI	CERTIS USA LLC
BACILLUS THURINGIENSIS SSP. KURSTAKI 1	DIPEL DF DRY FLOWABLE /ORGANIC PRODUCTION	VALENT BIOSCIENCES CORP.
BACILLUS THURINGIENSIS SSP. KURSTAKI 1	DIPEL ES	VALENT BIOSCIENCES CORP.
BACILLUS THURINGIENSIS SSP. KURSTAKI 1	JAVELIN WG BIOLOGICAL INSECTICIDE -OMRI-	CERTIS USA LLC
BACILLUS THURINGIENSIS SSP. KURSTAKI 2348	CONDOR WP WETTABLE POWDER BIOINSECTICIDE	CERTIS USA LLC
BACILLUS	LEPINOX WDG INSECTICIDE	CERTIS USA LLC

THURINGIENSIS SSP. KURSTAKI 7826			
BACILLUS THURINGIENSIS SSP. KURSTAKI 7841	CRYMAX BIOINSECTICIDE		CERTIS USA LLC
BACILLUS THURINGIENSIS SSP. KURSTAKI STRAIN BMP123	BARITONE BIO-INSECTICIDE		AGRAQUEST INC.
BACILLUS THURINGIENSIS SSP. TENEBRIONIS	NOVODOR FLOWABLE CONC.		VALENT BIOSCIENCES CORP.
BEAUVERIA BASSIANA ATCC 74040	NATURALIS L		TROY BIOSCIENCES INC.
BEAUVERIA BASSIANA GHA	BOTANIGARD 22WP		EMERALD BIO-AGRICULTURE
BEAUVERIA BASSIANA GHA	BOTANIGARD ES		EMERALD BIO-AGRICULTURE
BEAUVERIA BASSIANA GHA	MYCOTROL O -OMRI-		EMERALD BIO-AGRICULTURE
BETA-CYFLUTHRIN	BAYTHROID XL		BAYER CROPSCIENCE LP
BIFENAZATE	ACRAMITE -4SC		CHEMTURA CORPORATION
BIFENAZATE	ACRAMITE -4SC (POTATOES SUCCULENT PEAS)		CHEMTURA CORPORATION
BIFENAZATE	ACRAMITE -4SC (POTATOES-CHEMIGATION)	WA-070011	CHEMTURA CORPORATION
BIFENAZATE	ACRAMITE -4SC (POTATOES-CHEMIGATION) (US)	OR-070019	CHEMTURA USA CORPORATION
BIFENAZATE	ACRAMITE -4SC (US)		CHEMTURA USA CORPORATION
BIFENTHRIN	BIFENTHRIN 2EC INSECTICDE/MITICIDE		HELENA CHEMICAL COMPANY
BIFENTHRIN	BIFENTURE EC AG INSECTICIDE		UNITED PHOSPHOROUS INC
BIFENTHRIN	BRIGADE 2EC INSECTICIDE/MITICIDE		FMC CORP - AG PRODUCTS GROUP
BIFENTHRIN	BRIGADIER INSECTICIDE		FMC CORP - AG PRODUCTS GROUP
BIFENTHRIN	CAPTURE 2EC INSECTICDE/MITICIDE		FMC CORP - AG PRODUCTS GROUP
BIFENTHRIN	CAPTURE LFR INSECT (VARIOUS CROPS)		FMC CORP - AG PRODUCTS GROUP
BIFENTHRIN	CAPTURE LFR INSECTICIDE		FMC CORP - AG PRODUCTS GROUP
BIFENTHRIN	FANFARE 2EC (ADD'L CROPS)		MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
BIFENTHRIN	SNIPER INSECTICIDE/MITICIDE		UAP LOVELAND PRODUCTS
CANOLA OIL	MONTEREY TAKE DOWN GARDEN SPRAY		MONTEREY LAWN & GARDEN PROD. INC.
CARBARYL (CARBAMATE)	10% SEVIN GRANULES		UAP LOVELAND PRODUCTS
CARBARYL (CARBAMATE)	BAYER ADV COMPLETE INSECT KILLER/GARDENS R-T-U [SPANISH]		BAYER ADVANCED B.U. OF BAYER CROPSCIENCE LP
CARBARYL (CARBAMATE)	CARBARYL 4L INSECTICIDE		UAP LOVELAND PRODUCTS
CARBARYL (CARBAMATE)	DREXEL CARBARYL 4L INSECTICIDE		DREXEL CHEMICAL COMPANY

CARBARYL (CARBAMATE)	GARDENTECH SEVIN RTU BUG KILLER		TECHPAC L.L.C.
CARBARYL (CARBAMATE)	SEVIN 4F BRAND CARBARYL INSECTICIDE (B)		BAYER CROPSCIENCE LP
CARBARYL (CARBAMATE)	SEVIN 80 SOLUPAK		BAYER CROPSCIENCE LP
CARBARYL (CARBAMATE)	SEVIN BRAND 80S CARBARYL INSECTICIDE (B)		BAYER CROPSCIENCE LP
CARBARYL (CARBAMATE)	SEVIN BRAND 80WSP CARBARYL INSECTICIDE (B)		BAYER CROPSCIENCE LP
CARBARYL (CARBAMATE)	SEVIN BRAND RP2 CARBARYL INSECT-HOME&GARDEN INSECT (B)		BAYER CROPSCIENCE LP
CARBARYL (CARBAMATE)	SEVIN BRAND RP4 CARBARYL INSECITICIDE (B)		BAYER CROPSCIENCE LP
CARBARYL (CARBAMATE)	SEVIN BRAND XLR PLUS CARBARYL INSECTICIDE (B)		BAYER CROPSCIENCE LP
CARBARYL (CARBAMATE)	WILBUR ELLIS SEVIN 5 BAIT		WILBUR-ELLIS COMPANY
CARBOFURAN (CARBAMATE)	FURADAN 4F (POTATOES)	OR-910006	FMC CORP - AG PRODUCTS GROUP
CARBOFURAN (CARBAMATE)	FURADAN 4F INSECTICIDE/NEMATICIDE		FMC CORP - AG PRODUCTS GROUP
CARBOFURAN (CARBAMATE)	FURADAN LFR (POTATOES)	OR-060017	FMC CORP - AG PRODUCTS GROUP
CARBOFURAN (CARBAMATE)	FURADAN LFR INSECTICIDE/NEMATICIDE		FMC CORP - AG PRODUCTS GROUP
CHLOROPICRIN	TELONE C-17 (POTATOES/ONIONS)		DOW AGROSCIENCES LLC
CINNAMALDEHYDE	CINNACURE		PROGUARD INC
CINNAMALDEHYDE	CINNACURE RTU		PROGUARD INC
CINNAMON	ECOTROL G -OMRI-		ECOSMART TECHNOLOGIES INC.
CLARIFIED HYDROPHOBIC EXTRACT OF NEEM OIL	AGRONEEM PLUS EMULSIFIABLE CONC./AG. HORT. & G-H USE -OMRI-		AGRO LOGISTIC SYSTEMS INC
CLARIFIED HYDROPHOBIC EXTRACT OF NEEM OIL	TRILOGY FUNGICIDE/MITICIDE/INSECTICIDE -OMRI-		CERTIS USA LLC
CLOTHIANIDIN	BELAY 16WSG INSECT (POTATO)		VALENT USA CORPORATION
CLOTHIANIDIN	BELAY 16WSG INSECTICIDE		VALENT USA CORPORATION
CLOTHIANIDIN	BELAY 50WDG INSECTICIDE		VALENT USA CORPORATION
CLOTHIANIDIN	CLUTCH 50 WDG INSECT (GRAPES & POTATOES)		ARYSTA LIFESCIENCE NORTH AMERICA
CLOTHIANIDIN	VALENT BELAY INSECT (POTATO SEED-PIECE TREATMENT)		VALENT USA CORPORATION
CLOTHIANIDIN	VALENT BELAY INSECTICIDE		VALENT USA CORPORATION
COPPER METALLIC	COPPER-COUNT-N		CHEMICAL SPECIALTIES INC.
COTTONSEED OIL	GC-MITE (FOOD CROPS)		JH BIOTECH INC.
CRYOLITE	KRYOCIDE INSECTICIDE		CEREXAGRI INC
CRYOLITE	KRYOCIDE INSECTICIDE		CEREXAGRI-NISSO LLC
CRYOLITE	KRYOCIDE INSECTICIDE		UNITED PHOSPHOROUS INC
CRYOLITE	PROKIL CRYOLITE 96		GOWAN CO.
CYFLUTHRIN	BAYTHROID 2 EMULSIFIABLE		BAYER CROPSCIENCE LP

	PYRETHROID INSECTICIDE (B)		
CYFLUTHRIN	LEVERAGE 2.7 SUSPENSION EMULSION INSECTICIDE (B)		BAYER CROPSCIENCE LP
CYFLUTHRIN	RENOUNCE 20WP INSECTICIDE (B)		BAYER CROPSCIENCE LP
CYFLUTHRIN	TOMBSTONE HELIOS INSECTICIDE		UAP LOVELAND PRODUCTS
CYFLUTHRIN	TOMBSTONE INSECTICIDE		UAP LOVELAND PRODUCTS
CYROMAZINE	TRIGARD INSECTICIDE		SYNGENTA CROP PROTECTION INC.
DELTAMETHRIN	AGRISOLUTIONS DELTA GOLD INSECTICIDE		AGRILIANCE
DELTAMETHRIN	AGRISOLUTIONS DELTA GOLD INSECTICIDE		WINFIELD SOLUTIONS LLC
DELTAMETHRIN	BATTALION 0.2 EC INSECTICIDE		ARYSTA LIFESCIENCE NORTH AMERICA
DELTAMETHRIN	BATTALION 1.5 EC INSECTICIDE		ARYSTA LIFESCIENCE NORTH AMERICA
DELTAMETHRIN	DECIS 1.5 EC INSECTICIDE		BAYER CROPSCIENCE LP
DELTAMETHRIN	DECIS 1.5EC INSECTICIDE (B)		BAYER CROPSCIENCE LP
DIAZINON (ORGANOPHOSPHATE)	DIAZINON AG500 INSECT (POTATO)	WA-040034	MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
DIAZINON (ORGANOPHOSPHATE)	DIAZINON AG500 INSECT (POTATO-WIREWORMS)	OR-050008	MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
DICHLOROPROPENE	TELONE C-17 (POTATOES/ONIONS)		DOW AGROSCIENCES LLC
DICHLOROPROPENE	TELONE II (NEMATODE/WIREWORM-POTATO/ONION)		DOW AGROSCIENCES LLC
DIMETHOATE (ORGANOPHOSPHATE)	AGRISOLUTIONS DIMATE 4E SYSTEMIC INSECTICIDE		AGRILIANCE
DIMETHOATE (ORGANOPHOSPHATE)	AGRISOLUTIONS DIMATE 4E SYSTEMIC INSECTICIDE		WINFIELD SOLUTIONS LLC
DIMETHOATE (ORGANOPHOSPHATE)	CHEMINOVA DIMETHOATE 4E		CHEMINOVA INC.
DIMETHOATE (ORGANOPHOSPHATE)	DIMATE 4EC SYSTEMIC INSECTICIDE		WINFIELD SOLUTIONS LLC
DIMETHOATE (ORGANOPHOSPHATE)	DIMETHOATE 267		MICRO-FLO COMPANY LLC
DIMETHOATE (ORGANOPHOSPHATE)	DIMETHOATE 267 ORGANOPHOSPHATE		ARYSTA LIFESCIENCE NORTH AMERICA
DIMETHOATE (ORGANOPHOSPHATE)	DIMETHOATE 400		UAP LOVELAND PRODUCTS
DIMETHOATE (ORGANOPHOSPHATE)	DIMETHOATE 4E		ARYSTA LIFESCIENCE NORTH AMERICA
DIMETHOATE (ORGANOPHOSPHATE)	DIMETHOATE 4E		MICRO-FLO COMPANY LLC
DIMETHOATE (ORGANOPHOSPHATE)	DIMETHOATE 4EC SYSTEMIC INSECTICIDE		HELENA CHEMICAL COMPANY
DIMETHOATE (ORGANOPHOSPHATE)	DREXEL DIMETHOATE 2.67 SYSTEMIC INSECTICIDE/MITICIDE		DREXEL CHEMICAL COMPANY
DIMETHOATE (ORGANOPHOSPHATE)	DREXEL DIMETHOATE 4EC SYSTEMIC INSECITICIDE/MITICIDE		DREXEL CHEMICAL COMPANY
DIMETHOATE (ORGANOPHOSPHATE)	GOWAN DIMETHOATE E267		GOWAN CO.
DINOTEFURAN	VENOM 20SG INSECTICIDE		VALENT USA CORPORATION
DINOTEFURAN	VENOM INSECTICIDE		VALENT USA

		CORPORATION
DISULFOTON (ORGANOPHOSPHATE)	BONIDE SYSTEMIC GRANULES R-T-U	BONIDE PRODUCTS INC
DISULFOTON (ORGANOPHOSPHATE)	HI-YIELD DI-SYSTON	VOLUNTARY PURCHASING GROUPS
ENDOSULFAN	DREXEL ENDOSULFAN 3EC INSECTICIDE	DREXEL CHEMICAL COMPANY
ENDOSULFAN	THIODAN 3EC INSECTICIDE (B)	BAYER CROPSCIENCE LP
ENDOSULFAN	THIONEX -ENDOSULFAN- 3EC	MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
ENDOSULFAN	THIONEX -ENDOSULFAN- 50WSB INSECTICIDE	MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
ENDOSULFAN	THIONEX 3EC INSECTICIDE	MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
ENDOSULFAN	THIONEX 50W INSECTICIDE	MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
ESFENVALERATE	ADJOURN INSECTICIDE	MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
ESFENVALERATE	ASANA XL INSECTICIDE	DU PONT AG E.I.
ESFENVALERATE	DuPONT ASANA XL INSECTICIDE	DU PONT AG E.I.
ESFENVALERATE	S-FENVALO STAR INSECTICIDE	LG INTERNATIONAL - AMERICA- INC
ETHOPROP (ORGANOPHOSPHATE)	MOCAP 15% GRANULAR LOCK'N LOAD (B)	BAYER CROPSCIENCE LP
ETHOPROP (ORGANOPHOSPHATE)	MOCAP 15% GRANULAR NEMATICIDE-INSECTICIDE (B)	BAYER CROPSCIENCE LP
ETHOPROP (ORGANOPHOSPHATE)	MOCAP EC NEMATICIDE-INSECTICIDE (B)	BAYER CROPSCIENCE LP
FIPRONIL (AMINODICHLOROPYRAZOLE CARBONITRILE)	REGENT 4SC INSECT (IN-FURROW USE ON POTATOES)	BASF CORP
FLONICAMID	BELEAF 50 SG INSECTICIDE	FMC CORP - AG PRODUCTS GROUP
FLONICAMID	BELEAF 50 SG INSECTICIDE	ISK BIOSCIENCES CORPORATION
FLUDIOXONIL	CRUISER MAXX POTATO INSECTICIDE & FUNGICIDE	SYNGENTA CROP PROTECTION INC.
GARLIC OIL/POWDER	GC-MITE (FOOD CROPS)	JH BIOTECH INC.
HZNPV (HELICOVERPA ZEA)	GEMSTAR LC INSECTICIDAL VIRUS -OMRI-	CERTIS USA LLC
IMIDACLOPRID	ADMIRE 2 FLOWABLE INSECTICIDE (B)	BAYER CROPSCIENCE LP
IMIDACLOPRID	ADMIRE PRO SYSTEMIC PROTECTANT	BAYER CROPSCIENCE LP
IMIDACLOPRID	AGRISOLUTIONS ADVISE 2FL	AGRILIANCE
IMIDACLOPRID	AGRISOLUTIONS ADVISE 2FL	WINFIELD SOLUTIONS LLC
IMIDACLOPRID	AGRISOLUTIONS GALLANT 1.6L	WINFIELD SOLUTIONS LLC
IMIDACLOPRID	AGRISTAR IMPULSE 1.6FL	ALBAUGH INC.
IMIDACLOPRID	AGRISTAR MACHO 2.0 FL	ALBAUGH INC.
IMIDACLOPRID	ALENZA INTERNATIONAL IMIDACLOPRID 2SC	DEANGELO BROTHERS INC.
IMIDACLOPRID	ALIAS 2F FLOWABLE INSECTICIDE	MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
IMIDACLOPRID	BENEFIT 60WP GREENHOUSE & NURSERY INSECTICIDE IN WSP	SCOTTS-SIERRA CROP PROTECTION CO.
IMIDACLOPRID	BRIGADIER INSECTICIDE	FMC CORP - AG PRODUCTS GROUP

IMIDACLOPRID	COURAZE 1.6F INSECTICIDE	CHEMINOVA INC.
IMIDACLOPRID	COURAZE 2F INSECTICIDE	CHEMINOVA INC.
IMIDACLOPRID	GAUCHO-MZ POTATO SEED-PIECE TREATMENT	BAYER CROPSCIENCE LP
IMIDACLOPRID	GAUCHO-MZ POTATO SEED-PIECE TRTMT	GUSTAFSON LLC
IMIDACLOPRID	GENESIS	GUSTAFSON LLC
IMIDACLOPRID	HAWK-I N/O 2L INSECTICIDE	PHOENIX ENVIRONMENTAL CARE
IMIDACLOPRID	HAWK-I N/O 60WSP INSECTICIDE	PHOENIX ENVIRONMENTAL CARE
IMIDACLOPRID	IMIDA E-AG 1.6F INSECTICIDE	ETIGRA LLC
IMIDACLOPRID	IMIDA E-AG 2F INSECTICIDE	ETIGRA LLC
IMIDACLOPRID	IMIDA E-PRO 2F T&O INSECTICIDE	ETIGRA LLC
IMIDACLOPRID	IMIDA E-PRO 60WSP ORN INSECTICIDE	ETIGRA LLC
IMIDACLOPRID	LEVERAGE 2.7 SUSPENSION EMULSION INSECTICIDE (B)	BAYER CROPSCIENCE LP
IMIDACLOPRID	MANA ALIAS 4F FLOWABLE INSECTICIDE	MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
IMIDACLOPRID	MANTRA 2F GREENHOUSE & NURSERY INSECTICIDE	NUFARM AMERICAS INC
IMIDACLOPRID	MIDASH 2SC AG INSECTICIDE	SHARDA USA LLC
IMIDACLOPRID	MONTANA 2F INSECTICIDE	ROTAM NORTH AMERICA INC
IMIDACLOPRID	NUPRID 1.6F INSECTICIDE	NUFARM AMERICAS INC
IMIDACLOPRID	NUPRID 2F INSECTICIDE	NUFARM AMERICAS INC
IMIDACLOPRID	NUPRID 4.6F PRO INSECTICIDE	NUFARM AMERICAS INC
IMIDACLOPRID	PASADA 1.6F FLOWABLE INSECTICIDE	MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
IMIDACLOPRID	PREY 1.6 INSECTICIDE	UAP LOVELAND PRODUCTS
IMIDACLOPRID	PROVADO 1.6 FLOWABLE INSECTICIDE (B)	BAYER CROPSCIENCE LP
IMIDACLOPRID	QUALI-PRO IMIDACLOPRID 2F NURSERY & GREENHOUSE INSECTICIDE	MAKHTESHIM-AGAN /FARMSAVER.COM LLC
IMIDACLOPRID	SHERPA INSECTICIDE	UAP LOVELAND PRODUCTS
IMIDACLOPRID	TOPS-MZ-GAUCHO	GUSTAFSON LLC
IMIDACLOPRID	TOPS-MZ-GAUCHO POTATO SEED-PIECE TREATMENT	BAYER CROPSCIENCE LP
IMIDACLOPRID	TORRENT 1.6F	SIPCAM AGRO USA INC.
IMIDACLOPRID	TORRENT 2F	SIPCAM AGRO USA INC.
IMIDACLOPRID	WIDOW INSECTICIDE	UAP LOVELAND PRODUCTS
INDOXACARB	DuPONT AVAUNT INSECT (LETTUCE & POTATO)	DU PONT AG E.I.
INDOXACARB	DuPONT AVAUNT INSECT (MANY CROPS)	DU PONT AG E.I.
INDOXACARB	DuPONT AVAUNT INSECT (POTATOES VIA SPRINKLER IRRIGATION)	DU PONT AG E.I.
INDOXACARB	DuPONT AVAUNT INSECTICIDE	DU PONT AG E.I.
JOJOBA OIL	ECO E-RASE -OMRI-	IJO PRODUCTS LLC
KAOLIN	SURROUND WP CROP PROTECTANT -OMRI-	ENGELHARD CORP
LAMBDA-CYHALOTHRIN	ENDIGO ZC INSECTICIDE	SYNGENTA CROP

		PROTECTION INC.
LAMBDA-CYHALOTHRIN	WARRIOR II W/ZEON TECHNOLOGY INSECTICIDE	SYNGENTA CROP PROTECTION INC.
LAMBDA-CYHALOTHRIN	WARRIOR INSECT W/ZEON (VEGETABLES NUTS & GRASS)	SYNGENTA CROP PROTECTION INC.
LAMBDA-CYHALOTHRIN	WARRIOR INSECTICIDE W/ZEON	SYNGENTA CROP PROTECTION INC.
MALATHION (ORGANOPHOSPHATE)	DREXEL MALATHION 5EC INSECTICIDE/MITICIDE	DREXEL CHEMICAL COMPANY
MALATHION (ORGANOPHOSPHATE)	FYFANON	HELENA CHEMICAL COMPANY
MALATHION (ORGANOPHOSPHATE)	FYFANON 8 LB EMULSION	HELENA CHEMICAL COMPANY
MALATHION (ORGANOPHOSPHATE)	GOWAN MALATHION 8 FLOWABLE	GOWAN CO.
MALATHION (ORGANOPHOSPHATE)	MALATHION 5	AGRILIANCE
MALATHION (ORGANOPHOSPHATE)	MALATHION 5	WINFIELD SOLUTIONS LLC
MALATHION (ORGANOPHOSPHATE)	MALATHION 5 EC	MICRO-FLO COMPANY LLC
MALATHION (ORGANOPHOSPHATE)	MALATHION 57 EC	UAP LOVELAND PRODUCTS
MALATHION (ORGANOPHOSPHATE)	MALATHION 5EC	ARYSTA LIFESCIENCE NORTH AMERICA
MALATHION (ORGANOPHOSPHATE)	MALATHION 8 AQUAMUL	UAP LOVELAND PRODUCTS
MALATHION (ORGANOPHOSPHATE)	MALATHION 8 EC	ARYSTA LIFESCIENCE NORTH AMERICA
MALATHION (ORGANOPHOSPHATE)	MALATHION 8EC	MICRO-FLO COMPANY LLC
MALATHION (ORGANOPHOSPHATE)	PRENTOX 5LB MALATHION SPRAY	PRENTISS INC
MALATHION (ORGANOPHOSPHATE)	PRENTOX MALATHION 50% EMULSIFIABLE INSECTICIDE	PRENTISS INC
MANCOZEB	GAUCHO-MZ POTATO SEED-PIECE TREATMENT	BAYER CROPSCIENCE LP
MANCOZEB	GAUCHO-MZ POTATO SEED-PIECE TRTMT	GUSTAFSON LLC
MANCOZEB	TOPS-MZ-GAUCHO	GUSTAFSON LLC
MANCOZEB	TOPS-MZ-GAUCHO POTATO SEED-PIECE TREATMENT	BAYER CROPSCIENCE LP
MEFENOXAM (R-ENANTIOMER OF METALAXYL)	PLATINUM RIDOMIL GOLD (PLANT EMERGENCE APPL-POTATOES)	SYNGENTA CROP PROTECTION INC.
MEFENOXAM (R-ENANTIOMER OF METALAXYL)	PLATINUM RIDOMIL GOLD INSECTICIDE/FUNGICIDE	SYNGENTA CROP PROTECTION INC.
METAM-SODIUM	METAM CLR 42% FUMIGANT	TAMINCO INC.
METAM-SODIUM	VAPAM HL SOIL FUMIGANT	AMVAC CHEMICAL CORP.
METHAMIDOPHOS (ORGANOPHOSPHATE)	MONITOR 4 LIQUID INSECTICIDE (B)	BAYER CROPSCIENCE LP
METHAMIDOPHOS (ORGANOPHOSPHATE)	VALENT MONITOR 4 SPRAY	VALENT USA CORPORATION
METHOMYL (CARBAMATE)	DuPONT LANNATE LV (POTATOES VIA OVERHEAD SPRINKLER IRRIGATN)	DU PONT AG E.I.
METHOMYL (CARBAMATE)	DuPONT LANNATE LV INSECTICIDE	DU PONT AG E.I.
METHOMYL	DuPONT LANNATE SP INSECTICIDE	DU PONT AG E.I.

(CARBAMATE)		
METHYL PARATHION (ORGANOPHOSPHATE)	CHEMINOVA METHYL 4 EC	CHEMINOVA INC.
METHYL PARATHION (ORGANOPHOSPHATE)	DECLARE	CHEMINOVA A/S
METHYL PARATHION (ORGANOPHOSPHATE)	PENNCAP-M	CEREXAGRI INC
METHYL PARATHION (ORGANOPHOSPHATE)	PENNCAP-M	CEREXAGRI-NISSO LLC
METHYL PARATHION (ORGANOPHOSPHATE)	PENNCAP-M (POTATOES - TO CONTROL APHIDS)	CEREXAGRI INC
METHYL PARATHION (ORGANOPHOSPHATE)	PENNCAP-M (POTATOES)	CEREXAGRI-NISSO LLC
METHYL PARATHION (ORGANOPHOSPHATE)	PENNCAP-M MICROENCAPSULATED INSECTICIDE	UNITED PHOSPHOROUS INC
MINERAL OIL - INCLUDES PARAFFIN OIL FROM 063503	PRES TRMT ULTRA-PURE OIL	WHITMIRE MICRO-GEN RESEARCH LABS
MINERAL OIL PETROLEUM DISTILLATES SOLVENT REFINED LIGHT	BIOCOVER LS	UAP LOVELAND PRODUCTS
MINERAL OIL PETROLEUM DISTILLATES SOLVENT REFINED LIGHT	BIOCOVER SS	UAP LOVELAND PRODUCTS
MINERAL OIL PETROLEUM DISTILLATES SOLVENT REFINED LIGHT	BIOCOVER UL	UAP LOVELAND PRODUCTS
MINERAL OIL PETROLEUM DISTILLATES SOLVENT REFINED LIGHT	GLACIAL SPRAY FLUID /ORGANIC PRODUCTION	UAP LOVELAND PRODUCTS
MINERAL OIL PETROLEUM DISTILLATES SOLVENT REFINED LIGHT	JMS STYLET-OIL	JMS FLOWER FARMS INC
MINERAL OIL PETROLEUM DISTILLATES SOLVENT REFINED LIGHT	ORGANIC JMS STYLET-OIL - OMRI-	JMS FLOWER FARMS INC
MINERAL OIL PETROLEUM DISTILLATES SOLVENT REFINED LIGHT	PRES TRMT ULTRA-FINE OIL ALL SEASON HORT INSECT/FUNG	WHITMIRE MICRO-GEN RESEARCH LABS
MINERAL OIL PETROLEUM DISTILLATES SOLVENT REFINED LIGHT	SAF-T-SIDE	MONTEREY LAWN & GARDEN PROD. INC.
MINERAL OIL PETROLEUM DISTILLATES SOLVENT REFINED LIGHT	SAF-T-SIDE SPRAY OIL EMULSION FUNG INSECT & MITICIDE	BRANDT CONSOLIDATED
NOVALURON	RIMON	MAKHTESHIM-AGAN OF NORTH AMERICAN INC.
NOVALURON	RIMON 0.83EC INSECTICIDE	CHEMTURA CORPORATION
NOVALURON	RIMON 0.83EC INSECTICIDE (CM)	CROMPTON

		MANUFACTURING CO
NOVALURON	RIMON 0.83EC INSECTICIDE (US)	CHEMTURA USA CORPORATION
OIL OF CLOVE	ECOTROL G -OMRI-	ECOSMART TECHNOLOGIES INC.
OIL OF CLOVE	GC-MITE (FOOD CROPS)	JH BIOTECH INC.
OIL OF ROSEMARY	ECOTROL EC -OMRI-	ECOSMART TECHNOLOGIES INC.
OIL OF SESAME	AGRONEEM PLUS EMULSIFIABLE CONC./AG. HORT. & G-H USE -OMRI-	AGRO LOGISTIC SYSTEMS INC
OIL OF THYME	ECOTROL G -OMRI-	ECOSMART TECHNOLOGIES INC.
OXAMYL (CARBAMATE)	DuPONT VYDATE C-LV (CONTROL-COLORADO POTATO BEETLE)	DU PONT AG E.I.
OXAMYL (CARBAMATE)	DuPONT VYDATE C-LV INSECTICIDE/NEMATICIDE	DU PONT AG E.I.
OXAMYL (CARBAMATE)	DuPONT VYDATE L INSECTICIDE/NEMATICIDE	DU PONT AG E.I.
PEPPERMINT	ECOTROL EC -OMRI-	ECOSMART TECHNOLOGIES INC.
PERMETHRIN	AMBUSH 25W INSECTICIDE	AMVAC CHEMICAL CORP.
PERMETHRIN	AMBUSH INSECTICIDE	AMVAC CHEMICAL CORP.
PERMETHRIN	ARTIC 3.2 EC INSECTICIDE	AGRILIANCE
PERMETHRIN	ARTIC 3.2 EC INSECTICIDE	WINFIELD SOLUTIONS LLC
PERMETHRIN	BIOMIST 4+4 ULV	CLARKE MOSQUITO CONTROL PRODUCTS
PERMETHRIN	FIRST CHOICE PERMETHRIN CUTWORM BAIT	WESTERN FARM SERVICE INC.
PERMETHRIN	HI-YIELD GARDEN PET & LIVESTOCK DUST	VOLUNTARY PURCHASING GROUPS
PERMETHRIN	HI-YIELD GARDEN PET & LIVESTOCK INSECT CONTROL	VOLUNTARY PURCHASING GROUPS
PERMETHRIN	HI-YIELD INDOOR/OUTDOOR BROAD USE INSECTICIDE	VOLUNTARY PURCHASING GROUPS
PERMETHRIN	PERM-UP 25DF INSECTICIDE	UNITED PHOSPHOROUS INC
PERMETHRIN	PERM-UP 25WP INSECTICIDE	UNITED PHOSPHOROUS INC
PERMETHRIN	PERM-UP 3.2EC INSECTICIDE	UNITED PHOSPHOROUS INC
PERMETHRIN	PERMETHRIN	UAP LOVELAND PRODUCTS
PERMETHRIN	PERMETHRIN 3.2 AG	MICRO-FLO COMPANY LLC
PERMETHRIN	PERMETHRIN 3.2EC INSECTICIDE	HELENA CHEMICAL COMPANY
PERMETHRIN	PERMETHRIN 3.2EC INSECTICIDE	TENKOZ INC
PERMETHRIN	POUNCE 25WP INSECTICIDE	FMC CORP - AG PRODUCTS GROUP
PERMETHRIN	POUNCE 3.2 EC INSECTICIDE	AGRILIANCE
PERMETHRIN	POUNCE 3.2 EC INSECTICIDE	FMC CORP - AG PRODUCTS GROUP
PERMETHRIN	POUNCE 3.2 EC INSECTICIDE	WINFIELD SOLUTIONS LLC
PERMETHRIN	PROZAP GARDEN & POULTRY DUST	CHEM-TECH LTD.

PERMETHRIN	TENKOZ PERMETHRIN 3.2EC INSECTICIDE		TENKOZ INC
PERMETHRIN	WAYLAY 3.2 AG PERMETHRIN INSECTICIDE		CONTROL SOLUTIONS INC
PHORATE (ORGANOPHOSPHATE)	AGRISOLUTIONS PHORATE 20G INSECTICIDE		AGRILIANCE
PHORATE (ORGANOPHOSPHATE)	AGRISOLUTIONS PHORATE 20G INSECTICIDE		WINFIELD SOLUTIONS LLC
PHORATE (ORGANOPHOSPHATE)	MICROFLO THIMET 20-G LOCK'N LOAD		MICRO-FLO COMPANY LLC
PHORATE (ORGANOPHOSPHATE)	PHORATE 20 G		UAP LOVELAND PRODUCTS
PHORATE (ORGANOPHOSPHATE)	PHORATE 20G SOIL & SYSTEMIC INSECTICIDE/CLOSED LOADING SYSTM		ACETO AGRICULTURAL CHEMICALS CORP
PHORATE (ORGANOPHOSPHATE)	THIMET 20-G EZLOAD		AMVAC CHEMICAL CORP.
PHORATE (ORGANOPHOSPHATE)	THIMET 20-G LOCK'N LOAD		AMVAC CHEMICAL CORP.
PHORATE (ORGANOPHOSPHATE)	THIMET 20-G SMARTBOX		AMVAC CHEMICAL CORP.
PHOSMET (ORGANOPHOSPHATE)	IMIDAN 2.5-EC		GOWAN CO.
PHOSMET (ORGANOPHOSPHATE)	IMIDAN 70-W (POTATO)	WA-030031	GOWAN CO.
PHOSMET (ORGANOPHOSPHATE)	IMIDAN 70-W AG INSECTICIDE		GOWAN CO.
PIPERONYL BUTOXIDE	BIOMIST 4+4 ULV		CLARKE MOSQUITO CONTROL PRODUCTS
PIPERONYL BUTOXIDE	EVERGREEN CROP PROTECTION EC 60-6		MCLAUGHLIN GORMLEY KING
PIPERONYL BUTOXIDE	MASTER NURSERY TOMATO & VEGETABLE INSECT CONTROL		BONIDE PRODUCTS INC
PIPERONYL BUTOXIDE	PRENTOX EMULSIFIABLE SPRAY CONC NO.96		PRENTISS INC
PIPERONYL BUTOXIDE	PRENTOX PYRONYL 303 EMULSIFIABLE CONC.		PRENTISS INC
PIPERONYL BUTOXIDE	PRENTOX PYRONYL CROP SPRAY		PRENTISS INC
PIPERONYL BUTOXIDE	PRES TRMT PYRETH-IT		WHITMIRE MICRO-GEN RESEARCH LABS
PIPERONYL BUTOXIDE	PRES TRMT PYRETH-IT FORM2		WHITMIRE MICRO-GEN RESEARCH LABS
PIPERONYL BUTOXIDE	PYRENONE CROP SPRAY (ES)		BAYER ENVIRONMENTAL SCIENCE (ES)
POTASSIUM LAURATE	BONIDE INSECTICIDAL SOAP MULTI-PURPOSE INSECT CONTROL CONC		BONIDE PRODUCTS INC
POTASSIUM LAURATE	M-PEDE INSECTICIDE/FUNGICIDE		DOW AGROSCIENCES LLC
POTASSIUM LAURATE	M-PEDE INSECTICIDE/FUNGICIDE -OMRI-		DOW AGROSCIENCES LLC
POTASSIUM LAURATE	NATURAL GUARD INSECTICIDAL SOAP /ORGANIC PRODUCTION		VOLUNTARY PURCHASING GROUPS
POTASSIUM N-METHYLDITHIOCARBAMATE	K-PAM HL		AMVAC CHEMICAL CORP.
POTASSIUM N-METHYLDITHIOCARBAMATE	METAM KLR 54%		TAMINCO INC.

POTASSIUM SILICATE	SIL-MATRIX FUNGICIDE/MITICIDE/INSECTICIDE		PQ CORPORATION
PROPARGITE	COMITE (POTATO/CHEMIGATION)	OR-080011	CHEMTURA CORPORATION
PROPARGITE	COMITE (POTATO/CHEMIGATION)(CM)	OR-040001	CROMPTON MANUFACTURING CO
PROPARGITE	COMITE AGRICULTURAL MITICIDE		CHEMTURA CORPORATION
PROPARGITE	COMITE AGRICULTURAL MITICIDE (CM)		CROMPTON MANUFACTURING CO
PROPARGITE	COMITE AGRICULTURAL MITICIDE (POTATOES)	WA-040020	CHEMTURA CORPORATION
PROPARGITE	COMITE AGRICULTURAL MITICIDE (RED. APPL. INTERVAL-POTATOES)	OR-080012	CHEMTURA CORPORATION
PROPARGITE	COMITE AGRICULTURAL MITICIDE (RED. APPL.INTERVAL-POTATO)(CM)	OR-040036	CROMPTON MANUFACTURING CO
PROPARGITE	COMITE AGRICULTURAL MITICIDE (US)		CHEMTURA USA CORPORATION
PROPARGITE	OMITE-6E AGRICULTURAL MITICIDE		CHEMTURA CORPORATION
PROPARGITE	OMITE-6E AGRICULTURAL MITICIDE (CM)		CROMPTON MANUFACTURING CO
PROPARGITE	OMITE-6E AGRICULTURAL MITICIDE (US)		CHEMTURA USA CORPORATION
PROPYLENEGLYCOL MONOLAURATE	ACARITOUCH		OTSUKA CHEMICAL CO LTD
PYMETROZINE	FULFILL INSECTICIDE		SYNGENTA CROP PROTECTION INC.
PYRETHRINS	EVERGREEN CROP PROTECTION EC 60-6		MCLAUGHLIN GORMLEY KING
PYRETHRINS	MASTER NURSERY TOMATO & VEGETABLE INSECT CONTROL		BONIDE PRODUCTS INC
PYRETHRINS	MGK EVERGREEN GROWERS SPRAY		MCLAUGHLIN GORMLEY KING
PYRETHRINS	MONTEREY TAKE DOWN GARDEN SPRAY		MONTEREY LAWN & GARDEN PROD. INC.
PYRETHRINS	PRENTOX EMULSIFIABLE SPRAY CONC NO.96		PRENTISS INC
PYRETHRINS	PRENTOX PYRONYL 303 EMULSIFIABLE CONC.		PRENTISS INC
PYRETHRINS	PRENTOX PYRONYL CROP SPRAY		PRENTISS INC
PYRETHRINS	PRES TRMT PYRETH-IT		WHITMIRE MICRO-GEN RESEARCH LABS
PYRETHRINS	PRES TRMT PYRETH-IT FORM2		WHITMIRE MICRO-GEN RESEARCH LABS
PYRETHRINS	PYGANIC CROP PROTECTION EC 1.4 II -OMRI-		MCLAUGHLIN GORMLEY KING
PYRETHRINS	PYGANIC CROP PROTECTION EC 5.0 II -OMRI-		MCLAUGHLIN GORMLEY KING
PYRETHRINS	PYRELLIN E.C.		WEBB WRIGHT CORPORATION
PYRETHRINS	PYRENONE CROP SPRAY (ES)		BAYER ENVIRONMENTAL SCIENCE (ES)
PYRIPROXYFEN (NYLAR)	VALENT KNACK IGR (BERRY BULB VEG. CRANBERRY LEGUMES ROOT&T)		VALENT USA CORPORATION

ROTENONE	PYRELLIN E.C.	WEBB WRIGHT CORPORATION
SODIUM BORATE (BORAX)	PREV-AM ULTRA CONTROL	ORO AGRI INC.
SOYBEAN OIL	GOLDEN PEST SPRAY OIL	STOLLER ENTERPRISES INC.
SPINETORAM (SPINOSYNS J+L)	RADIANT SC INSECTICIDE	DOW AGROSCIENCES LLC
SPINOSAD (SPINOSYNS A+D)	ENTRUST -OMRI-	DOW AGROSCIENCES LLC
SPINOSAD (SPINOSYNS A+D)	SUCCESS NATURALYTE INSECT CONTROL	DOW AGROSCIENCES LLC
SPIROMESIFEN	OBERON 2SC INSECTICIDE/MITICIDE	BAYER CROPSCIENCE LP
SULFUR	BT 320 SULFUR 25 DUST	WILBUR-ELLIS COMPANY
SULFUR	COSAVET DF FUNGICIDE--MITICIDE	AGVALUE INC.
SULFUR	COSAVET-DF FUNGICIDE-MITICIDE -OMRI-	SULPHUR MILLS LTD
SULFUR	CSC 80% THIOSPERSE	MARTIN OPERATING PARTNERSHIP LP
SULFUR	DREXEL SUFFA	DREXEL CHEMICAL COMPANY
SULFUR	DREXEL SULFUR 90W	DREXEL CHEMICAL COMPANY
SULFUR	DUSTING SULFUR	WILBUR-ELLIS COMPANY
SULFUR	GOLDEN-DEW /ORGANIC PRODUCTION	WILBUR-ELLIS COMPANY
SULFUR	KUMULUS DF	MICRO-FLO COMPANY LLC
SULFUR	KUMULUS DF FUNGICIDE/ACARACIDE	ARYSTA LIFESCIENCE NORTH AMERICA
SULFUR	LIQUID SULFUR SIX	HELENA CHEMICAL COMPANY
SULFUR	MICRO SULF (N)	NUFARM AMERICAS INC: AGT DIVISION
SULFUR	MICROTHIOL DISPERSS MICRONIZED WETTABLE SULFUR	CEREXAGRI INC
SULFUR	MICROTHIOL DISPERSS MICRONIZED WETTABLE SULFUR	CEREXAGRI-NISSO LLC
SULFUR	MICROTHIOL DISPERSS MICRONIZED WETTABLE SULFUR	UNITED PHOSPHOROUS INC
SULFUR	PRONATURAL MICRONIZED SULFUR /ORGANIC PRODUCTION	WILBUR-ELLIS COMPANY
SULFUR	SULFUR 6L	ARYSTA LIFESCIENCE NORTH AMERICA
SULFUR	SULFUR 6L	MICRO-FLO COMPANY LLC
SULFUR	SULFUR DF	WILBUR-ELLIS COMPANY
SULFUR	SULPHUR W.G.	QUIMETAL INDUSTRIAL S.A.
SULFUR	SUPERSIX LIQUID SULFUR	JR SIMPLOT COMPANY
SULFUR	THAT FLOWABLE SULFUR	STOLLER ENTERPRISES INC.
SULFUR	THIOLUX JET DRY FLOWABLE MICRONIZED SULFUR -OMRI-	SYNGENTA CROP PROTECTION INC.
SULFUR	WILBUR ELLIS SPRAY SULFUR	WILBUR-ELLIS COMPANY

SULFUR	YELLOW JACKET WETTABLE DUSTING SULFUR II /ORGANIC PRODUCTION		GEORGIA GULF SULFUR CORP
THIAMETHOXAM	ACTARA INSECT (BARLEY BRASSICA CUCURBIT ARTICHOKE GRAPE ETC.		SYNGENTA CROP PROTECTION INC.
THIAMETHOXAM	ACTARA INSECT (BUSHBERRY/CRANBERRY/MINT/ ROOT VEG/STRAWBERRY)		SYNGENTA CROP PROTECTION INC.
THIAMETHOXAM	ACTARA INSECTICIDE		SYNGENTA CROP PROTECTION INC.
THIAMETHOXAM	CRUISER 5FS INSECT (LEGUME VEGETABLES/OILSEED CROPS)		SYNGENTA CROP PROTECTION INC.
THIAMETHOXAM	CRUISER 5FS INSECTICIDE		SYNGENTA CROP PROTECTION INC.
THIAMETHOXAM	CRUISER MAXX POTATO INSECTICIDE & FUNGICIDE		SYNGENTA CROP PROTECTION INC.
THIAMETHOXAM	ENDIGO ZC INSECTICIDE		SYNGENTA CROP PROTECTION INC.
THIAMETHOXAM	PLATINUM 75SG INSECTICIDE		SYNGENTA CROP PROTECTION INC.
THIAMETHOXAM	PLATINUM INSECT (BRASSICA-COLE GRAPE HOP LEAFY VEGGIES)		SYNGENTA CROP PROTECTION INC.
THIAMETHOXAM	PLATINUM INSECT (POTATOES/CHEMIGATION)	OR-060015	SYNGENTA CROP PROTECTION INC.
THIAMETHOXAM	PLATINUM INSECTICIDE		SYNGENTA CROP PROTECTION INC.
THIAMETHOXAM	PLATINUM RIDOMIL GOLD (PLANT EMERGENCE APPL-POTATOES)		SYNGENTA CROP PROTECTION INC.
THIAMETHOXAM	PLATINUM RIDOMIL GOLD INSECTICIDE/FUNGICIDE		SYNGENTA CROP PROTECTION INC.
THIOPHANATE METHYL	TOPS-MZ-GAUCHO		GUSTAFSON LLC
THIOPHANATE METHYL	TOPS-MZ-GAUCHO POTATO SEED-PIECE TREATMENT		BAYER CROPSCIENCE LP
TRIPHENYLTIN HYDROXIDE (FENTIN HYDROXIDE)	AGRI TIN AGRICULTURAL FUNGICIDE (Nu)		NUFARM AMERICAS INC: AGT DIVISION
ZETA-CYPERMETHRIN	MUSTANG INSECTICIDE		FMC CORP - AG PRODUCTS GROUP
ZETA-CYPERMETHRIN	MUSTANG MAX EC INSECTICIDE		FMC CORP - AG PRODUCTS GROUP
ZETA-CYPERMETHRIN	MUSTANG MAX EW INSECTICIDE		FMC CORP - AG PRODUCTS GROUP
ZETA-CYPERMETHRIN	MUSTANG MAX INSECT (VARIOUS CROPS)		FMC CORP - AG PRODUCTS GROUP
ZETA-CYPERMETHRIN	MUSTANG MAX INSECTICIDE		FMC CORP - AG PRODUCTS GROUP
ZETA-CYPERMETHRIN	RESPECT EC INSECTICIDE		BASF CORP
ZETA-CYPERMETHRIN	RESPECT INSECT (ROOT&TUBER VEG/TREE NUTS/ALFALFA&CLOVER)		BASF CORP