

Late Blight of Potato and Tomato

March, 2016

Late blight is the most destructive disease of potato in British Columbia. It is caused by *Phytophthora infestans*, an oomycete (fungal-like organism). It occurs in all areas of the province but it is more dependent on wet weather conditions, mainly rainfall, high humidity and cool to moderate temperature regimes. Monitoring for timely detection of early symptoms and knowledge of weather conditions are crucial for employing effective disease management practices. Late blight monitoring services are available for growers in the Fraser Valley. In North America, besides potato and tomato, the pathogen has been reported to infect other solanaceous plants, including *Solanum sarachioides* (hairy nightshade).

Symptoms

On potato, early symptoms of late blight first appear on leaves as small, circular or irregularly shaped, dark necrotic lesions within 3 to 5 days of initial infection (Figure 1A). Symptoms may first appear on mature lower leaves where high humid/damp conditions and cooler temperature are most likely to prevail. However, early infections can also occur on other parts of the foliage under favourable weather conditions. This includes air currents that can carry spores from nearby infected fields or volunteer potato plants. On petioles and stems, symptoms appear as dark, water-soaked lesions (Figure 1B). Lesions expand with time as the pathogen colonizes the internal plant tissues.

On mature lesions, the pathogen produces glistening white spore-bearing structures called sporangia on the underside of the leaves or surface of stems (Figure 1C). As the disease progresses, the entire infected tissue will blight and decay (Figure 1D). Tubers become infected at any stage of their development and they start to turn brown and rot slowly from the outside (Figure 1E & 1F). Infected tubers become susceptible to secondary infections by other soft rot pathogens present in the soil or at storage.



Figure 1A. Symptoms of Late Blight on potato leaves



Figure 1B. Early symptoms on young potato leaves.



Figure 1C. Appearance of white sporangia on the underside of infected leaf and on stem



Figure 1D. Dead tissue caused by Late Blight infection



Figure 1E-F. Browning and rotting of tubers

Photos for Figure 1A-F courtesy of Karina Sakalauskas, E.S. Cropconsult.



On tomato, leaf and stem infections are very similar to those on potato (Figure 2A). If wet weather continues after the onset of disease, the fruit also becomes infected (Figure 2B). The fruit rot is slow developing but eventually destroys the fruit before it ripens. Green fruits harvested in the fall turn black and leathery before they ripen if they were infected in the field.



Figure 2. Symptoms of Late blight on tomato. Blight infection on leaf-petiole (A) and appearance of white sporangia on infected green fruit (B).

Spread

Numerous sporangia are produced on mature lesions when environmental conditions are favourable; leaf wetness for more than 10 to 12 hours and moderate temperatures are favourable for sporangial production. Sporangia are dispersed by rain and/or overhead irrigation water and long distance dispersal up to several miles can occur in wind currents. Upon contact with host plants, sporangia and/or small motile spores (zoospores) released from sporangia germinate and infect the plants in the presence of free moisture on plant surfaces. Disease development is favoured by moderate temperatures and wet, humid conditions. If wet weather continues, rapid development and multiple reproductive/infection cycles of the pathogen can cause complete foliar blight and defoliation of potato within a few days. Tubers become infected at any stage of their development if heavy rains wash spores from leaves through the soil or if the tubers come into contact with diseased vines during harvest. *P. infestans* is an obligate pathogen and, thus, requires a host plant or plant tissue for its survival between seasons. It can survive on infected tubers in soil, cull piles or storage. Planting infected seed potatoes is one of the common pathways of introducing disease in the field. Seed-pieces with mild infection often result in the emergence of infected/symptomatic plants. Heavily infected seed-pieces rapidly decay in soil and, as a result, no plant emerges.

Nationwide, late blight has become more difficult to control. This is believed to be due to the introduction of new and aggressive genotypes (strains) of the pathogen. *P. infestans* consists of two distinct mating type populations, mating types A1 and A2, which are necessary for sexual reproduction and emergence of new and aggressive strains. Thick-walled resting spores (oospores) are produced as a result of sexual reproduction, and are capable of surviving for many years in dead vines and in soil. Both A1 and A2 mating types are present in Canada. In B.C., studies conducted from 2010 to 2015 indicate that the genotype US-23 (mating type A1) being the predominant strain, has been replaced with US-8 (mating type 2) in the Fraser Valley region of the lower mainland.

Late Blight Management

- An integrated approach is essential for successful management of late blight.
- Avoid replanting fields which had severe late blight incidence the previous year; crop rotation with a non-solanaceous crop is highly recommended.
- Remove culls and volunteers from the farm and safely destroy/deep bury them. Kill any sprouts from cull piles with herbicides.
- Avoid planting highly susceptible potato varieties.
- Plant only clean, certified seed potatoes each year. Seed pieces should be treated with a protectant fungicide containing mancozeb to minimize spread of late blight from infected tubers. Do not plant seed pieces showing signs of decay. Dispose of them off farm where they will not be able to grow.
- Do not over-fertilize or overwater. Dense lush foliage stays wet longer and is more likely to become infected. Avoid using overhead irrigation when possible.
- Use of floating mulches or row covers on early potatoes encourages early succulent growth which is susceptible to late blight infection. Apply a fungicide as soon as the cover is removed.
- Separate fields of early and late crops as much as possible to slow down the spread of disease from early to late crops. Early crops should not be planted upwind of late crops. Ensure potatoes are well chilled.

Late Blight Management (cont.)

- Solanaceous weeds such as hairy nightshade are hosts of late blight. Check adjacent crops and weedy areas in and around the field for Solanaceous weeds and implement appropriate weed control measures.
- Monitor your field on a regular basis for timely detection of early blight symptoms. Pay close attention to the weather forecast to predict onset of late blight. Adopt an effective fungicide spray program before or soon after onset of disease and before row closure.
- If blight gets out of control, top-kill the crop followed by a fungicide application when tops are about half-dead.
- Harvest in dry weather after the vines have been dead for at least two weeks to ensure no or minimum tuber infection during harvest and allow grading out of tubers that were infected in the field. If infected tubers and wet soil get into storage the pathogen can sporulate and spread to other tubers.

Use of Fungicides

Careful selection of fungicides and a well-managed spray program, as an integral part of an IPM program, will ensure success in the battle against late blight and, perhaps, growing of more popular potato varieties susceptible to late blight.

- Select fungicides based on their efficacy, mode of action, chemical group and resistance management criteria.
- Do not apply a fungicide or fungicides belonging to the same chemical group repeatedly; this will result in development of resistance to the fungicide by the pathogen. Alternate fungicides belonging to different chemical groups to maintain their efficacy and longevity.
- For best results, the first spray must be applied before any infections appear. Fungicides must be applied at timely intervals (Table I), depending on the residual effect of each fungicide.
- Read the label for rates of application, days to harvest limitations, application criteria and worker exposure safety.
- Spraying can be suspended during dry weather in mid-summer but start again before the onset of fall rains.
- Most of the registered fungicides are non-systemic therefore residues can be washed off from foliage if a fungicide spray is soon followed by a rain event or irrigation.

Table 1. A summary of registered fungicides on Potato. Please strictly adhere to product label instructions for rate of application and use patterns when using the chemicals.

Product	Active ingredient	Chemical Group	Mode of Action	REI1	PHI2	Application
Copper 53W or Copper oxychloride 50	copper sulphate	M1	preventative, non-systemic	48 hrs	1 day	apply preventatively at 7-10 day intervals; maximum 10 applications per year; low risk of resistance development
Copper Spray	copper oxychloride (fixed copper)	M1	preventative, non-systemic	48 hrs	1 day	apply preventatively at 7-10 day intervals; maximum 10 applications per year; low risk of resistance development
Cueva	copper octanoate	M1	preventative, non-systemic	4 hrs	1 day	apply preventatively at 7-10 day intervals; maximum 15 applications per year; low risk of resistance development
Kocide 2000	copper hydroxide	M1	preventative, non-systemic	48 hrs	1 day	apply preventatively at 7-10 day intervals; maximum 10 applications per year; low risk of resistance development
Parasol WPF	copper hydroxide	M1	preventative, non-systemic	48 hrs	1 day	apply preventatively at 7-10 day intervals; maximum 10 applications per year; low risk of resistance development
Dithane F-45	mancozeb	M3	preventative, non-systemic	24 hrs	1 day	apply preventatively at 7-10 day intervals; low risk of resistance development
Dithane DG Rainshield NT	mancozeb	M3	preventative, non-systemic	24 hrs	1 day	apply preventatively at 7-10 day intervals; low risk of resistance development
Manzate DF	mancozeb	M3	preventative, non-systemic	24 hrs	1 day	apply preventatively at 7-10 day intervals; low risk of resistance development
Penncozeb 75DF or Penncozeb 75DF + Raincoat	mancozeb	M3	preventative, non-systemic	24 hrs	1 day	apply preventatively at 7-10 day intervals; low risk of resistance development
Polyram DF	metiram	M3	preventative, non-systemic	NA	1 day	apply preventatively at 7-10 day intervals; low risk of resistance development

Table I. (cont.)

Product	Active ingredient	Chemical Group	Mode of Action	REI1	PHI2	Application
Maestro 80DF	captan	M4	preventative, non-systemic	48 hrs	7 days	apply preventatively at 7-10 day intervals; maximum 7 applications per year; low risk of resistance development
Bravo 500	chlorothalonil	M5	preventative, non-systemic	48 hrs	1 day	apply preventatively at 7-10 day intervals; low risk of resistance development
Echo 90DF or Echo 720	chlorothalonil	M5	preventative, non-systemic	48 hrs	1 day	apply preventatively at 7-10 day intervals; low risk of resistance development
Ridomil Gold MZ 68WP	metalaxyl & mancozeb	4 & M3	preventative, locally systemic	24 hrs	3 days	apply preventatively at 10-14 day intervals; maximum 3 applications per season; high risk of resistance development & must alternate with fungicides from different chemical groups
Ridomil Gold / Bravo or Bravo 720	metalaxyl & chlorothalonil	4 & M3	Protective, locally systemic	NA	14 days	Apply preventatively at 14 day intervals; maximum 3 applications per year; high risk of resistance development & must alternate with fungicides from different chemical groups
Headline EC	pyraclostrobin	I I	preventative/curative, locally-systemic	12 hrs	3 days	apply preventatively at 5-7 day intervals; maximum 3 applications per season; high risk of resistance development & must alternate with fungicides from different chemical groups; can be tank mixed with Bravo 500 or Polyram DF
Reason 500SC	fenamidone	I I	preventative/curative, locally-systemic	Until dry	14 days	apply preventatively at 7-10 day intervals; maximum 6 applications per year; high risk of resistance development & must alternate with fungicides from different chemical groups; can be tank mixed with Dithane DG or Bravo 500

Table I. (cont.)

Product	Active ingredient	Chemical Group	Mode of Action	REI1	PHI2	Application
Cabrio Plus	pyraclostrobin & metiram	11 & M2	preventative/curative, locally-systemic	12 hrs	3 days	apply preventatively at 7-10 day intervals; maximum 3 applications per year; high risk of resistance development & must alternate with fungicides from different chemical groups
Tanos 50DF	fenamidone & cymoxanil	11 & 27	preventative/curative, locally-systemic	24 hrs	14 days	apply preventatively at 7 day intervals; maximum 6 applications per year; high (11) and medium (27) risk of resistance development
Cyazofamid or Ranman 400SC or Torrent 400SC	cyazofamid	21	preventative/curative, locally-systemic	12 hrs	7 days	apply preventatively at 7 day intervals; maximum 6 applications per season; medium risk of resistance development; use with a surfactant, Sylgard 309
Zoxium 80W	zoxamide	22	preventative	48 hrs	3 days	apply preventatively at 7 day intervals; maximum 6 applications per season; medium risk of resistance development & must be tank mixed with Dithane DG
Gavel 75DF	zoxamide & mancozeb	22 & M3	preventative	48 hrs	3 days	apply preventatively at 7 day intervals; maximum 6 applications per season; medium (22) and low (M3) risk of resistance development.
Curzate 60DF	cymoxanil	27	protective, locally-systemic	24 hrs	8 days	apply preventatively at 5-7 day intervals; maximum 7 applications per season; medium risk of resistance development & must be tank mixed with mancozeb
Tattoo	propamocarb	28	preventative, locally-systemic	48 hrs	14 days	apply preventatively at 7-10 day intervals; do not exceed 7.5 L / hectare/season; can be tank mixed with other chemicals (refer to product label)

Table I. (cont.)

Product	Active ingredient	Chemical Group	Mode of Action	REI1	PHI2	Application
Tattoo C	propamocarb & chlorothalonil	28 & M	preventative, locally-systemic	48 hrs	7 days	apply preventatively at 7-14 day intervals; maximum 3 applications per season
Allegro 500F	fluazinam	29	preventative, locally-systemic	24 hrs	14 days	apply preventatively at 7-10 day intervals; maximum 10 applications per season (i.e. not to exceed 4 L product/hectare/season); low risk of resistance development
Confine or Rampart	mono-/di-potassium salt of phosphorous acid	33	preventative, suppressive, systemic	NA	NA	Apply as post-harvest; low risk of resistance development.
Confine Extra	mono-/di-potassium salt of phosphorous acid	33	preventative, suppressive, systemic	NA	1 day	apply preventatively at 7-14 day intervals, maximum 5 applications per season, and as post-harvest; low risk of resistance development.
Phostrol	mono-/di-sodium, potassium & ammonium phosphites	33	preventative, suppressive, systemic	NA	1 day	apply preventatively at 7-14 day intervals, maximum 7 applications per season, and as post-harvest; low risk of resistance development; may be tank mixed with other fungicides
Acrobat 50WP or Forum	dimethomorph	40	preventative, locally-systemic	12 hrs	0 day	apply preventatively at 7-10 day intervals; maximum 3 applications per season; medium risk of resistance development; may be tank mixed with Polyram DF, Dithane DG or Bravo 500

Table I. (cont.)

Product	Active ingredient	Chemical Group	Mode of Action	REI1	PHI2	Application
Revus	mandipropamid	40	preventative, locally-systemic	12 hrs	14 days	apply preventatively at 7-10 day intervals; maximum 4 applications per season; medium risk of resistance development
Zampro	ametoctradin & dimethomorph	40 & 45	preventative, locally-systemic	12 hrs	NA	apply preventatively at 5-10 day intervals; maximum 3 applications per season; medium risk of resistance development
Presidio	fluopicolide	43	preventative, locally-systemic	7 days	NA	apply preventatively at 7-10 day intervals; maximum 3 applications per season; resistance development not known

1 REI - re-entry interval listed on the label. Note that Worksafe BC regulations require a minimum of 24 hours for slightly toxic pesticides and 48 hours for moderately or very toxic pesticides before worker re-entry.

2 PHI - pre-harvest interval

NA – information is not available (please refer product label & contact the manufacturer)

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