Crop Profile for Potatoes in West Virginia

Prepared: June, 2003

General Production Information

- Approximately 700 acres are planted for potato production in West Virginia.
- The average annual production cost is $250/Acre.
- Annual potato sale value averaged $2,500/Acre in 2002.
- The average yield per acre for West Virginia potato production is 100 cwt/ Acre.
- Estimated production value of potatoes in the state was about $1.75 million in year 2002.

Production Regions

West Virginia's potato crop is produced for fresh market and certified seeds. Farms planted for potatoes are distributed in pockets throughout regions of the state. Preston County (located in the northeastern region) is the largest potato-producing county, followed by Jefferson, Mineral, Morgan, and Hancock counties.

The principal variety widely used in the state is Kennebec. Other varieties grown in the state include Salem, Elba, German Butterball, Green Mountain, Chippewa, Pontiac, Chieftain, and Keuka Gold. Varieties are all round and white with good culinary qualities.

Cultural Practices

Potatoes grow in most soil types, but they prefer a sandy loam to clay loam. General cultural practices for potato production include:

- Selection of reliable certified seeds
- Conventional ground preparation, which normally starts when soil temperature is 50 °F or higher (plowing at 10- to 12-inch depth, disking, and leveling)
- Planting 1 ½ -2 oz. seed pieces at 9-10 inches row distance and 36-inch spacing between the rows.
- Fertilizing at a rate of 100 lb. N/A, for most varieties, using 10-20-20 or similar formulation (mix fertilizer well)

The Crop Profile/PMSP database, including this document, is supported by USDA NIFA.

- Adopting a regular spray schedule against damaging insects and diseases
- Vine killing and then harvesting (based on maturity of variety: Kennebec 90 days; Russet 110 days). Allow 10-12 days before lifting tubers from soil
- Storing potatoes in 20 Bu. bin boxes at 38-45 °F with air circulation
- Grading and selling (potato must be handled carefully to minimize bruising)
- Always keep a close watch on the crop and seek help before it is too late

Worker Activities

Workers will be involved in most, if not all, field activities throughout the season. Workers participate in field preparation, crop maintenance, harvesting, and other activities including:

- Plowing, disking, and leveling the soil
- Planting seeds by hand or mechanically
- Transporting, handling, and applying fertilizers in furrow by hand/machine
- Transporting, mixing, and applying insecticide, fungicide, and herbicide (foliar and soil application) on a regular time schedules. Also, spot treating for Colorado potato beetles when needed
- Hilling by cultivation (commercial) or by hand using a hoe (small scale operation)
- Vine killing using chemicals
- Harvesting by machine or manual (small plots)
- Grading and storage

Throughout the growing season, pesticides and other chemicals are sprayed/handled (foliar or soil) regularly; thus workers are subject not only to pesticide exposure, but to other chemicals as well. Reading the label and using proper protective equipments need to be implemented on site in order to minimize risk of chemical exposure.

Note: Information cited in the cultural and worker activities section was obtained from grower's comments (personal communications).

Insect Pests

The most economically important insect pests in potato production are Colorado potato beetle, potato leafhopper, aphids, and European corn borer. Other insect pests that invade potato plants and cause noticeable damage include wireworm and flea beetle.

Colorado Potato Beetle

Colorado potato beetles remain the most important and destructive insect pest in West Virginia's potato production. Adults and larvae eat the leaves and young terminal growth, causing defoliation. From plant emergence until the pre-harvest vine desiccation process begins, potato acreage is under continual threat of complete defoliation from Colorado potato beetles. There are one or two generations per year. They overwinter in a multitude of ornamental crops and other members of the nightshade family, causing a further control problem. Part of the difficulty in controlling this insect is its ability to develop resistance to chemical compounds quickly. For this reason, chemical control agents must be continually rotated and tank mixed within and between chemical classes to avoid resistance.

Chemical Control:

Admire (Imidacloprid) is the main pesticide used by West Virginia's farmers to control Colorado potato beetle. A single application of Admire in the spring at a rate of 2 oz/A controls not only Colorado potato beetle, but also other insects, such as aphids, leafhoppers, fleabeetles, and European corn borers for up to 60 days after planting. Admire also controls even resistant Colorado potato beetles from the time it's applied at planting into the season when beetles are not as devastating. Use of Admire has made the adequate control of potato insects possible at an overall reduced cost. However, this is only possible by using this compound within the framework of a total program that includes organophosphates and pyrethroids.

Provado (Imidacloprid) was reported to be used as a foliar application for Colorado potato beetle control in regions that do not experience the beetles until late in the season. Provado is applied at a rate of 1.5 oz/ A.

Guthion (Azinphos-methyl) works well in nonresistant beetle regions. It is applied at a rate of 1 lb/A.

Pest Management Alternatives:

Rotating potato crop fields to small grains or forage crops can reduce Colorado potato beetle populations. Monitoring and spot treatment reduce the amount of pesticide needed. Hand-picking insects reduces insect populations and works well on small acreages. Lime dust also is used for Colorado potato beetle control on small acreage (<2 A). However, excessive use of lime dust will gradually increase soil pH and consequently increase crop susceptibility to scab.

Potato Leafhopper

Leafhoppers are a very mobile jumping insect that can cause great damage in a short amount of time. Leafhoppers suck plant juices and cause wilting, discoloring of the leaves, leaf curl, marginal burns, reduction in photosynthesis, decreasing productivity, and stunting of plants. When feeding, the leafhopper injects a toxin that injures the plant. Yield reduction occurs if a large amount of defoliation occurs during tuber initiation and bulking.

Chemical Control:

Admire may be applied to the soil at planting, and its systemic action protects the plant before leafhoppers can cause damage. On the other hand, Baythroid (Cylfuthrin) has been used for potato leafhopper control during high levels of infestation at a rate of 3 oz/A. Other insecticides such as Provado and Monitor provide late-season control of potato leafhoppers.

Aphids

Aphids are one of the most economically damaging insects growers face. They can overwinter on the other hosts and then fly into potato fields. Aphids feed on plant juices, reducing plant vigor and possibly increasing water stress. They also carry viruses to the plant, so that even a low population of aphids can cause severe economic damage.

Chemical Control:

Admire, when applied at planting, will control aphids and therefore give the crop a healthy start, so they are better able to fight aphids. Also, admire allows many beneficial insects to thrive and help control aphids.

Monitor (Methamidophos) provides late-season control. It is applied after 60 days from planting at seven-day intervals. Monitor is applied at a rate of 1 pt/A.

Pest Management Alternatives:

Allow predators and parasites of aphids to do their job. Maintain weed control to prevent host plants.

European Corn Borer

Adult moths of European corn borer spend the day in weeds and grasses bordering the host plants, then flying to the host in the evening to lay eggs on the undersides of leaves. After hatching, the larvae crawl to the plant and feed for about five to seven days before boring into the stalks and stems. Once the larvae are in the plant, damage can’t be prevented. Larvae overwinter in the stalks and stems of host plant.

Chemical Control:

Guthion (Azinphos-methyl) is a broad-spectrum insecticide that controls many primary and secondary insect pests. It is applied at a rate of 1 lb/A.

Pest Management Alternatives:

To reduce the risk of infestation, do not rotate potatoes with corn. Chisel plowing, moldboarding, or disking prior to moth emergence can kill more than 50 percent of the larvae. Insecticides applied as the eggs hatch and before the larvae penetrate the plant will aid in control.

Desiccants and Growth Regulators:

The natural desiccation of the potato vine is nearly always artificially speeded up by diquat dibromide. This allows the harvest to proceed much sooner and decreases the time that the weakened plant is susceptible to disease. Potatoes that are to be stored may receive one of many generically available sprout inhibitors approximately four weeks prior to vine desiccation.

Integrated Pest Management:

Building a good soil, improving general plant health, using certified seeds, and proper using control measures are the main emphasis needed for an Integrated Pest Management program.

Potato growers in West Virginia were asked the following question "List the most important pesticides to your IPM program and if these pesticides are banned, how will they affect your crop production?"…….. Table 1 summarizes the growers' responses to the aforementioned question.

Table 1. Pesticides and their importance in an Integrated Pest Management Program.

Insecticide	% Crop treated	Estimated % crop loss (if banned)
Admire*	100	80+
Baythroid*	100	40
Monitor*	100	60
Provado*	100	90

*** Restricted-Use Pesticides**

Stakeholders Comments:

- It is very important to re-investigate tilling and field drainage to improve the subsoil. This investigation can be better performed if the process is subsidized by the government.
- The viruses which are carried by aphids who act as vectors must be considered important to control. The pesticide Monitor does a good job if properly used.
- Scab is another disease that many people question.

- If we (U.S. farmers) keep getting our chemicals banned, I would quit farming.

Weeds

Weed species including lambsquarters, pigweed, giant ragweed, morningglory, quackgrass, and Canada thistles are common invaders of potato fields. Yellow nutsedge is also common. Weed infestations significantly affect potato production and are difficult to control. A majority of the weed species in potato fields are normally controlled using a combination of pre-emergence herbicides and mechanical cultivation. Perennial grass and broadleaf weeds are less common but much more difficult to control. Where present, perennial weeds require post-emergence, selective herbicide treatments and intensive chemical and nonchemical management outside of the normal potato production cycle.

Chemical Control:

Farmers with small potato acreage tend not to rely heavily on herbicides; rather they cultivate, hoe, or hand pull the weeds. However, large-scale potato farmers use herbicides more regularly in addition to mechanical control measures. Herbicides that are commonly used for weed control in West Virginia potatoes include:

Metribuzin (Sencor) applied as Pre-emergence treatments at a rate of 1.5 pt/A.It provides effective control for most of the annual broadleaves and some annual grasses.

Roundup is used as pre-plant at a rate of 1 qt/A. It is often used after harvest of the previous crop to get a complete kill of the entire perennial weed system. Roundup applied three days prior to plowing provides control of quackgrass and other perennial weeds **(growers' comments).**

Pest Management Alternative:

The herbicide metribuzin has been a standard treatment for many years and is cost effective. However, it is assumed that many broadleaf weeds have built up triazine resistance. For this reason, **pendimethalin** is often recommended for control of triazine-resistant lambsquarter in combination with metribuzin. Alternatives to pendimethalin for triazine-resistant lambsquarter control in potatoes include:

Rimsulfuron (Matrix) offers partial control of lambsquarter (Both pre- and post- applications). Currently, Matrix is not registered in West Virginia.

EPTC (Eptam) is a pre-emergence herbicide. It controls lambsquarter partially if applied prior to weed emergence, but after crop emergence. Existing weeds need to be managed by cultivation or other mechanical control means.

Trifluralin (Treflan), applied pre-emergence, provides partial control of lambsquarter.Perennial weeds are managed through more consistent tillage and chemical weed control in rotation crops.

Diseases

Potato Foliar Diseases

Two leaf diseases are common on potatoes in West Virginia, late blight and early blight. Late blight, an extremely destructive disease, requires a cool and moist environment and often occurs earlier in the season than early blight.

Late Blight

Late blight of potato, caused by the fungus *Phytophthora infestans*, is an extremely destructive potato disease in the state. It attacks both tubers and foliage during any stage of crop development. When conditions are favorable, the fungus can spread rapidly through the foliage and is capable of causing complete blighting of foliage within a very short time. If no controls are implemented, entire fields can be destroyed. Tubers can be infected while they are still in the ground or in storage.

The first symptoms of late blight in the field are small, light to dark green, circular to irregular-shaped water-soaked spots. These lesions usually appear first on the lower leaves. Lesions often begin to develop near the leaf tips or edges, where dew is retained longest. During cool, moist weather, these lesions expand rapidly into large, dark brown or black lesions, often appearing greasy. Stem and petiole infections is also important, because when the leaflet dies, the stem can hold residual inoculums.

Pest Management and Alternatives:

Effective control of this disease requires implementing an integrated disease management approach. The most important measures are cultural (removal and destroying of cull piles, sanitation, and fertilization). Currently, there are no resistant cultivars that provide complete protection against this disease. Proper chemical control measures, however, can be utilized.

Cultural practices are the first line of defense against this disease. The following is a list of measures that can be used for the management of late blight.

- Avoid introducing late blight into a field by planting only disease-free seed tubers, preferably certified seed.
- Keep a clean operation by destroying all cull and volunteer potatoes. These potatoes can serve as a site for the pathogen to overwinter and spread to nearby potato fields. Spread culls over a field

in a thin layer in late fall to ensure that they will freeze over the winter.

- Hilling will reduce the incidence of tuber infection. The fungus infects tubers by washing through the soil and contacting the tubers. Good soil coverage provides better protection of the potato tubers (in a non-blight season).
- Harvest should not be started until vines are completely dead. At *least* one week, and as much as two to three weeks, should pass after vine killing for harvest of fields in an area where late blight is known to occur. In fields where late blight was confirmed, a minimum of two weeks should pass between vine killing and harvest. The pathogen will not survive on dead vegetation, so the tubers that are exposed at harvest are less likely to be infected.
- Remove infected tubers before storage to reduce additional losses from soft rot. Tubers should be dry when placed in storage. If any infection is believed to be present, forced air ventilation through the storage bin can help minimize spread from tuber to tuber. Storage of seed potatoes with small amounts of late blight at 38°F. will retard late blight tuber rot. The storage temperatures required for processing potatoes (48-52 °F.) make storing late blight-infected potato tubers very difficult since these temperatures also favor disease development. Potato lots with excessive tuber rot (greater than 5 percent total decay) are not storable and should be sold or processed directly from the field.
- The storage of potatoes in 20 Bu. bin boxes aids in cooling and control of breakdown of potatoes

Resistance:

No cultivar is **immune** to late blight, and most cultivars are susceptible to late blight. However, some cultivars offer partial resistance to this disease. These moderately resistant cultivars could be planted if blight was expected to be a problem.

Crop Monitoring and Disease Forecasting:

Efforts must be made to closely monitor crops for the incidence of disease. Field scouting should be concentrated in areas of the field most likely to have high moisture, dew, or relative humidity for the greatest length of time. Because of the high potential for loss, crops should be monitored for this disease and controls should be implemented as disease risk increases. Early protective fungicide application is very important with a **complete coverage**.

Early Blight

Early blight, caused by the fungus *Alternaria solani*, is a disease that is most severe on maturing or under-fertilized potato vines. Symptoms usually develop first on the older leaflets of mature plants, spreading to the younger leaves under favorable weather conditions. Symptoms begin as small, dark brown to black spots on older leaflets on lower portions of plants. The spots enlarge and develop a characteristic "target spot" appearance of concentric rings in the dead tissue. This disease occurs over a wider range of climatic conditions than late blight. Early blight actually occurs late in the season and can

affect tubers too.

Pest Management Alternatives:

While no truly resistant cultivars are available, highly susceptible cultivars should be avoided where losses to early blight are significant. Very early maturing cultivars are often very susceptible to early blight. Since early varieties become diseased earlier than do later varieties, care should be taken to avoid planting early and late varieties in the same or adjacent fields. The early variety could act as a source of infection of the later variety.

Application of protectant fungicides is important in suppressing damage by the early blight fungus.

Potato Tuber Diseases

Pythium Seed Rot

This disease is characterized by the extremely watery condition of the infected seed piece. Seed planted in warm, moist soil will become infected, turning yellowish to brown and then black. When the seed piece is uncovered, it is very watery (but not slimy) with no distinct foul odor. The water is usually clear, but it may be yellowish or brown. Cut seed and ventilate 24 to 48 hours at 70 °F. to initiate suberization of cut area **(growers' comments)**.

Pythium Leak

A soilborne fungus, *Pythium ultimum*, causes the tuber and seed rot phase of leak disease. The fungus is found in almost all cultivated soils and is responsible for seedling diseases in many crops. In the field, potato seed and tubers become infected through wounds that may or may not be visible. Wet, warm soils are necessary for infection; late planted, cut potato seed is extremely vulnerable to infection. When temperatures are above normal for the season, harvested potatoes are very susceptible, especially if the soil is moist.

Tubers are believed to become infected only through wounds, bruises, or insect injuries. Infections usually do not become visible until the tubers are stored. After two to four weeks in storage, infected tubers become watery and soft; when the tuber is squeezed, clear, yellowish water oozes out. The rotted, central portion of the tuber is dark brown to black with a sharp line separating the healthy external tissue from the infected internal tissue. Unless bacterial soft rot has set in, the tuber will not be slimy or foul smelling. Leak disease is not transmitted from tuber to tuber in storage.

Pest Management and Alternatives:

Seed Rot pest management measures include:

1. Using whole seed for late plantings.
2. Handling seed gently to avoid new wounds.
3. Treating seed with a recommended fungicide. Available seed treatments are not completely effective against the leak fungus; however, they protect seed against other seed-rotting fungi and thus protect against subsequent invasion by the leak fungus.
4. Planting seed deep with shallow cover. Get the young plant up as quickly as possible. A seedling under stress is more susceptible to seedling and seed rot disease.

Pythium Tuber Rot pest management recommendations include:

1. Avoiding mechanical injury at harvest.
2. Not harvesting when temperatures are above normal and soil is moist.
3. Not allowing harvested potatoes to stand in the sun.
    - Heal-in tubers: maintaining temperatures of 50 to 60 ºF. and relative humidity of 85 to 90% for seven to 14 days.
    - If leak disease develops while potatoes are in storage, use the following control methods:
        - Do not lower the temperature if potatoes are going to be processed.
        - Force dry, warm air through the pile and exhaust moist air.
        - Do not regrade. Regrading opens new wounds creating susceptibility to bacterial rots.
        - If potatoes are for table stock, decrease the temperature to 40 ºF. or lower.

Tuber Late Blight

The late blight fungus, *Phytophorthora infestans*, causes tuber blight. The fungus, a water mold, requires high humidity or free water for reproduction and infection.

Small, irregular, pink, red, or brickish-red areas just beneath the skin are the earliest symptoms of tuber late blight. As the disease progresses, these areas enlarge, become depressed, and may turn brown. The blighted areas usually do not extend to the center of the tuber beyond the vascular ring.

If foliage blight has been noticeable in the field, the first tuber blight symptoms may appear at the stem end of the tuber. In this case, a round, sunken, brick-red area will surround the stem end. Tuber blight lesions are excellent entryways for soft rot bacteria; tubers blighted before harvest usually will decay rapidly due to secondary invasion by soft rot bacteria.

Tubers become infected in two ways: 1) by spores washing down through soil or soil cracks; and 2) by harvesting potatoes when the vines are green and moist. Tuber blight is most common and most severe in heavy, moist soils. However, loose shale soils allow tuber blight to develop if the soil remains wet.

Pest Management and Alternatives:

Several pest management measures maybe followed for proper control of this disease, some of which are:

1. Control foliage blight in the field.
2. Be sure potatoes are hilled well.
3. If blight has occurred in a field:
    - Kill vines as soon as possible; consider potential yield and potential loss.
    - Apply fungicide before or with vine killer.
    - Maintain a five- to seven-day fungicide application schedule until all vines are dead.
    - Harvest seven to 14 days after vines are dead.
    - If rotten tubers are visible at the proposed harvest date, delay harvest until all infected tubers are rotted. (It is better to have blighted tubers rot in the field than in storage.)
        - If blight is present in storage:
            - Do not attempt to heal-in potatoes.
            - Move processing potatoes as soon as possible or plan to sell potatoes as table stock.
            - Drop the temperature as low as possible and keep tubers dry.

Potato Ring Rot

Ring rot, one of the most-feared potato diseases, has occurred occasionally. Economic loss due to this disease is slight; however, since this disease is so easily spread in seed potatoes, take precautions to keep all seed free of the disease organism.

The bacteria causing ring rot may be persistent in storage, bags, and bins and on equipment. The bacteria can infect seed, causing drastic field losses. Because the bacteria live in plant debris and cull tubers, disease loss caused by residual bacteria in the soil will be minimal if plant and tuber debris is destroyed during the winter or rotational period.

The first sign of ring rot in tubers is the appearance of a light, creamy-yellow to brown discoloration of the vascular ring at the stem end. When the freshly cut tuber is squeezed, a creamy-yellow or light brown exudate (scrud) is discharged. In more advanced stages, the entire vascular ring will rot with cavities extending to the center of the tuber. The outer surface of such tubers will sometimes be cracked and depressed; secondary soft rot bacteria may invade these tubers.

Certified or foundation seed has a zero tolerance for ring rot. Therefore, any significant amount of ring rot must originate from homegrown seed, contaminated equipment or storage facilities, or volunteer plants in the field.

Pest Management and Alternatives:

Follow these precautions at even the slightest hint of ring rot:

1. Do not put seed in unclean, undisinfected trucks, bags, bins, or storage.
2. Hose down and disinfect seed-handling equipment.
3. Use only certified or foundation seed.

Fusarium Seed and Storage Rots

Fusarium rots are caused by *Fusarium sp.* fungi infecting the tuber through wounds and bruises caused during or after harvest. When infected seed is cut and the fungus is spread to the cut surfaces, seed decay intensifies. Infection of both seed and stored tubers depends on warm temperatures, open wounds, and moist conditions. Under ideal conditions, tubers can become completely rotted in four to six days.

Fusarium dry rot occurs only on seed and stored tubers. Sunken, shriveled, or broken areas occurring almost anywhere on the tuber surface are the initial symptoms. These areas are usually brown to black and may have a white, yellow, or reddish mold growth on or in them. Depending on the fungus involved, the tissue beneath the sunken areas may be jelly-like (Fusarium wet rot) or dry (Fusarium dry rot). If the rot is dry, it may extend far into the tuber or may only be superficial; the cavities may be covered with a brightly colored fungus growth if the dry lesion extends into the tuber. Fusarium rots are usually dry at low temperatures and wet at high temperatures. These rots do not have a foul odor, unless accompanied by other fungi and bacteria.

The symptoms of Fusarium rots vary greatly, depending on the species of Fusarium involved and the environmental conditions under which the rot takes place. The above description is general and should be applicable in most instances.

Pest Management and Alternatives:

The following are suggested management recommendations for seed piece decay control:

1. When seed is received, place it in storage and circulate air to dry it; maintain high humidity to speed healing of any wounds.
2. When seed is cut, treat it immediately with a recommended fungicide. This fungicide will prevent Fusarium spores from germinating on freshly cut surfaces and will thus prevent infection.
3. Treat the whole seed. Because fungicide dusts do not adhere well to whole seed, sprinkle the recommended rate on the seed when it is placed in the planter box.
4. Avoid "desprouting" of seed. This weakens the seed, creates many wounds, and thus makes the seed extremely susceptible to Fusarium rots.
5. If seed is handled correctly when cutting, little to no decay occurs. Better yet, use "B" size seed

(1 3/4 to 2 inches), so no cutting is required.

Stored Tuber Rot management recommendations:

- Avoid mechanical damage
- Heal-in the tubers. Dry tubers off after they are placed in storage, but maintain an 80 to 90% relative humidity, if possible. If there are no late blight-infected or frozen tubers, maintain a 50 to 60 ºF. temperature seven to 14 days. This will promote maximum wound healing and thus prevent most Fusarium rot development.

Chemical Control:

Potato plants need protection from early blight beginning shortly after ground cracking (4 weeks after planting). This protection must continue until potato vines are completely desiccated in preparation for harvest. Fungicides that have been used as part of a disease management program include Bravo (2 pt./ A), Copper (6 lb./A), Maneb (2 lb./A), and Captan (1 lb. of Captan 7.5%, for seed pieces treatment immediately after cutting). If the potato crop is not adequately protected against foliar diseases, the potato foliage becomes infected and dies. Dead or dying foliage slows or halts potato tuber formation. Fusarium and damping-off can cause disease at potato emergence under cool wet conditions. Some growers use Captan, the lone seed treatment available for these diseases, on earlier planted potatoes to prevent emergence-related diseases. The most important fungicides to the IPM program for West Virginia potato growers are listed in Table 2 (survey, 2002).

Table 2. Pesticides and their importance in an Integrated Pest Management Program.

Fungicides	% Crop treated	Estimated % crop loss (if banned)
Bravo	100	100
Captan	100	100
Copper	100	100
Maneb	100	100

Resistance:

The late blight fungus has shown the ability to develop strains that are resistant to some systemic/ eradicant fungicides. Resistance to protectant fungicides has never been identified. Because of this threat, eradicant fungicides should always be applied in combination with protectants. (Personal Contact: West Virginia University Vegetable Pathologist)

Nematodes

A variety of plant-parasitic nematodes occur in West Virginia potato fields. Lesion nematode (*Pratylenchus* spp.) and Root Knot nematode (*Meloidogyne* spp.) are the most commonly damaging nematode pests. Lesion nematode occurs in the majority of West Virginia potato fields and is of greatest concern when it is found in conjunction with *Verticillium* wilt, where the interaction produces the Potato Early Dying Syndrome. Root Knot nematodes are found in about one-fourth of fields sampled. At high population levels, it will suppress both yield and tuber quality, especially for processing, because the Root Knot nematode is able to invade tubers and damage them directly. Tuber damage from both nematodes leads to storage losses due to excessive water loss and shrinkage.

Other nematodes occur frequently, although rarely at damaging levels, including Ring nematode (*Mesocriconema* spp.), Stunt nematodes (*Tylenchorrhynchus* spp. and *Quinisulcius* spp.), and Spiral nematodes (*Helicotylenchus* spp.). Occasionally, Dagger nematodes (*Xiphinema* spp.) and Lance nematodes (*Hoplolaimus* spp.) are found.

Management practices specific to nematode control are seldom applied; however, a range of indirect management practices often contributes to suppression of plant-parasitic nematodes in potato production.

Chemical Control:

Farmers with small potato acreage tend not to rely heavily on nematicides, but usually practice crop rotations. However, large-scale potato farmers may use combination insecticide-nematicides that suppress nematode populations. **In a few cases, soil fumigants may be used, but this is seldom done due to the cost and difficulty of application to West Virginia fields.**

Pest Management Alternatives:

Nematode-resistant cultivars are not available or are not adapted to West Virginia conditions. Although later-maturing cultivars tend to have greater tolerance to Lesion nematode, their longer growing season may exacerbate problems with Root Knot nematode.

Crop rotation with corn or cereal grains suppresses Root Knot nematode, but it is ineffective against Lesion nematode. Longer rotations are needed to suppress populations of the *Verticillium* wilt fungus. In the absence of *Verticillium*, potato usually can tolerate low to moderate populations of Lesion nematode without significant loss. A few crops are suppressive to both nematodes (e.g., marigolds); however, these usually are not economically feasible for inclusion in crop rotations. Use of green manure crops (brassicas, sudan grass) provides a measure of nematode suppression in some cases, but is not widely practiced in West Virginia potato production.

Naturally occurring biological control agents for both nematodes occur in many soils; however, none are

commercially available, and more research is needed to evaluate practices that enhance effectiveness of indigenous biocontrol organisms.

(Personal Contact: Dr. James Kotcon, Nematologist, West Virginia University)

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Survey questionnaires were sent to potato producers in West Virginia. **Personal interviews also were made with major potato growers in the state. Survey responses and interview comments were summarized and reported accordingly.**