BRITISH COLUMBIA | Ministry of Agriculture

Late Blight of Potato and Tomato

May, 2018

Late blight is the most destructive disease of potato in British Columbia (B.C.). 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 addition to potato and tomato, the pathogen can 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 (Figure1A). Symptoms may first appear on mature lower leaves where 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.

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 develops slowly 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.

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 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.

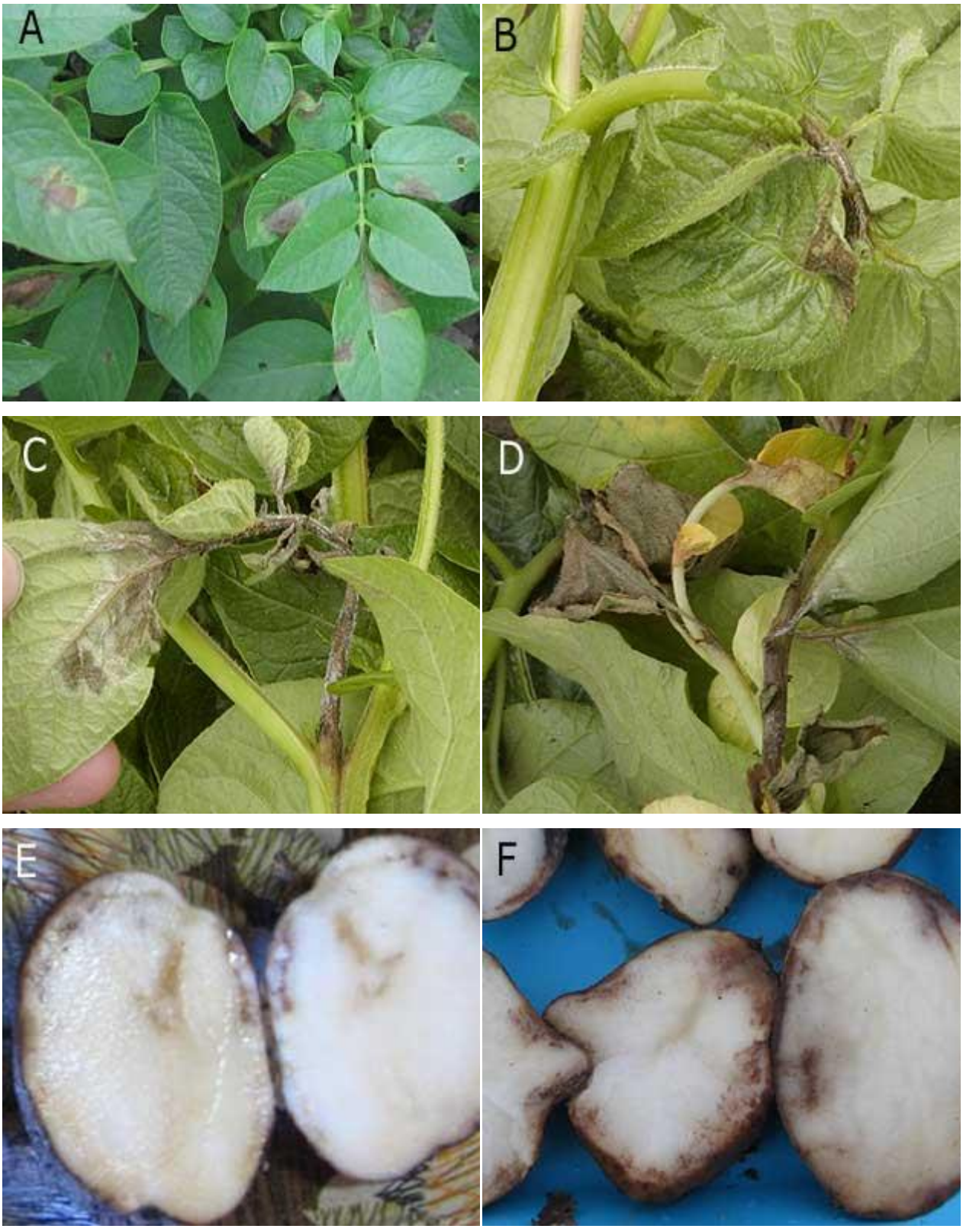

Figure 1. Symptoms of late blight on potato.
Early symptoms on young leaves (A) and stems (B).
Appearance of white sporangia on the underside of infected leaf and on stem (C).
Blight and death of infected tissues (D). Browning and rotting of tubers (E & F).
Photo (1E & F) credit: Karina Sakalauskas, E.S. Cropconsult.

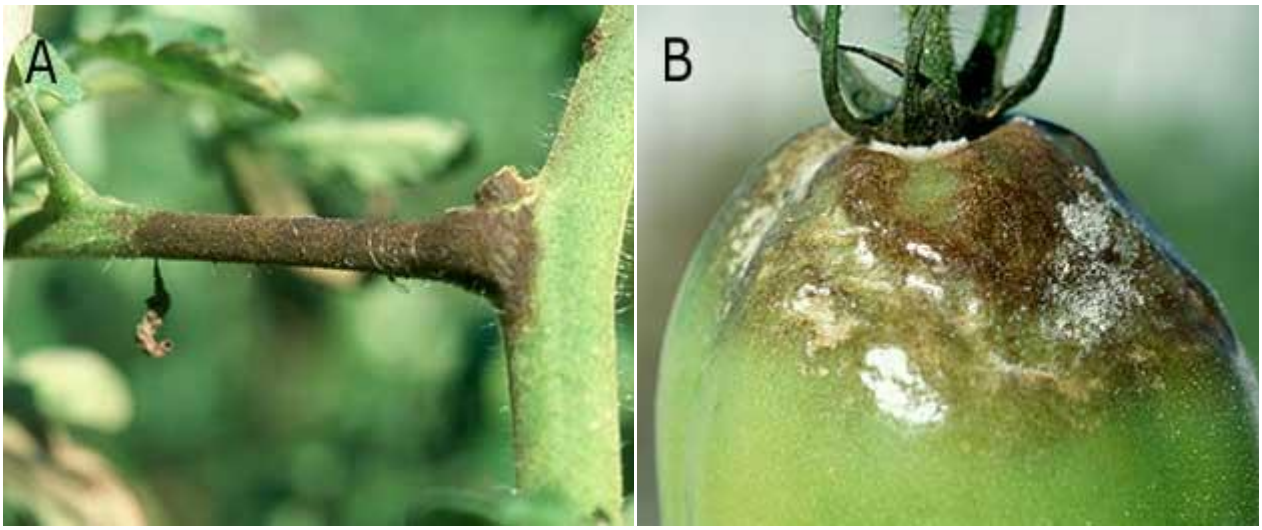

Figure 2. Symptoms of Late blight on tomato. Blight infection on leaf-petiole (A) and appearance of white sporangia on infected green fruit (B).

Phytophthora 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. *Phytophthora 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., a limited number of *P. infestans*-infected potato samples from the Fraser Valley submitted to the National Survey (from 2010 to 2015) indicates that the genotype US-23 (mating type A1), formerly the predominant strain, has now been replaced with US-8 (mating type 2).

Disease Management

Prevention

- 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.
- 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.

Eradication & Management

- 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 1), 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 chemicals, biological agents and label information. Please refer to Health Canada's Pest Management Regulatory Agency website for fungicide label information.

Product name	Active ingredient	Chemical or biological group	Mode of Action	REI[1] hrs	PHI[2] days	Application guidelines
Copper 53W	copper sulphate	M1	protectant (non-systemic)	48	1	Apply preventatively at 7- to 10-day interval. Do not exceed 10 applications per year. Low risk of resistance development.
Copper Spray	fixed copper	M1	protectant (non-systemic)	48	1	Apply preventatively at 7- to 10-day interval. Do not exceed 10 applications per year. Low risk of resistance development.
Cueva	copper octanoate	M1	protectant (non-systemic)	4	1	Apply preventatively at 7- to 10-day interval. Do not exceed 15 applications per year. Low risk of resistance development.
Kocide 2000, Parasol WPF	copper hydroxide	M1	protectant (non-systemic)	48	1	Apply preventatively at 7- to 10-day interval. Do not exceed 10 applications per year. Low risk of resistance development.
Dithane F45, Dithane DG Rainshield NT, Penncozeb 75DF or Penncozeb 75DF + Raincoat, Manzate DF	mancozeb	M3	protectant (non-systemic)	24	1	Apply preventatively at 7-10 day intervals. Low risk of resistance development
Polyram DF	metiram	M3	protectant (non-systemic)	NA	1	Apply preventatively at 7-10 day intervals. Low risk of resistance development.
Maestro 80DF	captan	M4	protectant (non-systemic)	48	7	Apply preventatively at 7-10 day intervals. Do not exceed 7 applications per year. Low risk of resistance development.
Bravo 500, Echo 90DF or 720	chlorothalonil	M5	Protectant (non-systemic)	48	1	Apply preventatively at 7-10 day intervals. Low risk of resistance development.
Ridomil Gold MZ 68WP	metalaxyl & mancozeb	4 & M3	protectant (locally systemic)	24	3	Apply preventatively at 10- to 14-day interval. Do not exceed 3 applications per season. High risk of resistance development; must alternate with fungicides from different chemical groups.
Ridomil Gold / Bravo Twin-Pak	metalaxyl & chlorothalonil	4 & M5	protectant (locally systemic)	48	14	Apply preventatively at 14-day interval. Do not exceed 3 applications per year. High risk of resistance development; must alternate with fungicides from different chemical groups.

Product name	Active ingredient	Chemical or biological group	Mode of Action	REI[1] hrs	PHI[2] days	Application guidelines
Headline EC	pyraclostrobin	11	protectant & curative (locally systemic)	12	3	Apply preventatively at 5- to 7-day interval. Do not exceed 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	11	protectant & curative (locally systemic)	Until dry	14	Apply preventatively at 7- to 10-day interval. Do not exceed 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.
Cabrio Plus	pyraclostrobin & metiram	11 & M	protectant & curative (locally systemic)	12	3	Apply preventatively at 7- to 10-day interval. Do not exceed 3 applications per year. High risk of resistance development & must alternate with fungicides from different chemical groups.
Tanos 50DF	fenamidone & cymoxanil	11 & 27	protectant & curative (locally systemic)	24	14	Apply preventatively at 7-day interval. Do not exceed 6 applications per year. High (11) to medium (27) risk of resistance development.
Cyazofamid, Ranman 400SC, Torrent 400SC	cyazofamid	21	protectant & curative (locally systemic)	12	7 days	Apply preventatively at 7-day interval. Do not exceed 6 applications per season. Medium risk of resistance development. Use with a surfactant, Sylgard 309.
Zoxium 80W	zoxamide	22	protectant	48	3	Apply preventatively at 7-day interval. Do not exceed 6 applications per season. Medium risk of resistance development & must be tank mixed with Dithane DG.
Gavel 75DF	zoxamide & mancozeb	22 & M3	protectant	48	3	Apply preventatively at 7-day interval. Do not exceed 6 applications per season. Medium (22) to low (M3) risk of resistance development.
Curzate 60DF	cymoxanil	27	protectant (locally-systemic)	24	8	Apply preventatively at 5- to 7-day interval. Do not exceed 7 applications per season. Medium risk of resistance development. Must be tank mixed with mancozeb.

Product name	Active ingredient	Chemical or biological group	Mode of Action	REI[1] hrs	PHI[2] days	Application guidelines
Tattoo	propamocarb	28	protectant (locally-systemic)	48	14	Apply preventatively at 7- to 10-day interval. Do not exceed 7.5 L/hectare/ season. Medium risk of resistance development. Can be tank mixed with other chemicals.
Tattoo C	propamocarb & chlorothalonil	28 & M5	protectant (locally-systemic)	48	7	Apply preventatively at 7- to 14-day interval. Medium risk of resistance development. Do not exceed 3 applications per season.
Allegro 500F	fluazinam	29	protectant (locally-systemic)	24	14	Apply preventatively at 7- to 10-day interval. Do not exceed 10 applications per season. Low risk of resistance development
Confine or Rampart	phosphorous acid (mono- & di-potassium salts)	33	protectant & suppression (systemic)	NA	1	Apply as post-harvest. Low risk of resistance development.
Confine Extra	phosphorous acid (mono- & di-potassium salts)	33	protectant & suppression (systemic)	NA	1	Apply preventatively at 7- to14-day interval. Do not exceed 5 applications per season and as post-harvest. Low risk of resistance development.
Phostrol	mono- & di-sodium, potassium & ammonium phosphites	33	protectant & suppression (systemic)	NA	1	Apply preventatively at 7- to 14-day interval. Do not exceed 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	protectant (locally systemic)	12	4	Apply preventatively at 7- to 10-day interval. Do not exceed 3 applications per season. Medium risk of resistance development. Must be tank mixed with Polyram DF, Dithane TM DG Rainshield TM or Bravo 500.
Revus	mandipro-pamid	40	protectant (locally systemic)	12	14	Apply preventatively at 7- to 10-day interval. Do not exceed 4 applications per season. Medium risk of resistance development
Zampro	ametoctradin & dimethomorph	40 & 45	protectant (locally systemic)	12	NA	Apply preventatively at 5- to 10-day interval. Do not exceed 3 applications per season. Medium risk of resistance development.
Presidio	fluopicolide	43	protectant (locally systemic)	12	NA	Apply preventatively at 7- to 10-day interval. Do not exceed 3 applications per season. Resistance development not known.

Product name	Active ingredient	Chemical or biological group	Mode of Action	REI[1] hrs	PHI[2] days	Application guidelines
Orondis	oxathiapiprolin	49	protectant (locally systemic)	12	0	Apply preventatively at 5- to 14-day interval. Do not exceed 4 applications per crop cycle. Resistance development not known.

[1]REI - re-entry interval indicated on label
[2]PHI - pre-harvest interval
NA - information is not available (please refer product label & contact the manufacturer)

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