Crop Profile for White Potatoes in Virginia

Prepared: April, 2003

General Production Information

- In 2001, 6,300 acres of summer potatoes were harvested in Virginia.Potato production in Virginia averaged roughly 220 cwt./acre or 22,000 lbs./acre in 2001.
- A total of 1,386,000 cwt. or 138,600,000 lbs. of fresh market potatoes were produced in Virginia in 2001.
- The 2001 crop was valued at $9,494,000 or approximately $0.069/lb.
- Virginia ranked 6th of 12 potato-producing states, accounting for 7.65% of the national potato production in 2001.

Production Regions

A few hundred acres of potatoes are grown in southeastern Virginia, primarily in Chesapeake County and also in the western part of the state. However, most of those produced in Virginia, approximately 4,000 acres, are grown on the Eastern Shore.

Cultural Practices

White-skinned varieties recommended for planting in Virginia include *Superior*(early season), *Atlantic*, *Reba* and *Red LaSoda* (midseason), and *Kennebec* and *Snowden* (late season). Red-skinned varieties include *Cherry Red* and *NorDonna* (midseason). Variety selection often depends on the market choice of the grower, either for chipping or fresh. Chipping potatoes are grown only on the Eastern Shore and account for roughly half of the potato production in that region. Fresh market potatoes account for the other half of Eastern Shore production and are also grown throughout the rest of the regions described above.

March 10 to April 5 is the recommended planting time in Virginia for summer potatoes. Before planting, seed potatoes are cut into blocky pieces, which contain at least one eye. Following cutting, pieces should be immediately dusted with the appropriate fungicide (*Captan 7.5%*, *Polyram 7%*, *Maneb 8%*, *Tops 2.5%*, or *Maxim 0.5%*) and planted or stored under conditions suitable for rapid healing. Spacing of these pieces in the ground depends on their size and also on the marketing tactics of the finished product. As the aboveground portion of the plant reaches the early bud stage, the underground portion produces tubers or potatoes. Typically this occurs approximately 6-8 weeks after planting.

Soil tests should be taken before planting to aid in soil implement decisions. The target pH for scab-susceptible potatoes is 5.2 and for scab-resistant potatoes it is 6.2. Average fertilizer inputs for both fresh and chipping potatoes include 100 lb. of nitrogen, 200 lb. of phosphorus, and 200 lb. of potassium. Annual soil tests may suggest slightly different values. Approximately two-thirds of the required fertilizer is banded at planting, and the additional one-third is sidedressed at a later date. Generally, potatoes respond well to both fertilization and irrigation. Irrigation is utilized as needed depending on environmental conditions. In addition, potato fields may be cultivated to control small weeds before close-in. The length of maturation varies for chipping vs. fresh market potatoes, with chipping potatoes remaining in the ground longer for higher yields. Both fresh market and chipping potatoes are harvested by machine.Harvesting usually occurs late June to early August.

During the growing season, worker activities in the field could include such things as planting seed potatoes (March-

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April), cultivating, scouting, spraying, and harvesting (June-August). The workers risk potential exposure to pesticides during these activities and should follow all safety procedures determined by the label, mostly wearing proper personal protective equipment (PPE) and strictly following Re-Entry Intervals (REIs) when returning to the field. Activities that bring workers in direct contact with the plants during the growing season are generally uncommon, as most work performed in the field is done mechanically.

Special Use Labels

Section 18 Emergency Use Exemption and Special Local Needs (24C) labels are used to supplement the chemical tools available to producers for pest control. Once the problem or gap in pest control has been identified, specialists submit the proper documentation for the emergency/special label. Thus far, Extension specialists have been successful in obtaining these labels, which must be applied for annually and are usually only valid for limited time intervals. Without these, pest control in vegetable crops would be extremely difficult for producers.

Insect Pests

Control recommendations found below were modified from information presented in the 2002 Commercial Vegetable Production Recommendations--Virginia[2] *unless otherwise noted.*

INSECTS

Insect pests of potatoes in Virginia include aboveground foliage-feeders and stalk borers, as well as belowground root and tuber feeders. Overall, the Colorado potato beetle (CPB) is the most important pest. Other pests include aphids, potato leafhopper, European corn borer, potato tuberworm, wireworms, flea beetles, and cutworms. A number of insecticides are labeled for insect control on potatoes, but many are organophosphates or carbamates, and relatively few are effective against CPB. If uses of these insecticide classes were limited or removed, pest control would become even more challenging for potato producers. Details regarding insect pests of potatoes and their management in Virginia can be found below.

Aphids
Green Peach Aphid, *Myzus persicae*
Melon Aphid, *Aphis gossypii*
Potato Aphid, *Macrosiphum euphorbiae*

Several species of aphids infest potatoes in Virginia. Green peach aphid, potato aphid, and melon aphid are the primary three species and are, for the most part, equally abundant in Virginia. Aphids may be present on plants throughout the growing season, but peak infestations often occur in late spring and then again in early fall. Aphids feed on plant sap, which may reduce plant vigor, size, and yield. Also, as they feed on the underside of the leaves, aphids excrete honeydew. This, in turn, leads to the growth of black sooty mold, which may block out sunlight and thus reduce plant yield. Aphids also have the potential to transmit plant viruses. Each of the three species carries a different array of viruses, all of which can be devastating.

Monitoring: Aphids are generally controlled by the insecticides applied for other pests, primarily Colorado potato beetle. Thus, they are not a primary concern for Virginia potato growers. Nonetheless, scouting for aphids is recommended. Large aphid populations may be detected by the appearance of cast skins, sooty mold, or shiny honeydew accumulations on lower foliage. When incidence of aphids appears in the field, examine five fully expanded leaves from each of ten locations in the field. Insecticide treatments are recommended when potato and green peach aphids exceed two aphids/leaf before bloom, four aphids/leaf during bloom, and ten aphids/leaf within two weeks of vine kill, or when melon aphid counts exceed one aphid/leaf before bloom, two aphids/leaf during bloom, and five aphids/leaf within two weeks of vine kill.

Chemical Control: Insecticide applications for Colorado potato beetle or potato leafhopper usually control this pest.

See *Chemical Insect Control* section.

Biological Control: A number of natural enemies such as lady beetles (adults and larvae), lacewing larvae, syrphid larvae, parasitic wasps, and fungal pathogens will reduce aphid populations. Natural enemies will often keep aphid populations below damaging numbers and, therefore, should be considered before an insecticide application. However, if the spread of virus is of concern, chemical treatment will be necessary.

Cultural Control: Many potato cultivars are resistant to plant viruses and should be considered in the pest management decision-making process for aphids. Plant disease-free certified seed. Avoid planting fields immediately downwind of a barrier such as hedgerows or wood lots, which reduce wind velocity and increase the number of dispersing aphids falling into fields. Harvest the crop as soon as possible to avoid late-season aphid colonization.

Colorado Potato Beetle, *Leptinotarsa decemlineata*

In Virginia, the Colorado potato beetle (CPB) is the most serious pest of potatoes. Adults and larvae feed on the leaves and terminal growth of potatoes, which hinders tuber development and may result in yield loss or possibly plant death. The amount of yield loss depends on the growth stage of the potato plant at infestation. CPB overwinter as adults in the soil and emerge in the spring and feed for a short time before mating and laying eggs. Each female deposits 300-500 yellow eggs on the undersides of plant leaves. Eggs hatch in 4-9 days and larvae feed for three weeks, then drop to the ground and pupate. A new adult generation will then emerge 5-10 days later. There can be three annual generations of CPB in Virginia, but not all the beetles go on to form a third generation. The third generation usually develops on weeds and is often overlooked.

Monitoring: Fields should be sampled weekly beginning at plant emergence. When scouting, at least ten sites should be selected along a V- or W-shaped path throughout a given field. At each site, chose one stem from each of five adjacent plants and count and record all adults, large larvae (more than half-grown), and small larvae (less than half-grown). If more than 50 adults or 75 large larvae or 200 small larvae are counted per 50 stems, treatment is recommended.

Chemical Control: Many currently labeled insecticides on potatoes are no longer effective against CPB because of insecticide resistance development. This varies considerably from state to state. Therefore, it is important to check the results of the latest local efficacy trials. When insecticides are used, proper timing, rates, and good spray coverage are crucial to managing resistance. Rotation of chemicals is also very important. Currently, in Virginia, effective control of CPB can be achieved with imidacloprid (*Admire*, *Provado*, *Gaucho seed piece-treatment*), abamectin (*Agri-Mek*), thiamethoxam (*Actara*, *Platinum*), and spinosad (*SpinTor). Bt tenebrionis* (*Novodor*, *Raven*) will control young larvae but not adults and large larvae. Endosulfan (*Thiodan, Phaser*) and cryolite (*Kryocide, Prokil cryolite*) are two older chemistries that are still effective against CPB but are not often used by growers. Imidacloprid is by far the most commonly used insecticide for CPB control.

Biological Control: "New Leaf" white potatoes are available and provide season-long control of CPB. These potatoes have been genetically altered to express *Bacillus thuringiensis tenebrionis* (Bt) protein that is toxic to CPB. The use of this control tactic has been limited by market acceptability of transgenic crops. Several natural enemies of CPB occur, including egg parasitoids, lady beetles, predatory bugs, and tachinid flies, but they do not normally provide sufficient control. The fungal pathogen *Beauveria bassiana* has been used for CPB control with moderate success. The pathogen is limited mostly by economics and incompatibilities with fungicides.

Cultural Control: Rotation to non-solanaceous crops - those other than potato, tomato, eggplant and pepper - is extremely important in reducing CPB problems. Also, physical distance between fields containing the previous year's solanaceous crop and the current crop is important for reducing CPB problems. The greater the distance between fields, the longer it takes for colony establishment and thus resistance development. Cultural manipulations such as application of straw mulch increases ground predators and causes decreased numbers of beetles. In addition, proper spray timing is important. For example, avoiding application of late-season sprays will also help prevent the buildup of insecticide-resistant beetles.

Cutworms
Black cutworm, *Agrotis ipsilon*
Variegated cutworm, *Peridroma saucia*

Cutworm larvae may be dull gray, brown, or black and may be striped or spotted, depending on species. Another distinguishing quality is their act of rolling into a tight C-shape if disturbed. The two major species attacking potatoes are the variegated cutworm, which feeds on lower leaves and petioles, and the black cutworm, which largely feeds at the soil surface and below on roots/tubers and lower stems, but will occasionally feed on leaves. Both feed at night and can be especially troublesome to tubers where soil cracking occurs. Typically, however, cutworms are not a major concern for potato producers in Virginia.

Monitoring: Cutworm larvae are present during July and August, although they are not typically seen in the open during the day. Digging the soil around injured plants may reveal their presence. If cutworms exceed six/plant or foliar loss is more than 10%, protective sprays should be applied.

Chemical Control: No materials (foliar and systemic) are effective if larvae are not feeding above ground. Several spray applications may be required for control. Insecticides are typically applied to foliage and the soil surface for control. See *Chemical Insect Control* for options.

Biological Control: No current recommendations for commercial production.

Cultural Control: No current recommendations for commercial production.

European Corn Borer, ***Ostrinia nubilalis***

The European corn borer (ECB) is an annual pest of potatoes, but seldom in populations damaging enough to sufficiently reduce yields in Virginia. ECB overwinters as a mature larva inside stems of numerous crops. They pupate in the spring, emerge as moths, and mate. Following mating, females lay between 500 and 600 eggs in small scale-like masses on the undersides of leaves. As eggs develop, they change color from clear to white to pale yellow to a "blackhead" stage before hatching. After hatch, ECB larvae feed initially on leaf tissue, then bore into potato stems. Stalk tunneling weakens stems and allows the entrance of bacterial and fungal pathogens, causing the stems to further weaken and collapse. Tubers may also be of poor quality or may rot in the presence of disease organisms. Three to four generations of ECB occur each year in Virginia.

Monitoring: Moth activity and relative abundance can be monitored with blacklight or pheromone traps. Eggs can be sampled by visual examination of foliage, but this is a time-consuming and difficult task. In addition, timing is critical because eggs can hatch in 3 to 5 days. Close attention must therefore be paid to the presence of moths at traps. Treatments should typically be applied 7-10 days after moth flight.

Chemical Control: Proper timing of ECB sprays is critical because most insecticides are effective only during the 2- to 3-day period between egg hatch and when larvae bore into stems. Apply the first spray when 10% of the stems have entry holes in fresh market varieties or 25% in processing varieties. Make 2-3 applications on a 5- to 10-day schedule. See *Chemical Insect Control* section for insecticide options. If a pyrethroid (*Ambush 2EC, Asana XL, Baythroid 2E, Pounce3.2EC*) is used for ECB control, make first application when 8-10 ECB moths are being trapped in local pheromone or blacklight traps. Apply 2-3 additional applications at 5- to 7-day intervals, based on moth activity.

Biological Control: Many natural enemies of the ECB occur, including lady beetles, minute pirate bugs, parasitoids, and insect pathogens. However, these natural enemies do not provide adequate commercial control of ECB.

Cultural Control: Avoid planting potatoes in fields that have been rotated to corn. If this is impossible, then cut corn stubble as short as possible and shred stalk material. Mowing grasses and weeds will help drive moths away from fields.

Potato Flea Beetle, ***Epitrix cucumeris***

Flea beetles are not of particular concern to potato producers in Virginia. However, if present, they can be devastating, particularly to young plants. These pests may also transmit early blight and bacterial ring rot as they chew plant leaves. Adult flea beetles overwinter in the soil and emerge in the early spring to feed on a variety of crops. Feeding on potato leaves, in the spring, typically results in small round holes. Female adults lay eggs on the soil near the plant

base. Larvae hatch in about a week and burrow into the soil, where they feed on roots for 2-3 weeks, then pupate and emerge from the soil as adults. There are approximately two generations per year in Virginia.

Monitoring: Because the beetles are small, mobile, and feed on the undersides of leaves, sampling for leaf damage is the preferred method. No economic thresholds have been developed.

Chemical Control: Insecticide applications for Colorado potato beetle or potato leafhopper usually control this pest. See *Chemical Insect Control* section.

Biological Control: No effective natural enemies.

Cultural Control: Cultural practices function as a first line of defense against flea beetle infestations. These include: removal/destruction of plant trash or culled potatoes, weed control, and late planting. Plowing after harvest in the fall will serve to remove crop debris and also control weeds.

Potato Leafhopper, *Empoasca fabae*

After the CPB, potato leafhopper (PLH) is probably the second most serious insect pest for potato producers in Virginia. Both PLH nymphs and adults feed by piercing the undersides of leaves and sucking out the plant sap. These pests also contain a toxin in their saliva that damages photosynthetic tissue and affects the plant?s ability to produce food. Initially, leafhopper feeding results in stippling of the leaf surface followed by rolling and yellowing of leaves and, in severe cases, leaf or plant death. Yield losses may be high with large PLH populations. Damage is typically worse in dry years.

Monitoring: Sampling for PLH is usually done via visual examination of leaves or by sweep net. Monitor fields for potato leafhoppers from early June until early August. Treatment is suggested if leafhopper counts exceed one adult per sweep or one nymph per ten leaves.

Chemical Control: See *Chemical Insect Control* section for specific recommendations.

Biological Control: Although several natural enemies of PLH occur, their impact on populations is minimal.

Cultural Control: Glandular-haired varieties of potatoes are available that are resistant to PLH.

Potato Tuberworm, *Phthorimaea operculella*

Historically the potato tuberworm has been a severe pest in potatoes planted in the fall, but in recent years it has not been a problem in Virginia. Tuberworms overwinter as larvae or pupae in the soil or in potatoes that are not subjected to freezing temperatures. Five generations can occur in Virginia. Moths emerge in the spring, mate, and then the females lay their eggs either on rough surfaces around potato eyes or on the lower leaf surfaces. Larvae hatch, feed, and mature in 7-10 days under ideal summer conditions or longer under cooler temperatures. The tuberworm larvae can cause damage by mining the leaves and by boring into the tubers of potato. Foliage infestations result in gray, papery blotches, which become brownish and brittle and are usually concentrated on older, lower leaves. Tuber feeding renders the potatoes completely unmarketable. Larvae moving from the foliage access the tubers when they are near the surface of the ground by moving through cracks in the soil or shortly after they have been dug and are exposed to the air. As tuberworms feed they tunnel through the potato, leaving behind excrement and webbing on which disease-causing fungi may grow and cause further problems.

Monitoring: Pheromone traps are effective for monitoring moth activity.

Chemical Control: See *Chemical Insect Control* section for recommendations.

Biological Control: A number of parasitoids attack the eggs and larvae. Predators are less important.

Cultural Control: Cultural practices are usually effective in controlling tuberworms if done in a timely manner. Some of

these include destroying cull potatoes, cultivating or irrigating to prevent deep cracks in the soil, keeping adequate soil coverage on the potatoes, harvesting potatoes soon after maturing, and removing them from the field immediately. After harvesting the potatoes, store them at the proper temperature and screen the storage areas for egg-laying moths. Also, avoiding planting of infested seed pieces, covering newly dug potatoes with vines, and leaving piles of potatoes out overnight when egg-laying moths are active will help to further protect against tuberworm infestations.[3]

Wireworms
Corn Wireworm, *Melanotus communis*
Tobacco wireworm, *Conoderus vespertinus*

In Virginia, wireworms are the third largest pest problem for growers. Damage as a result of these insects typically occurs in fields or crop rotations favoring their development. Potatoes planted in weedy fallow fields or following potatoes, corn, and small grain cover crops are especially at risk. The two most common species attacking potatoes in Virginia include the corn wireworm and tobacco wireworm. Wireworm lifecycles are variable. Some species can spend from 3 to 6 years as larvae in the soil. Adults, otherwise known as click beetles, are active in mid- to late summer and lay their eggs in the soil among the roots of grasses. Larvae emerge and begin feeding on seed pieces, roots, and developing shoots. Larvae burrow deep in the soil when temperatures drop below 50°F and surface again in the spring after soils warm. Full development can take up to six years. Wireworm feeding holes can make plants more susceptible to fungal infection and other diseases.

Monitoring: Wireworms can be monitored in the spring or fall by sampling the soil with a shovel or auger and sifting for larvae, or by baiting. Baits consist of corn and wheat buried a few inches in the soil and covered with black plastic. After two weeks, the baits are examined for presence of larvae. Sampling is used for determining presence or absence of the pest. If wireworms are detected, a control measure is recommended.

Chemical Control: See *Chemical Insect Control* section for recommendations.

Biological Control: No effective natural enemies occur.

Cultural Control: Cultural practices for wireworm control includes plowing, crop rotation, and planting in well-drained areas. Plowing helps to dry out the soil and also to destroy the pupal chambers, larvae, and adults. Crop rotation, especially with more tolerant plants, will help limit wireworm population buildup. In addition, wireworms seem to favor areas with high soil moisture, so planting into well-drained areas should reduce environmental suitability.

Chemical Insect Control

The list below contains products available to producers for insect control in white potatoes along with the recommended application rates. Use estimates are also included based on anecdotal data.[4]

- **abamectin (***Agri-Mek* 0.15EC**)** - PHI-14 days. Avermectin. Apply at a rate of 0.01-0.02 lb. a.i./A for control of CPB. Do **NOT** exceed 0.04 total a.i./A/season. Do **NOT** make more than two sequential applications. REI-12 hours. Used on 5% of acreage for control of CPB.
- **azadirachtin (***Aza-Direct***,** *Azatin***,** *Ecozin***,** *Neemix***)** - PHI-0 days. Botanical. Apply at a rate of 0.02-0.04 lb. a.i./A when CPB first appear and are in their early larval stages. REI - 12 hours. Used on <1% of acreage for control of CPB.
- **azinphos-methyl (***Guthion* 2L**)** - PHI-7 days. Organophosphate. Apply at a rate of 0.38 lb. a.i./A for control of CPB. Apply at a rate of 0.50 lb. a.i./A for ECP and potato tuberworm control and 0.50-0.75 lb. a.i./A for control of flea beetles and leafhoppers. REI - 5 days. *Not currently used in Virginia.*
- ***Bacillus thuringiensis* (various formulations) -** PHI-0 days. Microbial. *Bt tenebrionis* formulations effective ONLY on small CPB larvae. Make first application when eggs begin to hatch and repeat applications at 5- to 7-day intervals if small larvae are present. If rainfall occurs within 24 hours post-treatment, reapplication may be necessary. REI - 4 days. Used on 5% of acreage for control of CPB.

carbaryl (*Sevin* 80S**,** *Sevin Bait***)** - PHI-0 days. Carbamate. Apply at a rate of 2.0 lb. a.i./A for control of cutworms. REI - 12 hours. Used on <1% of acreage for control of cutworms.

- **carbofuran (***Furadan* 4F**)** - PHI-14 days. Carbamate. Apply at a rate of 0.5-1.0 lb. a.i./A for control of ECB. Do **NOT** exceed eight applications per acre per season. REI - 48 hours. Used on 10% of acreage for control of ECB.
- **cryolite (***Kryocide***,** *Prokil cryolite***)** - PHI-0 days. Inorganic fluorine. Apply at a rate of 9.6-11.5 lb. a.i./A for CPB control. Do **NOT** apply more than 92 lbs. a.i./A/season. A copy of the label must be in the possession of user at time of application. REI - 12 hours. *Not currently used in Virginia.*
- **cyfluthrin (***Baythroid* 2E**)** - PHI-0 days. Pyrethroid. Apply at a rate 0.01-0.04 lb. a.i./A for control of flea beetles and leafhoppers, a rate of 0.01-0.03 for control of cutworms, a rate of 0.02-0.04 for control of potato tuberworm, and a rate of 0.03-0.04 lb. a.i./A for control of ECB. Do **NOT** exceed 0.26 total lb. a.i./A/season. REI - 12 hours. Used on 12% of acreage for control of PLH, ECB, and flea beetles.
- **diazinon (***Diazinon* 14G**)** - PHI-at plant. Organophosphate. For control of wireworm, broadcast and incorporate into soil just before planting at a rate of 3.0-4.0 lb. a.i./A. REI - 12/24 hours. Used on 15% of acreage for control of wireworms.
- **dimethoate (***Dimethoat*e 4EC**)** - PHI-0 days. Organophosphate. Apply at a rate of 0.25-0.5 lb. a.i./A for POA, GPA and leafhopper control. REI - 48 hours. Used on 40% of acreage for control of PLH.
- **disulfoton (***Di-Syston* 15G**)** - PHI-75 days. Organophosphate. For control of wireworm, flea beetles, and leafhoppers, broadcast at a rate of 2.0-3.1 lb. a.i./A and work into soil 2-3 inches or apply a similar rate at planting. If needed, an additional application may be sidedressed after plants become established. Do **NOT** make more than 2 applications per season (in-furrow or broadcast pre-plant and a sidedress). REI - 48 hours. Used on 10% of acreage for control of wireworm.
- **endosulfan (***Thiodan* 3EC, *Phaser***)** - PHI-1 day. Cyclodiene. Apply at a rate of 0.5-1.0 lb. a.i./A for control of CPB, flea beetles, and leafhoppers and at a rate of 0.5-1.0 lb. a.i./A for control of POA and GPA. Do **NOT** apply more than six times per season. Do **NOT** exceed 12.0 lb. a.i./A/season. REI - 48 hours. *Not currently used in Virginia.*
- **esfenvalerate (***Asana* XL 0.66EC**)** - PHI-7 days. Pyrethroid. Apply at a rate of 0.03-0.05 lb. a.i./A for control of cutworms, ECB, flea beetles, leafhoppers, and potato tuberworm. Do **NOT** exceed 0.35 lb. a.i./A/season. REI - 12 hours. Used on 10% of acreage.
- **ethroprop (***Mocap* 10G**)** - PHI-at plant. Organophosphate. Broadcast and incorporate just before planting at a rate of 4.0-6.0 lb. a.i./A or apply at planting at a rate of 3.0 lb. a.i./A for wireworm control. REI - 48 hours. Used on 20% of acreage for control of wireworms.
- **imidacloprid (***Gaucho seed-piece treatment, Admire* 2FS**)** - PHI-at plant. **(***Provado* 1.6F**)** - PHI-7 days. Chloronicotinyl. Apply *Admire* 2FS at a rate of 0.01-0.02 lb. a.i./1,000 row ft. pre-plant or at planting for control of CPB, POA, GPA, melon aphid, flea beetles, and leafhoppers. Apply *Provado* 1.6F at a rate of 0.05 lb. a.i./A for control of CPB, PLH, POA, GPA, and melon aphid ONLY IF *Admire* 2F was NOT used at planting. Do **NOT** exceed 0.31 lbs. a.i./A/year, regardless of application method or formulation. For crops not on the label, a 12-month plant-back interval must be observed. REI - 12 hours. Used on 90% of the acreage.
- **methamidophos (***Monitor* 4EC**)** - PHI-14 days. Organophosphate. Apply at a rate of 0.75-1.0 lb. a.i./A for control of ECB, POA, and GPA and at 0.50-0.75 lb. a.i./A for control of potato tuberworm. REI - 48 hours. Used on >1% of acreage for control of ECB.
- **methomyl (***Lannate* LV**)** - PHI-6 days. Organophosphate. Apply at a rate of 0.45-0.90 lb. a.i./A for control of cutworms, POA, GPA, melon aphid, potato tuberworm, flea beetles, and leafhoppers. REI - 48 hours. Used on 5% of acreage.
- **methyl parathion (***Penncap*-M 2FM**)** - PHI-5 days. Organophosphate. Apply at a rate of 0.5-1.0 lb. a.i./A for control of ECB. REI - 48 hours. Used on <1% of acreage.
- **oxamyl (***Vydate* L 2L**)** - PHI-7 days. Carbamate. Apply at a rate of 0.25-1.0 lb. a.i./A for control of CPB, wireworms, flea

beetles, and leafhoppers and at a rate of 0.5-1.0 lb. a.i./A for control of POA and GPA. REI - 48 hours. Used on 5% of acreage.

- **permethrin (***Ambush* 2EC**,** *Pounce* 3.2EC**)** - PHI-7 days. Pyrethroid. Apply *Ambush* 2EC at a rate of 0.05-0.20 lb. a.i./A and *Pounce* 3.2EC at a rate of 0.1-0.2 lb. a.i./A for control of cutworms (*Pounce* 3.2EC ONLY), POA, GPA, potato tuberworm, flea beetles, and leafhoppers. REI - 24 hours. Used on 30% off acreage for control of PLH and ECB.
- **phorate (***Thimet* 15G**)** - PHI-90 days. Organophosphate. Apply 2.25 lb. a.i./1,000 ft of row at planting for control of wireworm. REI - 48 hours. Used on 10% of acreage for control of wireworms.
- **phosmet (***Imidan* 50WP**)** - PHI-7 days. Organophosphate. Apply at a rate of 1.0 lb. a.i./A for control of CPB, flea beetles, and leafhoppers. REI - 24 hours. Used on <1% of acreage.
- **pymetrozine (***Fulfill* 50WP**)** - PHI-14 days. Pyridine azomethine. Apply at a rate of 0.085 lb. a.i./A for control of POA, GPA, and melon aphid. Do **NOT** exceed 0.17 total lb. a.i./A/season. REI - 12 hours. Used on <1% of acreage for control of aphids.
- **spinosad (***SpinTor* 2SC**)** - PHI-7 days. Spinosyn. Apply at a rate of 0.05-0.09 lb. a.i./A for control of CPB and ECB. Do **NOT** apply more than 0.33 total lb. a.i./A/season. REI - 12 hours. Used on 5% of acreage.
- **thiamethoxam (***Platinum* 2SG, *Actara* 25WDG**)** - PHI-30 days. Chloronicotinoid. Apply at a rate of 0.079-0.125 lb. a.i./A for control of CPB, flea beetles, and aphids. Do **NOT** apply more than 0.125 lb. total lb. a.i./A/season. REI - 12 hours. Used on 15% of acreage.

Disease Pests

Control recommendations were taken from the 2002 Commercial Vegetable Production Recommendations--Virginia[5].

DISEASES[6]

Diseases affect potatoes within the field but are also a problem during storage and handling of the harvested crop. Each of the diseases listed below occurs within Virginia, depending primarily on weather conditions but also on a number of other factors such as field location, history of incidence, soil pH, etc. Good sanitation and management practices are key to a successful disease control program.

Air Pollution

Symptoms appear as tiny spots of brown tissue on the upper surface of leaves and a bronzing of the lower surfaces. There are a few varieties, such as *Kanona*, *Norland*, *Rad Lasoda*, *Red Norland*, and *Snowden*, which are particularly sensitive.

Bacterial Soft Rot, *Erwinia sp.*

There are several soft rot bacterial diseases that are important in potato production. They include aerial stem rot and blackleg (both affect the stem), and tuber soft rot (affects tubers). Aerial stem rot primarily invades natural openings, such as leaf scars. Stems and petioles appear brown and inky black, and eventually will cause the plant to wilt and die. Blackleg is initiated by contaminated seed pieces. In postemergence, the stems exhibit an inky black to light brown decay, eventually causing the plant to wilt and die. Soft rot tubers appear watery and mushy, and the diseased tissues have a cream/tan color with a black border separating it from healthy areas.

Monitoring: It is critical to know that moisture and temperature play two major roles in the initiation and development of diseases caused by *Erwinia* bacteria.

Chemical Control: A chlorine wash maintained at 25ppm is beneficial in controlling soft rot. Otherwise, no

commercially effective controls are available.

Biological Control: No commercially effective controls are available.

Cultural Control: Pesticides and resistant cultivars are not available for management of these diseases. It is important that a thorough sanitation program is implemented and clean, quality seed stock is planted. Handling the tubers during harvest and storage is also important. Prevent wounding, and make certain tubers are dry before packing.

Common Scab, *Streptomyces scabies*

Scab is commonly introduced by infected seed potatoes and will last indefinitely once the soil is contaminated. The bacterial-like organism is more prevalent in soils with a pH greater than 5.5. The disease affects tubers and displays no aboveground symptoms.

Monitoring: Make sure your seed potatoes are certified.

Chemical Control: Use *Polyram* seed treatment to reduce incidence.

Biological Control: No commercially effective controls are available.

Cultural Control: Since no single cultural control can prevent infection, it is important to implement several during a planting season. Plant scab-resistant varieties, maintain soil pH slightly below 5.5, and rotate with green cover crops (i. e., alfalfa, rye, and soybeans) for 3 to 4 years. Do not use other root crops such as carrots, beets, rutabaga, turnips, and radishes as they are susceptible to scab as well. Avoid using animal manure on potato crops, this raises the organic matter content in the soil providing a food source for the scab pathogen.

Early Blight, *Alternaria solani*

This foliar disease is caused by the fungus *Alternaria solani* and develops when the leaves of adjacent rows touch. This closeness provides optimum conditions of high humidity, leaf yellowing of lower leaves, and moderate canopy temperatures. Leaves are often killed, reducing yields, and tuber infections make the diseased potatoes unmarketable. The first symptoms appear as small circular spots (dry and papery in texture), changing from dark brown to black as they expand. Lesions first appear on the older, lower leaves, spreading to the younger leaves under favorable weather conditions. They are often characterized as having a ?target? appearance because of the concentric rings of raised and depressed necrotic tissue.

Monitoring: Scouting crops early is very important and increases the chance to identify a potential problem before it gets out of control. The area should be scouted for potential problem areas before the crop emerges. Once the plants emerge, they should be inspected on a weekly basis until harvest.

Chemical Control: Begin sprays in mid-June and continue every 7-10 days unless there are threats of late blight. Then begin sprays when plants are eight inches tall. Azoxystrobin (*Quadris*) is particularly effective on early blight-susceptible varieties. See the *Chemical Disease Control* section for recommendations.

Biological Control: No commercially effective controls are available.

Cultural Control: Choose cultivars that have high levels of disease resistance. This can reduce the amount of fungicide applications and the type of fungicide needed. Field selection also plays an important role. You should choose fields with good drainage and fertility to promote healthy plants. Rotating in other non-solanaceous crops, like cereals or legumes, for several years can minimize re-introduction of overwintering early blight. Other pest-related stresses might cause the crop to become susceptible and promote early blight infection, so it is important to monitor and minimize insect and weed infestations.

Fusarium Tuber Rot (dry rot), *Fusarium solani*

Dry rot is caused by the soilborne fungus *Fusarium solani* and usually infects tubers that are injured during harvesting. The infected tuber will show small light -tan to brown blemishes that eventually sink in and wrinkle, sometimes in concentric circles. The decaying tissue looks brown to black in color, and can remain dry and firm in cool temperatures or wet and soft in high temperatures. The fungus lasts a long time in the soil and survives as resistant spores or mycelium in decaying plant tissues. Dry rot develops most rapidly at a high relative humidity and atmoderate temperatures (55°-65°F).

Monitoring: No monitoring necessary.

Chemical Control: Use seed that is treated before storage with thiabendazole (*Mertect* 340F) at 1,500ppm.

Biological Control: No commercially effective controls are available.

Cultural Control: Dry rot can be managed with proper harvesting techniques and good storage procedures and facilities. Tubers should only be harvested after the vines are completely dead, usually 1-2 weeks. Machinery should also be operated as so to minimize wounds and bruising during the harvest.

Late Blight, *Phytophthora infestans*

Late blight is one of the most devastating diseases of potato crops worldwide. This foliar disease is most active during periods of cool, moist weather. Cool nights and warm days accompanied by fog or rain are ideal conditions for late blight. Symptoms usually appear 3-5 days after infection as small, pale green, water-soaked spots on the leaf tips or edges of lower leaves. The lesions with a yellowish green border quickly enlarge, turning a brownish black color. Fungicides cannot be used alone for effective control of late blight, but must be used as one tool in an integrated management strategy. Cultural practices are the first line of defense, and forecasting techniques and proper application technology is essential for efficient, targeted applications of fungicides.

Monitoring: Scouting crops early is very important and increases the chance to identify a potential problem before it gets out of control. The area should be scouted for potential problem areas before the crop emerges. Once the plants emerge, they should be inspected on a weekly basis until harvest.

Chemical Control: All fungicides should be used as protectants, that is, before late blight is established. Attempting to use any fungicide to eradicate the disease after it is well established promotes the selection and spread of new resistance. Begin fungicide applications when plants are six inches tall and repeat every seven days, or apply fungicides according to a disease-forecasting system. Protective fungicides, such as, chlorothalonil, mancozeb, or *Polyram*, should be applied early in the season before the occurrence of any disease in the region. Dimethomorph (*Acrobat MZ*), cymoxanil (*Curzate*), mancozeb (*Gavel*), propamocarb hydrochloride (*Previcur Flex*), and azoxystrobin (*Quadris*) can be used when the threat of the disease is present and protectant fungicides have been used before disease occurrence. See the *Chemical Disease Control* section for recommendations.

Biological Control: No commercially effective controls are available.

Cultural Control: Choose cultivars that have high levels of disease resistance. This can reduce the amount of fungicide applications and the type of fungicide needed. Field selection also plays an important role. You should choose fields with good drainage and fertility to promote healthy plants. Rotating in other non-solanaceous crops, like cereals or legumes, for several years can minimize re-introduction of overwintering disease. Other pest-related stresses might cause the crop to become susceptible and promote early blight infection, so it is important to monitor and minimize insect and weed infestations. When a field contains new late-blight infections and harvest is near, vines should be killed immediately to help prevent tuber infection. Be sure tops are entirely dead before digging.

Leak (*Pythium*) and Pink Rot (*Phytophthora*)

Pythium leak and pink rot, sometimes collectively called water rot, are diseases caused by soilborne pathogens. These diseases are usually associated with excessive precipitation or irrigation either early or late in the season, especially on poorly drained soil. Leak usually enters the tubers through bruises occurring in conjunction with the harvesting of

immature tubers during warm weather. The disease begins with a discolored, water-soaked area, and a dark line binds the advancing margins. In advanced infections, hollow cavities form, and all that remains are tuber shells with thin, papery skins. Pink rot generally occurs in poorly drained areas and usually infects tubers before harvest. Symptoms can include brown or black roots and in serious cases can cause leaf chlorosis, wilting, and plant death.

Monitoring: Nitrogen levels in the soil should be monitored to avoid stimulating excessive vegetative growth, as soils tend to remain wetter under a heavy plant canopy, especially under humid conditions.

Chemical Control: Apply a fungicide (see *Chemical Disease Control* section) with as much gallonage as possible. Make three applications of one of the fungicides. The first application should be made at flowering, and the second and third applications should occur 14 and 28 days later. Be sure to get some coverage of the soil surrounding the plants for root uptake to occur.

Biological Control: No commercially effective controls are available.

Cultural Control: For leak, do crop rotation with cereals or grasses for 2-3 years, avoid over-watering near harvest, allow tubers to mature completely, and minimize bruising the tubers. For pink rot, crop rotation is important. Avoid long saturation times during irrigation, allow good drainage in your field, and do not harvest the tubers if they are wet. During storage, maintain cool temperatures, as the fungus becomes inactive below 40°F.

Verticillium Wilt, *Verticillium dahliae and V. alboatrum*

Verticillium wilt, also know as potato early dying, is a disease caused by *Verticillium*, a soilborne fungus. The fungus can persist in the soil for a long period of time. Symptoms may be hard to distinguish from other diseases. Foliar symptoms appear as uneven chlorosis with some wilting of the lower leaves, usually affecting leaflets on only one side of the petiole or leaves on only one side of the stem.

Monitoring: No monitoring necessary.

Chemical Control: Apply metam-sodium (*Busan* or *Vapam HL*) through center-pivot irrigation in the fall to fallow fields. See *Chemical Disease Control* section for recommendations.

Biological Control: No commercially effective controls are available.

Cultural Control: Plant tolerant cultivars whenever possible, do crop rotation with cereals or grasses for 2-3 years, and select fields with a low incidence of wilt. The use of sudangrass in rotation with potato and the use of ethoprop (*Mocap* 10G) will reduce lesion nematode levels in the soil, resulting in less Verticillium wilt.

White Mold, *Sclerotinia sclerotiorum*

White mold, also known as Sclerotinia stalk rot, is a disease caused by *Sclerotinia sclerotiorum*, a soilborne fungus.

Monitoring: No monitoring necessary.

Chemical Control: Before row closing, immediately apply iprodione (*Rovral* 50WP) and repeat 28 days later. See *Chemical Disease Control* section for recommendations.

Biological Control: No commercially effective controls are available.

Cultural Control: Foliar fungicides, crop rotation with cereals or grasses for four or more years, closer irrigation management, and modification of the crop's micro-environment are some ways to limit white mold.

Chemical Disease Control

The list below contains all of the products available for disease control in potatoes along with the recommended application rates of these chemicals based on the current labels[7].

- **azoxystrobin** (*Quadris* 2.1F) - PHI - 14 days. Strobilurins. For control of early blight, apply at a rate of 0.10-0.20 lb. a.i./A. For control of late blight, apply at a rate of 0.20-0.25 lb. a.i./A and only if protectant fungicides have been used before disease occurrence. Do **NOT** make more than 6 applications of *Quadris* flowable per acre per year for all diseases. REI - 4 hours.
- **chlorothalonil** (*Bravo, Echo, Equus*) - PHI - 0 days. Substituted aromatics. For control of early blight and late blight, apply at a rate of 0.75-1.13 lbs. a.i./A. REI - 12 hours. Apply *Bravo Zn* for control of early blight at a rate of 0.75-1.10 lbs. a.i./A. REI - 48 hours.
- **copper, fixed** (various formulations) - Inorganic. PHI - 0 days. For control of early blight, apply at a rate of 0.92 lb. a.i./A. REI - 24 hours.
- **cymoxanil** (*Curzate* 60DF) - PHI - 14 days. Acetamides. For control of late blight, apply at a rate of 0.02 lbs. a.i./A (use only in combination with a protectant fungicide; e.g., chlorothalonil or mancozeb). REI - 12 hours.
- **dimethomorph** (*Acrobat* MZ 60WP) - PHI - 14 days. Morpholines. For control of late blight, apply at a rate of 1.6 lb. a.i./A and only if protectant fungicides have been used before disease occurrence. Do **NOT** make more than 5 applications in any one season. REI - 24 hours.
- **iprodione** (*Rovral* 50WP) - PHI - 14 days. Dicarboximides. For the control of white mold, apply at a rate of 1.0 lb. a.i./A immediately before row closing, and repeat 28 days later. Apply at a rate of 0.5-1.0 lb. a.i./A for control of early blight. Do **NOT** irrigate for 24 hours after application. A maximum of 4 applications can be made per season. REI - 12 hours.
- **mancozeb** (*Dithane, Manex II, Manzate, Penncozeb*) - PHI - 14 days. Dithiocarbamates. For control of early blight, apply at a rate of 1.2-1.6 lbs. a.i./A and apply at a rate of 1.13-1.50 lb. a.i./A for control of late blight. Do **NOT** apply more than a total of 14 pounds of mancozeb or *Polyram* per acre per crop. REI - 12,24 hours. (*Gavel*) - PHI ?14 days. For control of late blight, apply at a rate of 1.13-1.50 lb. a.i./A and only if protectant fungicides have been used before disease occurrence. Do **NOT** make more than 6 applications or apply more than 12 lbs. in one season. REI - 48 hours.
- **mefenoxam/chlorothalonil** (*Ridomil Gold Bravo, Fluoronil*) - PHI - 7 days. Phenylamides. For control of leak and/or pink rot, apply a rate of 1.52 lb. a.i./A. REI - 48 hours.
- **metam-sodium** (*Busan, Vapam* HL) - PHI - N/A Dithiocarbamates. For the control of verticullium wilt, apply the fungicide through center-pivot irrigation in the fall to fallow fields at a rate of 158 lb. a.i./A. REI - 48 hours.
- **metiram** (*Polyram* 80DF) - PHI - 14 days. Dithiocarbamates. For the control of early blight and/or late blight, apply at a rate of 1.6 lb. a.i./A. Do **NOT** apply more than a total of 14 pounds of mancozeb or *Polyram* per acre per crop. REI - 24 hours.
- **propamocarb hydrochloride** (*Previcur Flex*) - PHI - 14 days. For the control of late blight, apply at a rate of 0.50-0.70-0.90 lbs. a.i./A. Rates listed in order for low-medium-high disease risk situations. Use only in combination with a protectant fungicide; e.g., chlorothalonil or mancozeb. REI - 12 hours.
- **triphenyltin hydroxide** (*Super Tin* 4L) - PHI - 21 days. Organotins. For the control of early blight, apply at a rate of 0.20 lb. a.i./A *plus* mancozeb (*Dithane, Manax II, Manzate, Penncozeb*) at a rate of 1.60 lb. a.i./A. REI - 24, 48 hours.

Nematode Pests

Control recommendations were taken from 2002 Commercial Vegetable Production Recommendations--Virginia[8]

NEMATODES[9]

Root-knot nematodes (*Meloidogyne incognita*), root-lesion nematodes (*Pratylenchus penetrans*), stubby-root nematodes (*Paratrichodorus minori*), and sting nematodes (*Belonolaimus longicaudatus*) are the most common species of nematodes affecting potatoes in Virginia. Symptoms and damage can mimic other diseases and pests, making identification nearly impossible to determine on site. Soil and root samples should be collected and analyzed by an expert for determination.

Monitoring: Both diagnostic and predictive nematode assay programs in Virginia provide data to producers on the numbers and kinds of nematodes in soil along with recommendations for control. Soil samples for diagnostic assays are processed without charge to determine the cause of production problems during the growing season. Predictive nematode assays are done on samples collected after harvest. These samples are processed at a cost of $11 per sample and must be collected in the fall no later than November 20.

Chemical Control: When using soil fumigation, it is important that the fields be sufficiently prepared for planting. All crop debris and clods should be removed, and soil moisture should be adequate. Otherwise, soil fumigation will not be effective due to lack of penetration of all soil particles by the gaseous fumigant. It is also necessary to allow an aeration period between fumigant applications and planting; otherwise, crop injury will occur. For recommendations, see the *Chemical Nematode Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: Sanitation and good cultural practices are the best preventative measures against nematodes. Examples include obtaining nematode-free roots and washing soil from machinery and tools before using them at different locations. Crop rotation with non-host crops to lower their population size is highly recommended in the event of nematode activity.

Chemical Nematode Control

Several chemicals are currently available for nematode control, although this may change in the next few years. Currently, the multipurpose soil fumigants chloropicrin, metam sodium *(Busan, Nemasol, Vapam HL*), and methyl bromide (*Terr-O-Gas 67, MC-33*) are recommended for use in Virginia. In addition, dichloropropene (*Telone II*), chloropicrin + dichloropropene (*Telone C-17, Telone C-35*) are soil fumigants used only for nematodes. The non-fumigant nematicide ethoprop (*Mocap* 10G) is also recommended for use in potatoes. Of the possible chemical controls, producers in Virginia chose *Mocap* most often when dealing with problem areas. Typically, chemical controls are used only when cultural practices are unable to provide adequate control. However, these chemicals are still important tools when other methods of control have failed.

Weed Pests

Control recommendations were taken from 2002 Commercial Vegetable Production Recommendations--Virginia[10].

WEEDS

The herbicides currently labeled for weed control in potato work on annual grasses, yellow nutsedge, and certain broadleaf weeds. However, producers in Virginia are faced with a multitude of additional broadleaf weed problems including common ragweed, common lambsquaters, and jimsonweed. If not controlled, weeds can greatly reduce root quality and may interfere with the harvest.

Monitoring: Proper weed identification is an important part of effective weed control. Weeds observed in previous crops within a given field should be noted to aid in future herbicide decisions. Fields should initially be scouted within a month of potato emergence to evaluate preplant incorporated and preemergent herbicide effectiveness. Depending on the

weeds found, it is possible that cultivation, a postemergent herbicide, or both may be required. Fields should be scouted again before vine kill to map out weed species and to plan weed control for the next crop.

Chemical Control: To provide additional pest control, a Special Local Need (24C) label has been approved, in Virginia for the postharvest use of paraquat (*Gramoxone Max* 3SC). Recommended rates can be found in *Chemical Weed Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: Cultivation may be used to control weeds during early stages of growth, but has several disadvantages. Direct damage to the potato roots and indirect damage due to increased soil compaction can occur, and it is not very effective in wet soils where some weed species can re-root very easily. Despite these disadvantages, cultivation can play an important role if done properly. Crop rotation is also important to prevent domination of any one weed species year after year. Also, avoiding fields with a history of severe weed infestations may be an appropriate action.

Chemical Weed Control

The list below contains all of the fully labeled products available to producers for weed control in white potatoes. Use estimates are also included based on anecdotal data[11].

- **clethodim** (*Select* 2EC): PHI - 30 days. Cyclohexanediones. Apply at a rate of 0.094-0.125 lb. a.i./A with oil concentrate to be 1% of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. *Select* 2EC will not consistently control goosegrass. The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do **NOT** tank-mix with or apply within 2 or 3 days of any other pesticides unless labeled, as the risk of crop injury may be increased or reduced control of grasses may result. REI - 24 hours. Estimated acres treated - 1%.
- **EPTC** (*Eptam* 7E): PHI - 45 days. Thiocarbamates. Apply 3.0-4.5 lb. a.i./A just before planting and disking. This treatment is best for early-season control of nutsedge and other weeds, but on plantings before April 1, it may reduce early vigor and yields slightly. Incorporate into soil in one or two cultivations with a spiketooth harrow or similar piece of equipment. Apply the same amount just before first or second cultivation. This treatment is best for late-season control of nutsedge and other weeds. Primarily controls annual grasses, yellow nutsedge, and a few broadleaf weeds. Use linuron or metribuzin according to recommendations after planting to increase the spectrum of broadleaf weeds controlled. REI - 12 hours. Estimated acres treated - 2%.
- **glyphosate** (*Roundup Ultra Max* 4SC, *Touchdown, Glyphomax Plus*): Phosphono amino acids. Apply 1.50-3.75 lb. acid equivalent/A in the fall after harvest to control perennial grasses and broadleaf weeds, including quack-grass, field bindweed, Canada thistle, and others. Delay application after harvest to allow for adequate weed re-growth to intercept the spray. Apply before frost to weeds with cold-sensitive foliage. Do **NOT** till or mow for 1 week after application. Consult the label for additional details and the rate to use for each weed species. REI - 4-12 hours. Estimated acres treated - no in-crop applications.
- **linuron** (*Lorox* 50DF): PHI - apply before potato emergence. Ureas. Apply 0.40-1.0 lb. a.i./A after planting or before potatoes emerge, but after final drag-off and before grasses are 2 inches tall and broadleaf weeds are six inches tall. Primarily controls broadleaf weeds. Tank-mix with *Dual Magnum* or *Prowl*, or use in addition to *Eptam* for preemergence annual grass control. Use lower rates if tank-mixed. Do **NOT** plant to crops not on the label for 4 months after treatment. REI - 24 hours. Estimated acres treated - 5%.
- **metribuzin** (*Sencor/Lexone*75DF): PHI - 60 days. Triazinones. Apply 0.38-0.50 lb. a.i./A just before emergence. If drag-off is practiced, then the application should be made after drag-off. Primarily controls broadleaf weeds. Tank-mix with *Dual*

Magnum or *Prowl*, or use in addition to *Eptam* for pre-emergence annual grass control. Read label for rotation crop restrictions. NOTE: Pre-emergence application to Atlantic and Norland or to any early maturing, smooth, white- or red-skinned potato varieties may cause crop injury, especially under adverse weather conditions and when higher labeled rates are used. REI - 12 hours

- (*Lexone/Sencor* 75DF): PHI - 60 days. Apply 0.25-0.50 lb. a.i./A before weeds are 1 inch tall. Primarily controls broadleaf weeds. Apply only if there have been at least three successive sunny days before application. Do **NOT** use on red-skinned or early maturing, smooth, white-skinned varieties. Treatment may cause some yellowing or minor burn. Read label for soil texture, crop rotation, and variety restrictions. REI - 24 hours. Estimated acres treated - 95%.
- **paraquat** (*Gramoxone Max* 3SC): PHI - 3 days. Bipyridyliums. Apply at a rate of 0.60 lb. a.i./A as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings. REI - 24 hours. Estimated acres treated - 1%.
- **pendimethalin** (*Prowl* 4EC): PHI - 60 days. Dinitroanilines. Apply 0.50-1.5 lb. a.i./A before potatoes emerge. *Prowl* primarily controls certain broadleaf weeds, including velvetleaf and early-season annual grasses, but does not control yellow nutsedge. Combine with *Lorox* to improve velvetleaf control, or with linuron or metribuzin to improve the control of most other broadleaf weeds. REI - 24 hours. Estimated acres treated - 1%.
- **rimsulfuron** (*Matrix* 25DF): PHI - 60 days. Sulfonylureas. Apply at a rate of 0.02 lb. a.i./A early postemergence to control many weeds, including foxtail species, pigweed species, wild mustard, and wild radish. Common lambsquarter, common ragweed, jimsonweed, morningglory species, and yellow nutsedge may only be suppressed. Tank-mix with reduced rates of metribuzin, following label instructions, to increase the spectrum of weeds controlled. Repeat the application 2 to 4 weeks after the initial spray to improve the suppression or control of common purslane and perennial weeds, such as field and hedge bindweed. Results may be most effective when used following a pre-emergence residual weed-control program. Add nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) to improve weed control. Do **NOT** exceed 2 ounces of *Matrix* 25DF per acre per year. Rimsulfuron, an ALS inhibitor, blocks acetolactate synthase, effecting cell division at the root tips. Herbicides in this class have a single site of action in susceptible plants. Always use in combination with other herbicides with a different site of action in the plant to prevent the development of resistant weed populations. Read and follow label cautions and resistance management recommendations. REI - 4 hours. Estimated acres treated - 15%.
- **sethoxydim** (*Poast* 1.5EC): PHI - 30 days. Cyclohexanediones Apply at a rate of 0.20-0.40 lb. a.i./A with oil concentrate to be 1% of the spray solution postemergence to control annual grasses and certain perennial grasses. The use of oil concentrates may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do **NOT** tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 5 pints per acre in one season. REI - 12 hours. Estimated acres treated - 5%.
- **s -metolachlor** (*Dual Magnum* 7.62E or *Dual II Magnum* 7.64E): PHI - 40 days. Chloroacetamides. Apply 0.96-1.91 lb. a.i./A *Dual Magnum* or *Dual II Magnum* before potatoes emerge, but after final drag-off. Primarily controls annual grasses. Nutsedge (nutgrass, coffeegrass) control may be adequate if weed pressure is light. Tank-mix *Dual Magnum* with linuron or metribuzin for broadleaf control. Apply 1.60 lb. a.i./A *Dual Magnum* as a directed spray after hilling/at lay-by to provide pre-emergence control of sensitive weeds for the remainder of the growing season. Emerged weeds will not be controlled. This treatment may be applied in addition to a previous (drag-off) application of *Dual Magnum* or *Dual II Magnum*, but do **NOT** apply more than 3.6 pints *Dual Magnum* per acre in one season. REI - 24 hours. Estimated acres treated - 95%.

Table 1: Effectiveness of herbicides recommended for weed control in potatoes.[12]

Herbicide	Barnyardgrass	Crabgrass, Large	Fall Panicum	Foxtail sp.	Goosegrass	Johnsongrass (Seedlings)	Yellow Nutsedge	Carpetweed	Cocklebur, Common	Cranesbill	Galinsoga, Hairy	Jimsonweed	Lambsquarters, Common	Morningglory sp.	Shepherdspurse	Pigweed sp.	Purslane, Common	Ragweed, Common	Smartweed, Pennsylvania	Nightshade, Eastern Black	Velvetleaf
Preplant or Preplant Incorporated																					
Eptam	G	G	G	G	G	G	G	G	P	G	N	P	F	F	-	G	G	P	P	F/G	F/G
Preemergence or Preplant Incorporated																					
Dual Magnum	G	G	G	G	G	G	F/G	F	N	-	G	N	P	N	-	G	F/G	N	P	G	P
Lorox	F	P/F	P	F	P/F	-	N	G	P	-	G	P/F	G	P	F	G	G	F	G	G	P
Prowl	G	G	G	G	-	G	N	G	N	-	N	N	F/G	P	N	F/G	F/G	N	F	P	G
Sencor	F	F	F	F	F	-	N	G	F	-	G	F/G	G	F/P	-	F/G	F	G	G	P	G
Postemergence																					
Matrix	G	P/F	F/G	G	P	-	F	-	F/G	-	G	F	F	F	G	G	F/G	P	P/F	P	F
Poast	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Select	G	G	G	G	P	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Sencor/Lexone	F	F	F	F	F	-	-	G	-	-	G	G	G	P	G	G	G	G	F	P	P/F

Herbicide performance is affected by weather, soil type, herbicide rates, weed pressure, and other factors. These ratings indicate ONLY relative effectiveness in tests conducted by the University of Delaware, University of Maryland System, The Pennsylvania State University, Rutgers, The State University of New Jersey, and Virginia Polytechnic Institute and State University. Actual performance may be better or worse than indicated in this chart.

G = good **F = fair** **P = poor** **N = no control** **- = insufficient data**

VINE KILLING and STORAGE[13]

Vine Killing:

Vine killing before harvest is a common practice in several Mid-Atlantic potato-producing states. However, in Virginia, potatoes are often dug while the vines are still green. If desiccation is necessary, the following are labeled for use in Virginia:

- **diquat** (Diquat 2SC) - PHI - 7 days. Bipyridyliums. Apply at a rate of 0.25 lb. a.i./A in 20-100 gallons of water. Add a nonionic surfactant to be 0.25% of the spray solution. Repeat after 5 days if needed. Do **NOT** graze livestock in treated areas. REI - 24 hours.
- **endothall** (Desicate II) - PHI - 10-14 days. Phthalic acids. Apply at a rate of 0.75-1.0 lb. a.i./A in combination with ammonium sulfate and a surfactant. Higher rates are necessary for cool and cloudy conditions. Do **NOT** use less than 5 or more than 40 gallons of water per acre. Do **NOT** graze livestock in treated areas. REI - 48 hours.
- **paraquat** (Gramoxone Extra 2.5SC) - PHI - 3 days. Bipyridyliums. Apply at a rate of 0.30-0.60 lb. a.i./A with 50-100

gallons of water. Do **NOT** use on vigorously growing vines if potatoes are to be stored or used for seed. Do **NOT** graze livestock in treated areas. REI - 24 hours.

Storage:

If potatoes are being stored, vines should be completely dead at least 14-21 days before harvest. Once in storage, potatoes should be kept at 50°-60°F for 2-3 weeks to promote healing of cuts and bruises. Following this period, the temperature should be dropped to 40°F for table and seed-stock potatoes. If rotting is a possibility given field frost, late blight, or soft rot presence, the curing period should be eliminated and the temperatures dropped to 45°F as soon as possible until the crop is sold.

Contacts

Developed and Written by:

Therese N. Schooley
Project Manager
Virginia Polytechnic Institute & State University
Department of Entomology
Virginia Tech Pesticide Programs (0409)
38 Agnew Hall
Blacksburg, VA 24061
Ph: (540)-231-2086
Fax: (540)-231-3057
e-mail: tschooley@vt.edu

Donna M. Tuckey
Integrated Pest Management Coordinator
Virginia Cooperative Extension
Middlesex County Office
P.O. Box 96
Saluda, VA 23149
Ph: (804)-758-4120
Fax: (804)-758-4010
e-mail: dtuckey@vt.edu

Collaborating Authors:

Diseases:

Samuel A. Alexander
Associate Professor, Plant Pathology
Eastern Shore Research and Extension Center (0512)
33446 Research Drive
Painter, VA 23420-2827
Ph: (757)-414-0724
Fax: (757)-414-0730
e-mail: salex@vt.edu

Insects:
Thomas P. Kuhar
Assistant Professor, Entomology

Eastern Shore Research and Extension Center (0512)
33446 Research Drive
Painter, VA 23420-2827
Ph: (757)-414-0724
Fax: (757)-414-0730
e-mail: tkuhar@vt.edu

Pesticides:

Michael J. Weaver
Extension Pesticide Coordinator
Virginia Polytechnic Institute & State University
Department of Entomology
Virginia Tech Pesticide Programs (0409)
Blacksburg, VA 24061
Ph: (540)-231-6543
Fax: (540)-231-3057
e-mail: mweaver@vt.edu

Weeds:

Henry P. Wilson
Professor, Weed Science
Eastern Shore Research and Extension Center (0512)
33446 Research Drive
Painter, VA 23420-2827
Ph: (757)-414-0724
Fax: (757)-414-0730
e-mail: hwilson@vt.edu

Reviewed by:

Association of Virginia Potato & Vegetable Growers
Butch Nottingham, VDACS Field Office Marketing Specialist
P.O. Box 26
Onley, VA 23418
Ph: 757-787-5867
Fax: 757-787-1041
e-mail: onleyva@shore.intercom.net

James N. Belote, III
Extension Agent, ANR
Virginia Cooperative Extension
Accomack County Unit
P.O. Box 60
Accomack, VA 23301-0060
Ph: (757)-787-1361
Fax: (757)-787-1044
e-mail: jbelote@vt.edu

M. Watson Lawrence
Extension Agent, ANR
Virginia Cooperative Extension
Agriculture Department
310 Shea Drive
Chesapeake, VA 23322-5597
Ph: (757)-382-6348
Fax: (757)-382-6665

e-mail: malawre3@vt.edu

On-Line Resources

C&P Press Online Crop Protection Reference
http://www.greenbook.net/free.asp

Crop Data Management Systems - Pesticide Labels
http://www.cdms.net/pfa/LUpdateMsg.asp

Insects and Related Pests of Vegetables
http://ipmwww.ncsu.edu/AG295/html

Pests of Vegetables and Fruit Trees
http://everest.ento.vt.edu/~idlab/vegpests/vegfact.html

Virginia Tech Pesticide Programs
http://www.vtpp.ext.vt.edu

References

[1] Virginia Agricultural Statistics Bulletin and Resource Directory. 2001. Virginia Agricultural Statistics Service, Richmond, Virginia. Bulletin 77, (pg. 6, 30).

[2] Alexander, S.A., Caldwell, J.S., Hohlt, H.E., Nault, B.A., O'Dell, C.R., Sterrett, S.B., and Wilson, H.P., 2001. Commercial Vegetable Production Recommendations (No. 456-420) Virginia Cooperative Extension, (pg. 173-178).

[3] Potato Tuberworm. Found online at http://ipmwww.ncsu.edu:8150/AG295/html/potato_tuberworm.htm.

[4] Kuhar, T. Assistant Professor, Department of Entomology, Virginia Tech. Personal communication with Donna Tuckey, December 31, 2001.

[5]Alexander, S.A., Bratsch, A. D., Hohlt, H.E., Kuhar, T. P., Phillips, S. B., Sterrett, S.B., and Wilson, H.P., 2002. Commercial Vegetable Production Recommendations (No. 456-420) Virginia Cooperative Extension, (pg. C109).

[6] Rowe, R. C., Editor, Curwen, D., Ferro, D. N., Loria, R., and Secor, G. A., 1993. Potato health management, (pg. 135-158).

[7] Page, B. G., and Thompson, W. T., 2002. The insecticide, herbicide, and fungicide quick guide, (pg. 134-172).

[8] Alexander, S.A., Bratsch, A. D., Hohlt, H.E., Kuhar, T. P., Phillips, S. B., Sterrett, S.B., and Wilson, H.P., 2002. Commercial Vegetable Production Recommendations (No. 456-420) Virginia Cooperative Extension, (pg. B54-B56).

[9] Eisenback, J. D., Professor. Virginia Tech Department of Plant Pathology, Physiology, and Weed Science. Communications via email, April 17, 2002.

[10] Alexander, S.A., Bratsch, A. D., Hohlt, H.E., Kuhar, T. P., Phillips, S. B., Sterrett, S.B., and Wilson, H.P., 2002. Commercial Vegetable Production Recommendations (No. 456-420), Virginia Cooperative Extension, (pg. C105-C106).

[11] Wilson, H. P., Extension Weed Scientist, Eastern Shore Agricultural Research and Extension Center. Personal communication with Donna Tuckey, November 20, 2000.

[12] Alexander, S.A., Bratsch, A. D., Hohlt, H.E., Kuhar, T. P., Phillips, S. B., Sterrett, S.B., and Wilson, H.P., 2002. Commercial Vegetable Production Recommendations (No. 456-420) Virginia Cooperative Extension, (pg. B41-B44).

[13] Alexander, S.A., Bratsch, A. D., Hohlt, H.E., Kuhar, T. P., Phillips, S. B., Sterrett, S.B., and Wilson, H.P., 2002. Commercial Vegetable Production Recommendations (No. 456-420) Virginia Cooperative Extension, (pg. C110).