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Organic Alternatives for Late Blight Control in Potatoes

Pest Management Technical Note

Abstract: New strains of late blight have emerged in recent years, making potato production especially challenging. Several nonchemical options are available for managing this disease, including cultural practices, some varietal resistance, and alternative sprays that discourage disease development.

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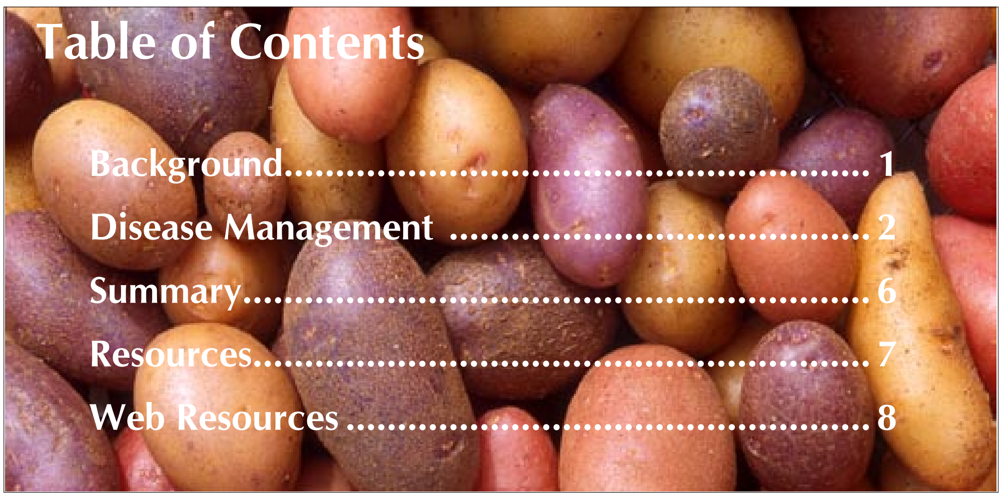
March 2004



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Background

Late blight (*Phytophthora infestans*) is a fungal disease that attacks the leaves, stems, and tubers of potato plants. In the 1840s, *P. infestans* caused the Irish potato famine, when a million people starved and another million and a half emigrated out of Ireland (1). In recent years, highly aggressive strains of this disease—many insensitive to popular synthetic fungicides—have surfaced and created new challenges for potato and tomato producers (2).

P. infestans reproduces both sexually and asexually. Sexual reproduction results in oospores—thick-walled spores that can survive for several years in the soil. When oospores germinate, they produce asexual spores called sporangia. Sporangia only survive in living host tissue, such as cull potatoes. These are often the original source of infection that initiates a major outbreak of the disease. Once released, sporangia can easily be carried for yards by rain splash and miles by wind (3). Wet conditions favor the disease. High humidity (greater than 90%) favors sporangia development; they also germinate readily on wet leaves. During moist weather, whole plants may be killed in a short time. Late blight is one of the few plant diseases that can absolutely destroy a crop, producing a 100% loss (1).

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Disease Management

Tools available for organic management of late blight include forecasting and monitoring techniques, cultural techniques, genetic resistance, and alternative spray materials.

FORECASTING AND MONITORING

Several states have blight forecasting and reporting programs to aid growers in managing this serious disease. Farmers should contact their local Cooperative Extension office to determine whether their area is being served by such programs and how to participate in them. Cooperative Extension can also provide good publications that aid in identifying the disease under field conditions. Several states have plant pathology laboratories to evaluate tissue samples and make disease identification.

Field scouting is important to late blight management. Catching an outbreak in its earliest stages can reduce losses and increase options for control. Growers should check fields twice a week. It is important to look at leaves and stems *under* the canopy, as this is where the disease gets established first. The first sign of infected tissue is a water-soaked appearance of the leaves, which, in dry weather, quickly turn dark brown and brittle. Infected areas may be surrounded by a halo of chlorotic, or yellowed, tissue. During moist weather, a white cottony growth will develop on the underside of the leaves. Infected stems and petioles will turn dark brown or black.

Symptoms first show up around low-lying areas, ponds or creeks, near center-pivot irrigation rigs, and in places protected from wind. Early-planted fields are likely to be affected first (4). Also note that the ideal conditions for an epidemic of late blight are when night temperatures are 50 to 60° F, along with fog, heavy dew, rain, or overhead irrigation, accompanied by daytime temperatures of 60 to 70° F. Four to five continual days of such weather are an open invitation for an outbreak.

Tubers going into storage should also be inspected and diseased tubers removed. Since it is difficult to identify the disease at this stage—especially if the tubers are dirty—it is often advisable to send samples to a plant pathology lab (5).

CULTURAL CONTROL

Sanitation is the first line of defense against late blight. Avoid piling and leaving culls. Culled potatoes should be disked, buried, composted, or otherwise disposed of before the new crop emerges. It goes without saying that however culls are dealt with, the further removed from new production fields, the better. Volunteer potatoes, solanaceous (potato family) weeds, and any infected plants should be destroyed as soon as they occur. Growers who have the option of planting several small, separated fields may have an advantage in containing outbreaks (6). Crop rotation also helps—especially where volunteer potatoes are a problem—but its efficacy is limited against this highly mobile organism (6, 7). Tomato, pepper, and eggplant are all hosts to late blight and should be avoided in rotation and as neighboring crops.

Excessive viney growth—caused by over-fertilization with nitrogen—invites late blight infection (5). While excessive nitrogen is seldom a problem in organic production, it can be, especially under circumstances where high-nitrogen manures are used.

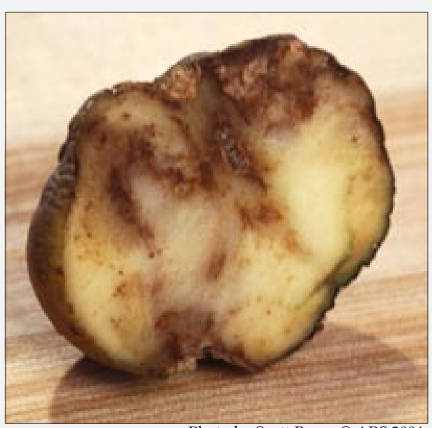

Photo by Scott Bauer © ARS 2004

Potatoes infected with late blight are purplish and shrunken on the outside, corky and rotted inside.

Use of certified seed can reduce the amount of infestation from infected seed pieces, but it will not prevent foliar infection from other sources, such as neighboring fields. Careful attention should be paid to seed potatoes. Any tubers that are discolored or show signs of phytophthora infection should be culled and destroyed.

Do not mix seed lots. It may be worthwhile to investigate the severity of late blight in the area from which seed potatoes have been ordered. Planting should take place when soil temperatures are 50° F and rising. Planting for an early harvest also helps to avoid infection (6).

Late blight spores may also be spread during seed piece cutting and planting. The AireCup® planter, which uses vacuum pressure instead of picks or cups, may help prevent early infection of seed pieces. According to its manufacturer, this planter uses a vacuum to "singulate" seed pieces, and air pressure to place the seed pieces in the potato rows. It is capable of planting accurately at a speed equal to or greater than pick planters. The manufacturer, which also makes pick planters, notes that the AireCup® planter is more accurate and makes fewer skips and doubles than pick planters.

For more information about the AireCup®Planter, contact:

Crary Company of Terra Marc Industries
Lockwood Product Line
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West Fargo, ND 58078
800-488-8085 (toll free)
701-282-5520
www.crary.com
www.lockwoodmfg.com

Seed planting depth and hilling operations should be carefully monitored. Shallow planting can expose tubers to late blight spores washing down from leaves, creating problems later on during storage and sale.

When late blight appears in isolated sections of fields, spread of the disease can be slowed considerably by quickly destroying infected plants (8). Killing the living potato tissue halts further spore production. Organic growers might try certifier-approved contact herbicides such as some of the vinegar or citric-acid based organic herbicides (Bioganic,™ Burnout,™ AllDown Green Chemistry Herbicide,®), generic vinegar and/or citric acid formulations, or a flame weeder. Tillage to bury the infected plants should also be effective. Kill all susceptible plants within 15 feet of the infection site (6).

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The duration of leaf wetness is a critical factor in late blight infection (9). Therefore, sprinkler irrigation should be carefully scheduled, or minimized, particularly late in the season when the closed potato canopy provides ideal conditions for late blight development. If possible, rows should be oriented parallel with prevailing winds to encourage better air circulation and foliage drying. Studies in Israel noted that late blight infection was greater on morning-irrigated potatoes than on potatoes irrigated at midday or evening (10). A rule of thumb: if rainfall or irrigation water exceeds 1.2 inches in a 10-day period, good conditions for late blight exist.

While vines can be allowed to die naturally prior to harvest, thorough destruction of green vines limits late blight infection—especially tuber infection. In conventional systems, vine desiccation is commonly accomplished through chemical sprays. In organic potato production the products for burning down vines are limited to certifier-approved contact herbicides, vinegar or citric-acid based organic herbicides such as Bioganic,™ Burnout,™ AllDown Green Chemistry Herbicide®, generic vinegar formulations, flame weeding, or other mechanical means. Mechanical flails are considered less effective at limiting tuber infection than spraying. Flailing is also slower, since fewer rows can be covered in a single pass. Flame desiccation appears (initially) to be a faster and more viable alternative, but this is not certain.

Leave tubers in the ground for about two weeks after the vines have been destroyed, if possible. This allows blighted tubers to rot so they can easily be left in the field. Following harvest, it's appropriate to till in all residues and plant a cover crop (6).

Harvest should be managed to minimize damage to tubers and avoid wet conditions. Infected tubers will continue to deteriorate and spread the disease in storage. Post-harvest losses of up to 100% can occur under some conditions (1). Regulate the flow of air through storage piles for minimal humidity, and keep the tubers as dry as is reasonable (5).

VARIETAL RESISTANCE

Currently, no potato varieties are fully resistant to late blight. A few cultivars, like Kennebec, Elba, Onaway, Rosa, and Sebago, however, demonstrate a degree of resistance (11, 12) and are under serious study in breeding programs.

Biotechnology is also being employed in the pursuit of late blight resistance. Fully resistant genetically engineered commercial strains are expected soon (13). Genetically engineered plants, however, are not acceptable for organic production (14).

ALTERNATIVE SPRAYS

Copper sprays can be used as a preventative to avoid the spread of late blight. Several approved commercial copper products are available, including Britz Copper Sulfur 15-25 dust, Champion WP, Clean Crop COCS 15 sulfur 25 dust, and Cueva Fungicide Ready-To-Use. As of August 2003, these copper products were listed with the Organic Materials Review Institute (OMRI*) as "regulated," meaning that they could be used, but a plan must be in place that indicates cultural controls are also being used and that ensures copper does not build to toxic levels in the soil. Some copper products may not be acceptable for certified production. Check with your certifying agent.

The frequency of copper application may be quite high and exceed the 9 to 15 sprays reported with conventional fungicides in some parts of the country. This raises the issue of eventual copper toxicity, as this element accumulates in soils—a definite concern for sustainable production.

Nine to 15 sprays of copper as Bordeaux mix would probably deliver anywhere from 2 to 6.5 lbs of elemental copper per acre to a field in a single season. (This assumes a 6:8 ratio of $CuSO_4$ to lime in Bordeaux; 25% Cu in $CuSO_4$; 2 to 4 lbs Bordeaux applied per spray.) This would result in the addition, that season, of 1 to 3.35 ppm copper to the six-inch plow layer of the soil where most nutrient extraction occurs. If potatoes are grown in a five-year rotation—as is recommended to dodge soil-borne diseases—with crops requiring little or no additional copper fungicides, an average addition of approximately .2 to .7 ppm copper is made per year. The estimated removal by crops on a practical rotation of small grains, potatoes, and alfalfa might average .0225 ppm annually—only about 3% to 11% of that applied.

The actual potential for toxic buildup of copper in the soil is dependent on a host of additional factors:

- native levels of soil copper
- copper content of fertilizers and manures applied
- soil pH and buffering capacity
- leaching from rainfall and irrigation
- copper content of spray materials used

On many soils and in many farm situations, sustained copper spraying might continue for decades—even centuries—at the frequencies described, before toxic buildup would become a concern. However, an additional problem with copper sprays is their impact on soil organisms. At applied rates, copper fungicides are directly toxic to several beneficial organisms, particularly earthworms and some soil microbes such as blue-green algae—an important nitrogen-fixer in many soils.

As a result of these concerns, organic growers and others using copper sprays are encouraged to adopt an integrated approach to late blight management that does not rely solely on copper.

Growers should also monitor soil copper levels through regular soil testing when these sprays are regularly used and the conditions warrant. Always apply all commercial pesticides according to label instructions.

Compost tea, applied as a foliar spray, is also reported to suppress late blight. In a German study (15), compost teas made from either horse manure or cow manure were sprayed on potato foliage as a control measure against late blight. These teas were used either alone or with additional microorganisms added to the mix. The tea treatments were compared to three fungicides or to a water control. The compost tea alone was applied seven times during the season. Compost tea with additional microbes was applied 11 times weekly. Fungicides were applied five times during the growing season. Results from the experiment can be seen in Table 1. As you can see, compost + microbes was equal to Ridomil MZ fungicide in reducing diseased leaf area and

**OMRI is a non-profit organization that publishes and disseminates lists of generic and brand-name materials allowed and prohibited in organic production. Contact OMRI, Box 11558 Eugene, OR 97440. Tel: 541-343-7600; FAX: 541-343-8971; Web: http://www.omri.org* produced similar high yields, as did two other fungicides. Ciluan and control produced the lowest yields. Results comparing compost tea alone and compost tea with added microorganisms, compared to a water control, are shown in Table 2. The addition of microbes to the compost tea was very beneficial, bringing yields from the mixture up to double that of the tea alone or the control.

Compost teas work by inoculating the leaf and stem surfaces with microorganisms that serve as antagonists to invading pathogens such as *Phytophthora infestans* by occupying the leaf surface, making it difficult for the pathogen to get started. The beneficial bacteria also induce resistance in the plants. Additional microbes were added to the tea to enhance the antagonistic effect.

Currently, the use of compost tea is regulated in organic production due to concerns about possible microbial contamination. Consult your certifier before using compost tea on any crop harvested for human consumption.

Table 1

Effect of compost teas with additional microorganisms compared to three fungicides on potato late blight (16).

Treatment	% Diseased leaf area	Yield (T/ac)
Control	96a[1]	11a
Compost + microbes	11c	15c
Ridomil MZ	8c	15c
Brestan 60	19b	15c
Ciluan	18b	13b

[1]Numbers followed by the same letter are not statistically different.

Table 2

Effect of compost teas with and without additional microorganisms on an organic farm (16)

Treatment	% Diseased leaf area	Yield (T/ac)
Control	93a[1]	8a
Compost tea alone	90a	9a
Comost tea + microbes	17b	18b

[1]Numbers followed by the same letter are not statistically different.

Organic farmer Jim Gerritsen of Bridgewater, Maine, has never had a problem with late blight on his organic potato crop. Since he supplies organic seed potatoes to all 50 states, he has an extra incentive to produce a clean crop. Gerritsen produces more than 300 cubic yards of compost from manure and bedding each year. Most of this compost is applied to his fields. A small amount is put into burlap bags and submerged in 55-gallon drums of water to brew compost tea. The burlap bag acts as a filter that catches larger particles that would clog the sprayer. Compost tea is sprayed onto the crop at full strength at a rate of 70 gallons per acre each week. The potatoes are sprayed with tea about 10 times each season, starting when the plants are six inches tall (16). ATTRA has a detailed publication on the preparation, use, and efficacy of compost teas titled *Notes on Compost Teas*.

Serenade™ biofungicide is a wettable powder formulation of *Bacillus subtilis,* QST-713 strain. *B. subtilis* is applied as a preventative fungicide and works as an antagonist against many pathogens, including *P. infestans,* that cause late blight. When applied to the foliage, Serenade inhibits attachment of the pathogen, stops it from growing, and induces an acquired resistance in the plant (17). Serenade was discovered and commercially introduced by AgraQuest, Inc. and is approved for organic production by OMRI. Rates range from 2 to 4 pounds per acre. Copper sulfate can be added to the mix. At the 2 -pound rate, the cost is about $5.50 per acre. For information on rates, formulation, and spray frequency for Serenade, contact AgraQuest.

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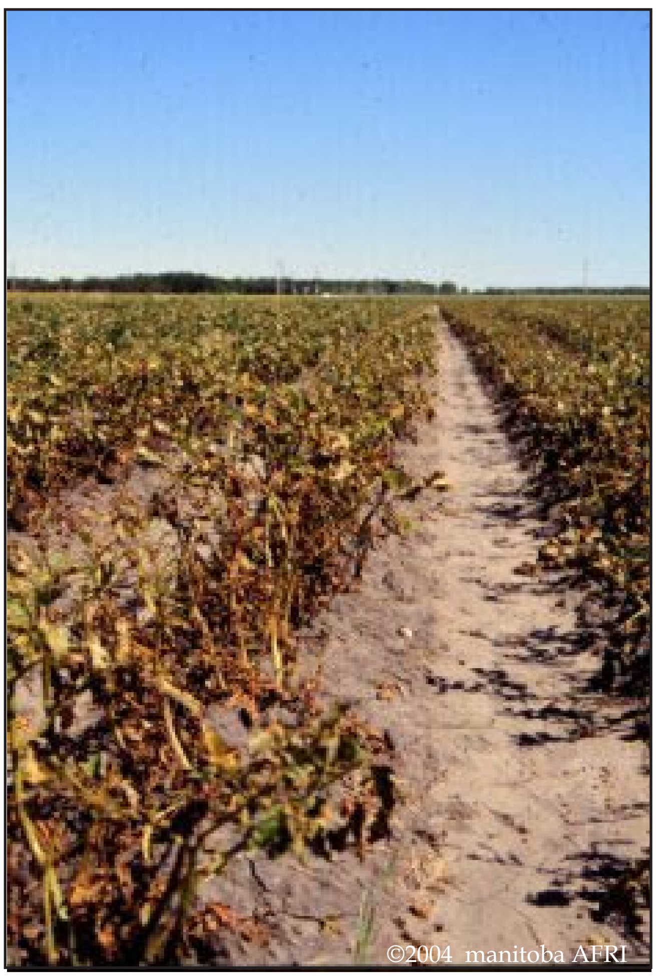

Storox is a hydrogen-dioxide based pesticide that is OMRI approved. It's a class-one danger, meaning the applier needs full personal protective equipment, due to Storox's corrosive properties. Once Storox dries, you can safely reenter the treated area. On potatoes it can be used as a curative and preventative. Check the Web page and label: <www.biosafesystems.com/labels.html>.

Foliar feeding has been associated with disease resistance. Two materials that have acquired such a reputation are kelp-based products and the Biodynamic™ preparation #508—made from the primitive plant horsetail (*Equisetum arvense*). ATTRA has additional information on foliar feeding, kelp, and Biodynamics™ available on request.

In all instances where sprays are used, complete coverage of foliage and stems is important. High-volume boom sprayers and air-assist sprayers are usually most effective. Flood jet nozzles have been shown inferior to hollow cone and flat fan designs. For aerial applications, a minimum of 5 gallons of water per acre is recommended (4). Aerial application is expensive and not as effective as ground application, but when you can't get into the field, to some growers it's better than nothing.

Summary

The emergence of new strains of late blight has created a serious challenge for potato growers in recent years. Several organic options for management are available, including cultural techniques, tolerant varieties, and alternative spray materials. To be successful and to avoid environmental consequences, these options should be evaluated and adopted using an integrated approach.

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Web Site Resources

www.cropinfo.net/Potatoblight.htm

Oregon State University's late blight forecast service. This site contains much practical information on the disease, color photos of infected plants and tubers, late blight hotline phone numbers in Oregon, Washington, and Idaho, and management recommendations.

www.ipm.ucdavis.edu/DISEASE/DATABASE/potatolateblight.html

The University of California has county-by-county, Web-accessible information that will automatically plot degree days for several insect and disease pests.

www.potatonews.com

Has a world of information on late blight as well as other potato information, and many links to other Web sites dealing with late blight.

www.uidaho.edu/ag/plantdisease/

The University of Idaho's late blight Web site. Contains information on cultural and chemical controls, forecasts, reporting fields, and a blight update.

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