



Understanding and Managing Potato Late Blight

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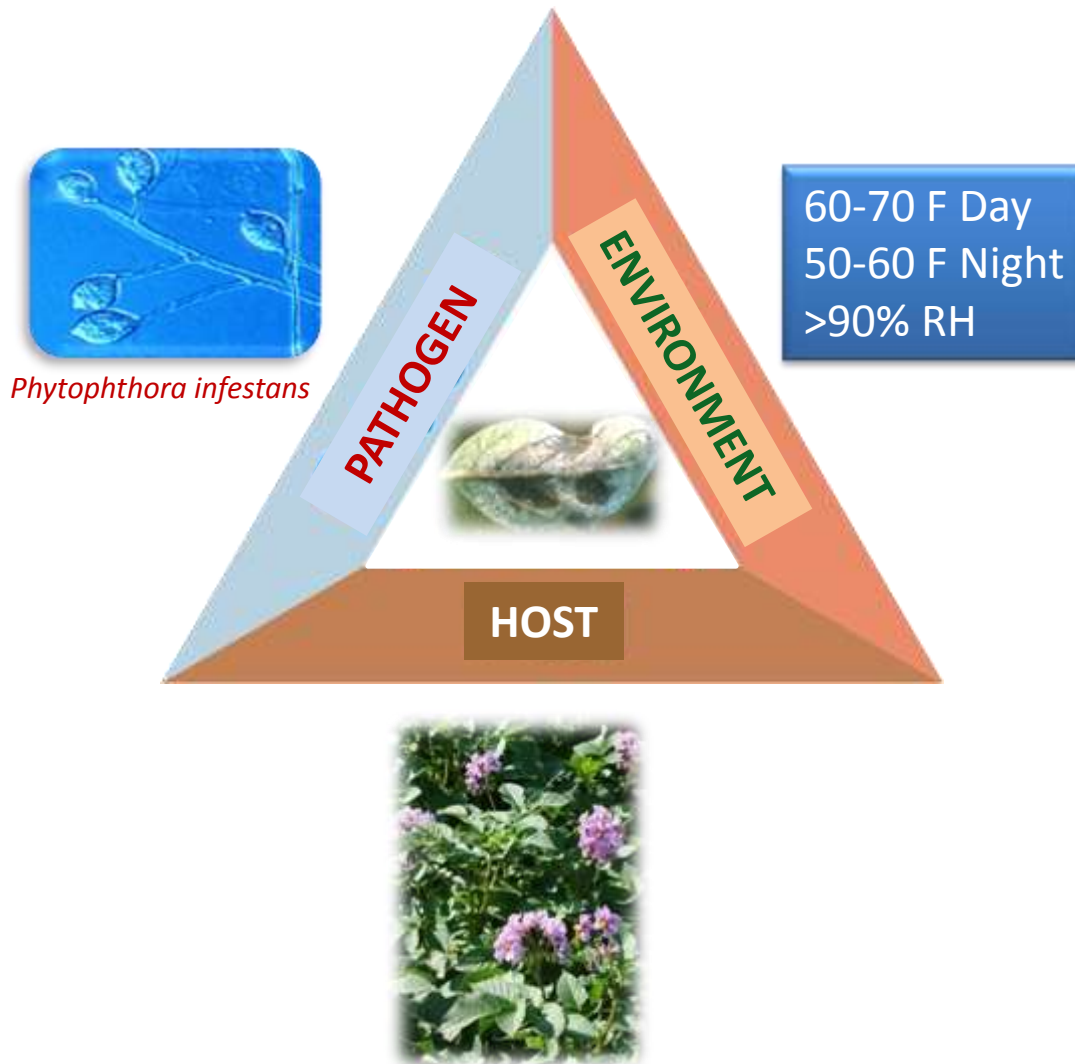
Chairman, National Potato Late Blight Working Group

What is Late Blight?

- A disease of potatoes caused by the fungus *Phytophthora infestans*.
- A problem wherever potatoes are grown.
- The most serious disease of potato worldwide.
- Community disease because it spreads far and fast.
- Requires multiple tactics for control.
- Can cause serious economic loss.

The Disease Triangle

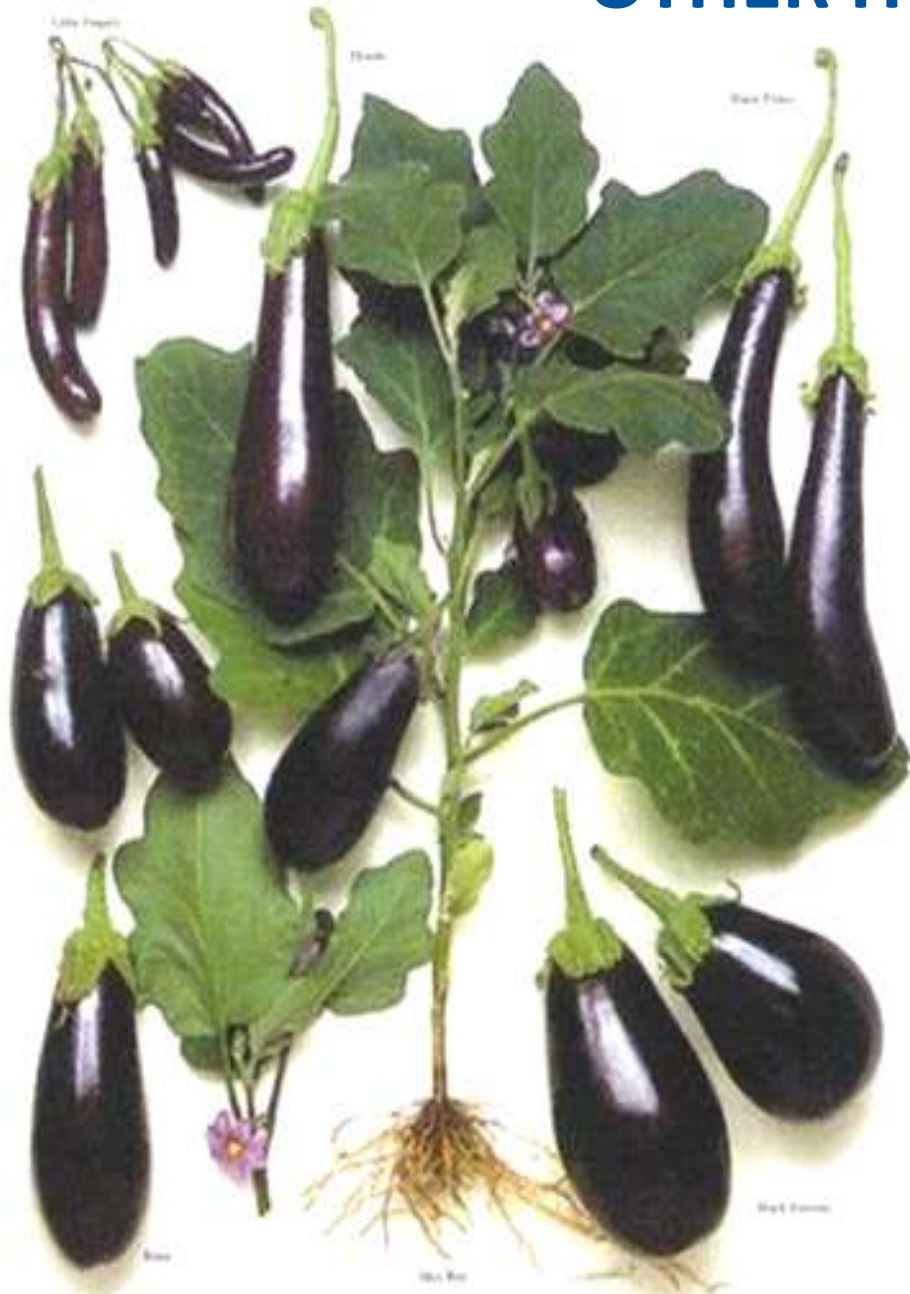
The three pillars of the disease triangle have to be present in order for the disease to occur



OTHER HOSTS



OTHER HOSTS



OTHER HOSTS



Hairy Nightshade



Black Nightshade



OTHER HOSTS



The Disease

- Favored by high moisture and moderate temperatures (night 50-60 F; day 60-70 F).
- Rain, dew, sprinkler irrigation, and high relative humidity (>90%) may all provide favorable conditions for disease development.



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Lesions are most apparent after wet nights or periods of rainfall

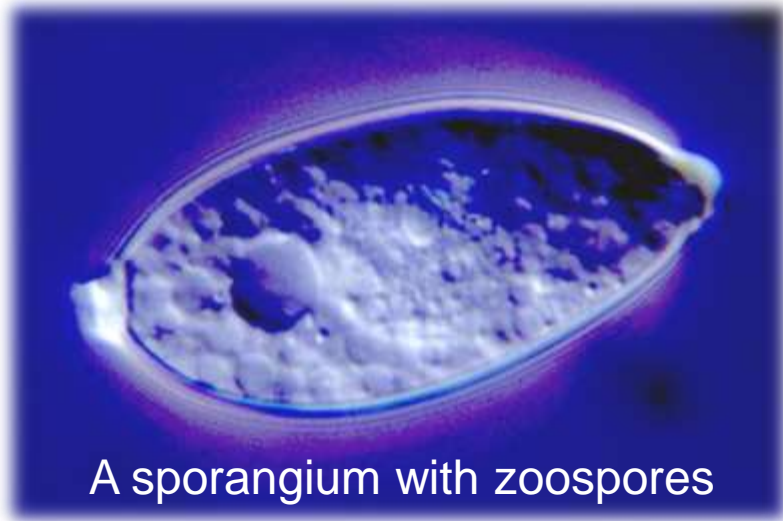


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The time between spores deposition on a leaf and lesion development = 7-10 DAYS

60-70 F Day
50-60 F Night
>90% RH

Conditions must remain moist for a minimum of 7-10 hours for spore production to occur



A sporangium with zoospores



Zoospore being ejected



Lemon-shaped sporangia on sporangiophores

How to Recognize the Disease?

**Affects all parts of the plant above
and below ground**

**The fungus can only survive in living host tissues; when
the host dies, the late blight pathogen dies**



Small, pale to dark green, irregularly shaped spots that appear water-soaked

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2 9 2004

Under favorable environmental conditions, the spots rapidly grow to large, brown to purplish black, necrotic lesions that may kill the entire leaflets and spread via petioles to the stem, eventually killing the entire plant



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18 8 2004

Under moist conditions, a white downy mildew (talc-like) appears mostly on the underside of the leaves





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Infection on leaf petioles and stems

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18 8 2004

An aerial photograph of a large agricultural field, likely corn, showing signs of late blight. The field is mostly green, but there are several distinct areas of brown and tan discoloration, indicating plant death or severe damage. These areas are scattered across the field, with a notable concentration in the upper-left and lower-right corners. The field is bordered by dense green trees and a road on the left side, and a road on the bottom right. The overall scene is a mix of vibrant green and brownish-tan patches.

Arial picture of a field infected with late blight

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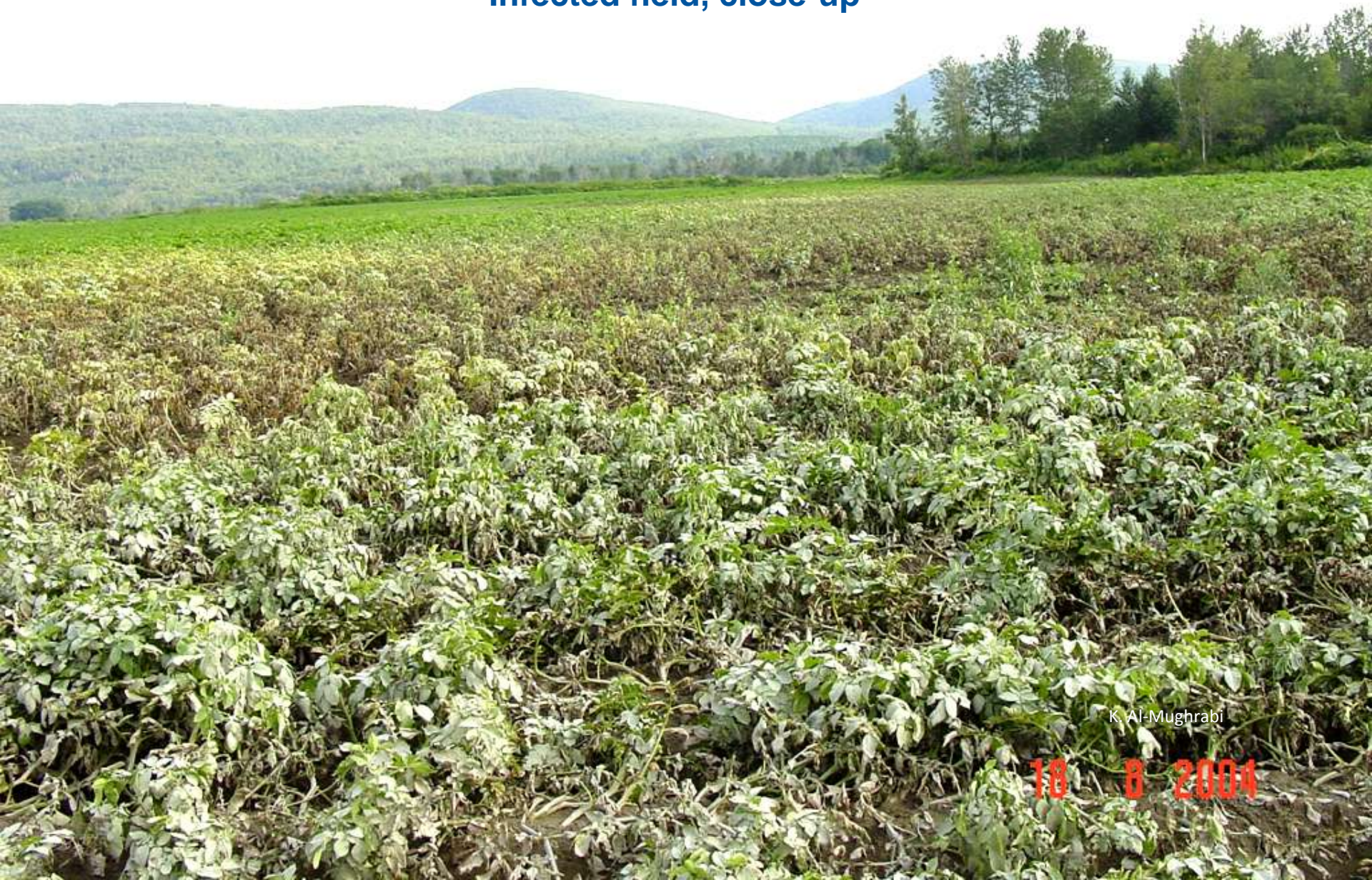
Infected field, close-up



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Infected field, close-up



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Infected field, close-up



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Tuber Symptoms

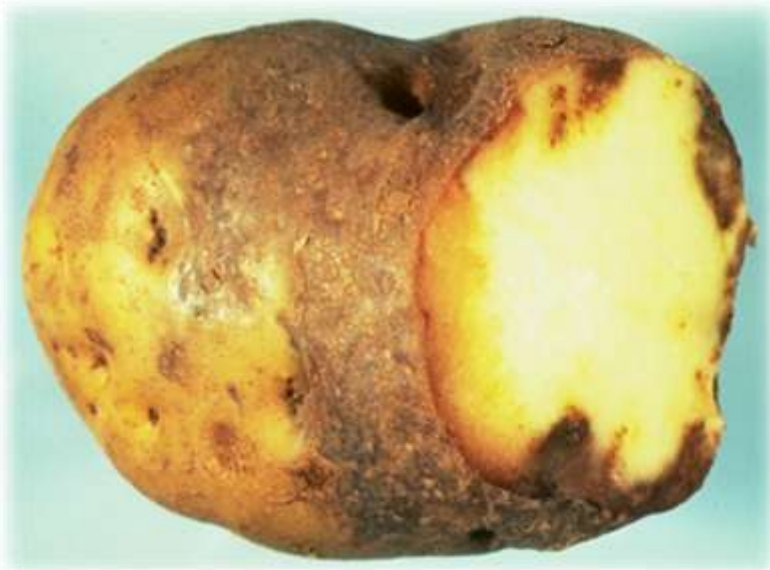
Exteriors of infected tubers show irregular, small to large, slightly depressed areas of brown to purplish skin.



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Tuber Symptoms

- Tan-brown, dry granular rot can extend into the tuber ~ 1.5 cm.
- The boundary between diseased and healthy tissue is not clearly defined.



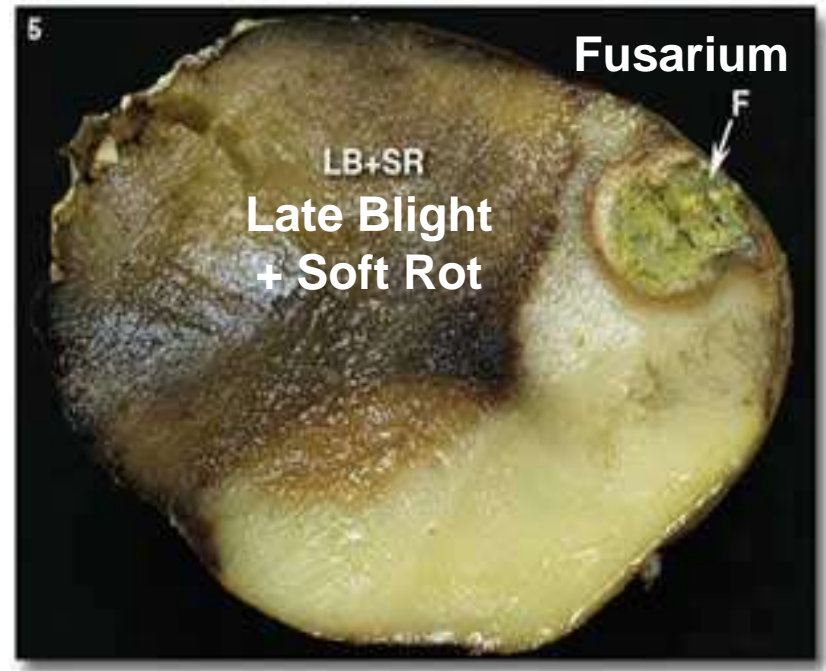
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Tuber Symptoms

- Under cool, dry storage conditions, tuber lesions develop slowly and may become slightly sunken after several months.
- Secondary organisms (bacteria and fungi) often follow infection by the late blight pathogen, resulting in partial or complete breakdown of tubers.



R. Peters

Tan-brown, dry granular rot





Tan-brown, dry granular rot

Tan-brown, dry granular rot



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18 10 2006

A close-up photograph of a sliced potato. The potato is cut in half, revealing its internal structure. The outer skin is a light brown color. The inner flesh is a pale, off-white color. On the left side of the slice, there is a significant area of damage characterized by irregular, dark brown to black, granular spots and streaks. These spots are concentrated near the skin and spread slightly into the inner flesh. The rest of the potato slice appears relatively normal, with a smooth, slightly moist texture. The background is a plain, light-colored surface.

Tan-brown, dry granular rot



Tan-brown, dry granular rot

Late Blight on Tomatoes



Late Blight on Tomatoes



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27 9 2004

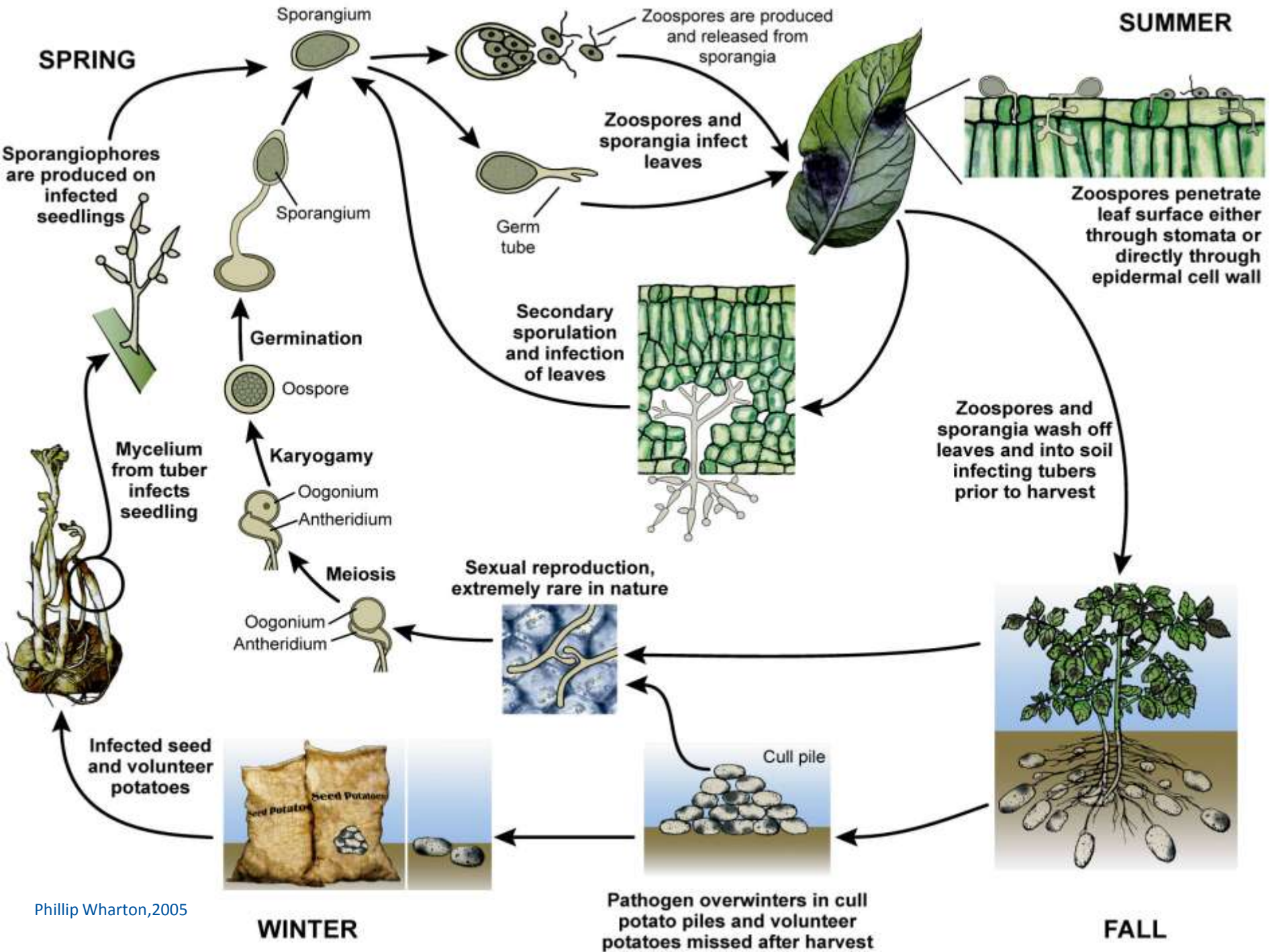
Survival

The late blight organism (*Phytophthora infestans*) may survive winter in:

- Seed.
- Culls.
- Volunteers.
- Alternate hosts.



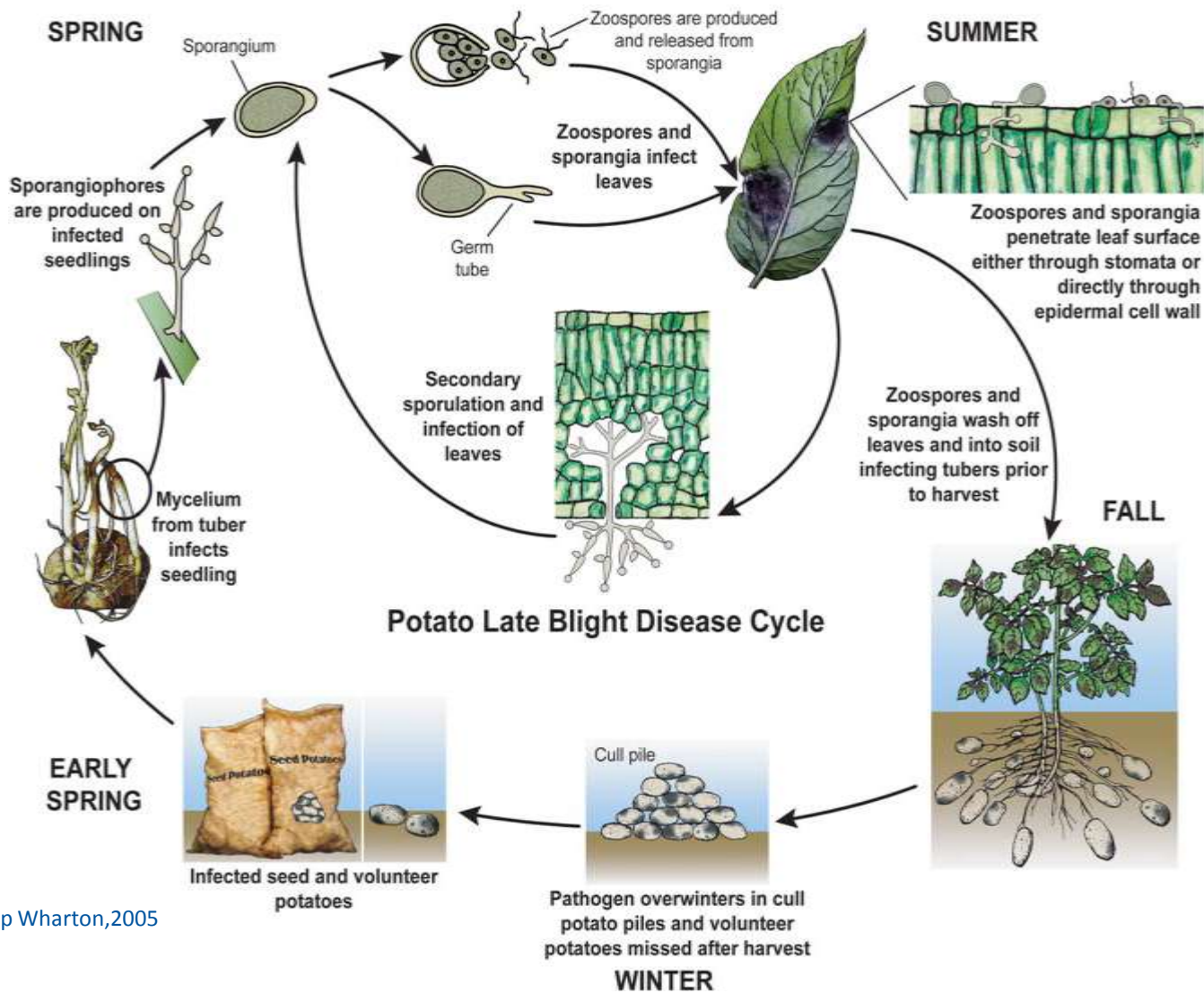
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Phillip Wharton, 2005

Blight Development Through Infected Seed





Phillip Wharton, 2005

Early opportunity for aggressive fungicide applications to reduce impact of seed-borne late blight

Infected Cull Pile



Foliage grows in a cull pile long before the crop emerges



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This unsprayed foliage will get infected with late blight and act as the source for the disease to your crop and neighboring crops

Potato Volunteers



- Volunteers are potatoes left over from harvest that sprout the following year in other crops. They can serve as host for late blight and other diseases that spread to healthy potato crops.
- Volunteer potatoes are very difficult to control. The most effective strategy is to use an integrated approach.

Late Blight on Nightshade



**Spores can go at least 50 miles in storm fronts;
probably more**

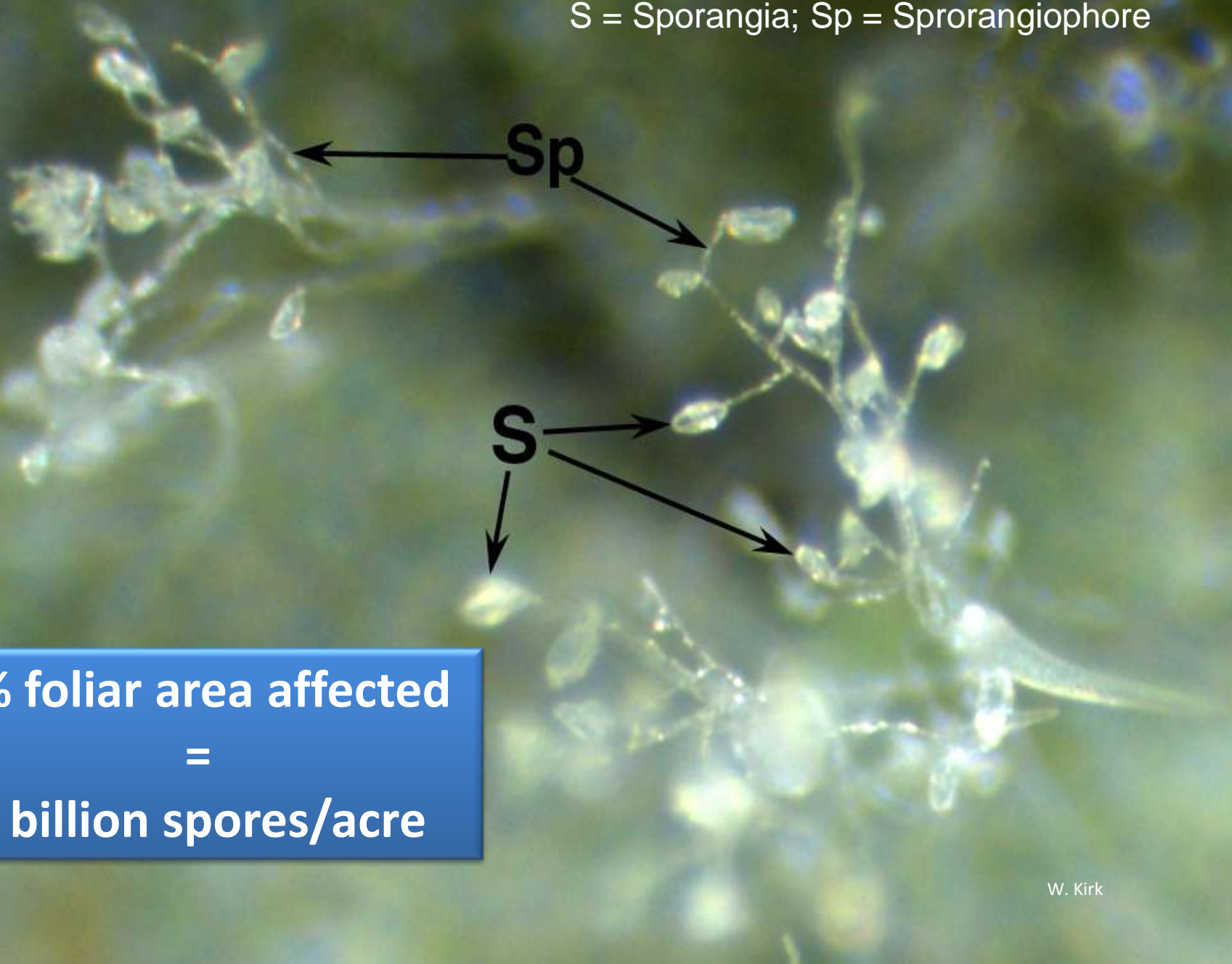


Disease Forecasting

- Disease forecasts can be helpful in determining when and how frequently to apply fungicides. However, do not rely on forecasts alone as an indicator of when to initiate a spray program. Other factors must be considered including crop stage, sources of inoculum, and weather forecasts.
- Several models use weather data to predict conditions favorable for late blight infections.
 - ➔ Most recommend fungicide application when weather conditions are favorable for late blight and **assume** inoculum is present.

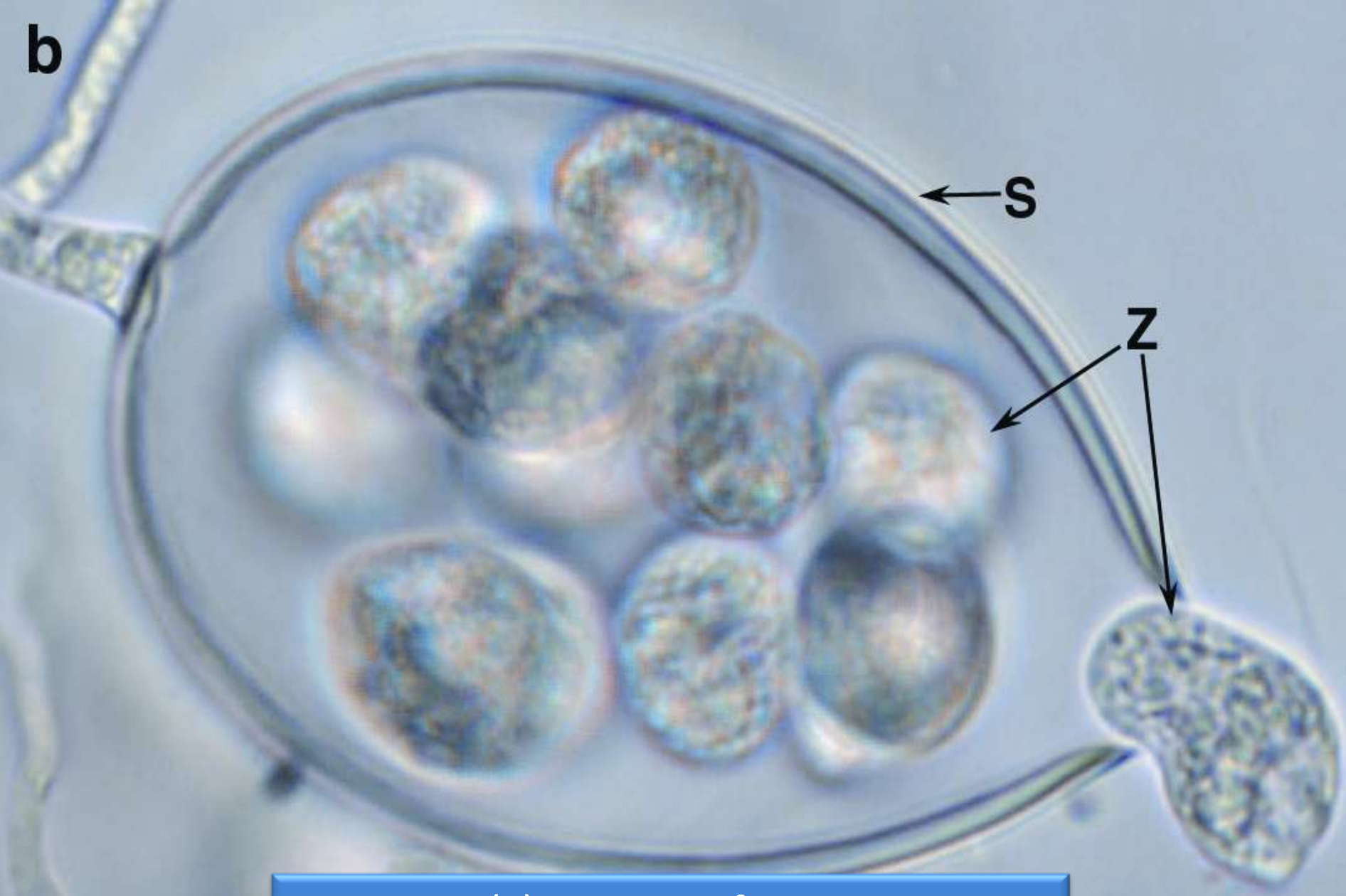
a

S = Sporangia; Sp = Sporangioophore



**1% foliar area affected
=
2 billion spores/acre**

b



Zoospores (Z) emerging from sporangium (S); potential for tuber infection increases

Seed Handling and Pre-plant Disease Considerations

Selecting Seed

- Plant only healthy certified seed tubers.
- Buy seed lots from a reliable source.
- No such thing as:
 - “a little bit of late blight”
- With a bargain seed lot you may get more than you bargained for!

Potential INFECTED SEED PER ACRE

Spacing	Seedlot infection level				
	1%	2%	3%	4%	5%
12"	145	290	435	580	725
16"	109	217	326	435	544

At 12" spacing, 14500 seed pieces are required per acre

Potential INFECTED PLANTS EMERGED PER ACRE

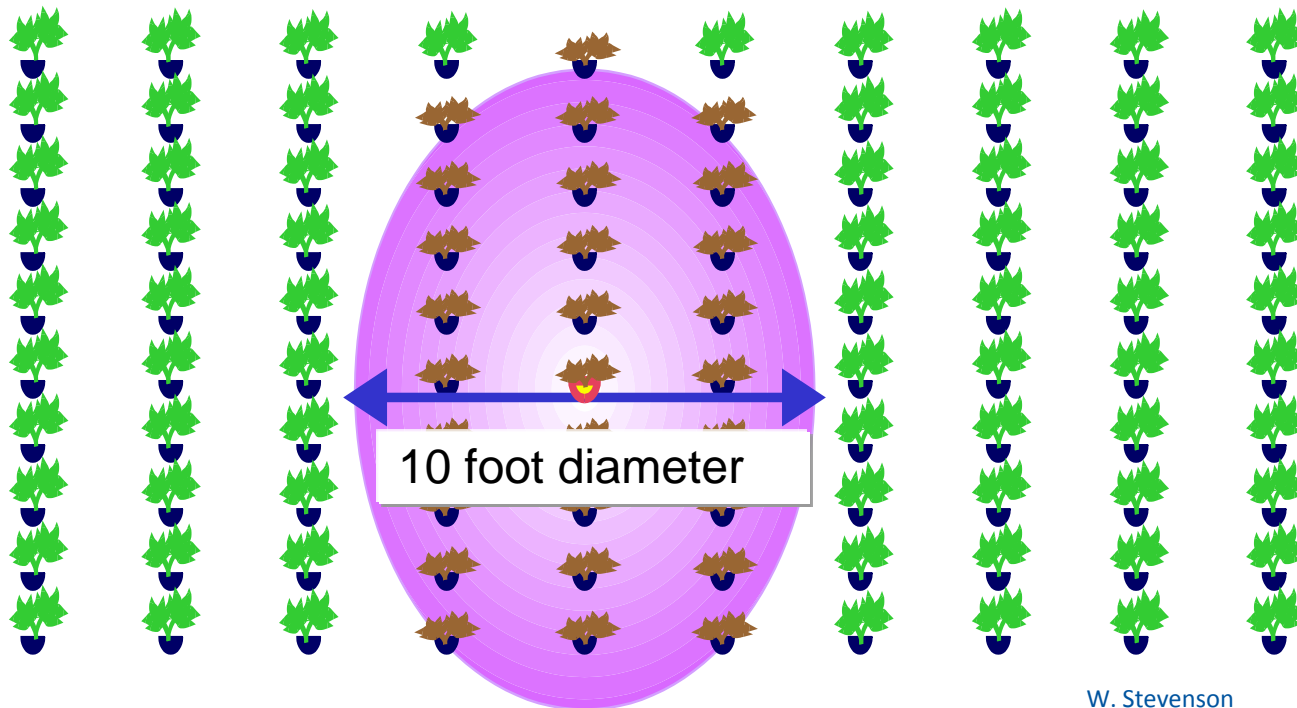
Spacing	Seedlot infection level				
	1%	2%	3%	4%	5%
12"	1	3	4	6	7
16"	1	2	3	4	5

L. Mikitzel

Late Blight . . .

The “Effect” of “Infected” Seed

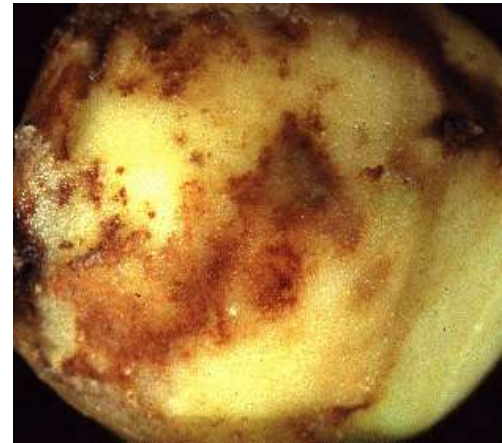
- 10 ft-diameter area killed . . . from 1 infected seedpiece



W. Stevenson

Know Your Seed Lot

- Inspect seed lots within 48 hours of delivery for brown lesions of late blight.



- You can get a re-inspection within 48 hours of delivery.

Know Your Seed Lot.....

- Grade out tubers with obvious symptoms and rot
- IMPOSSIBLE to remove all tubers with infection - hard to see on unwashed tubers
- Wash a sample under water



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Know Your Seed Lot.....

- Keep seed lots separate – avoid mixing of lots
- Grade and cut suspect lots after all other seed lots

Handling Seed Tubers

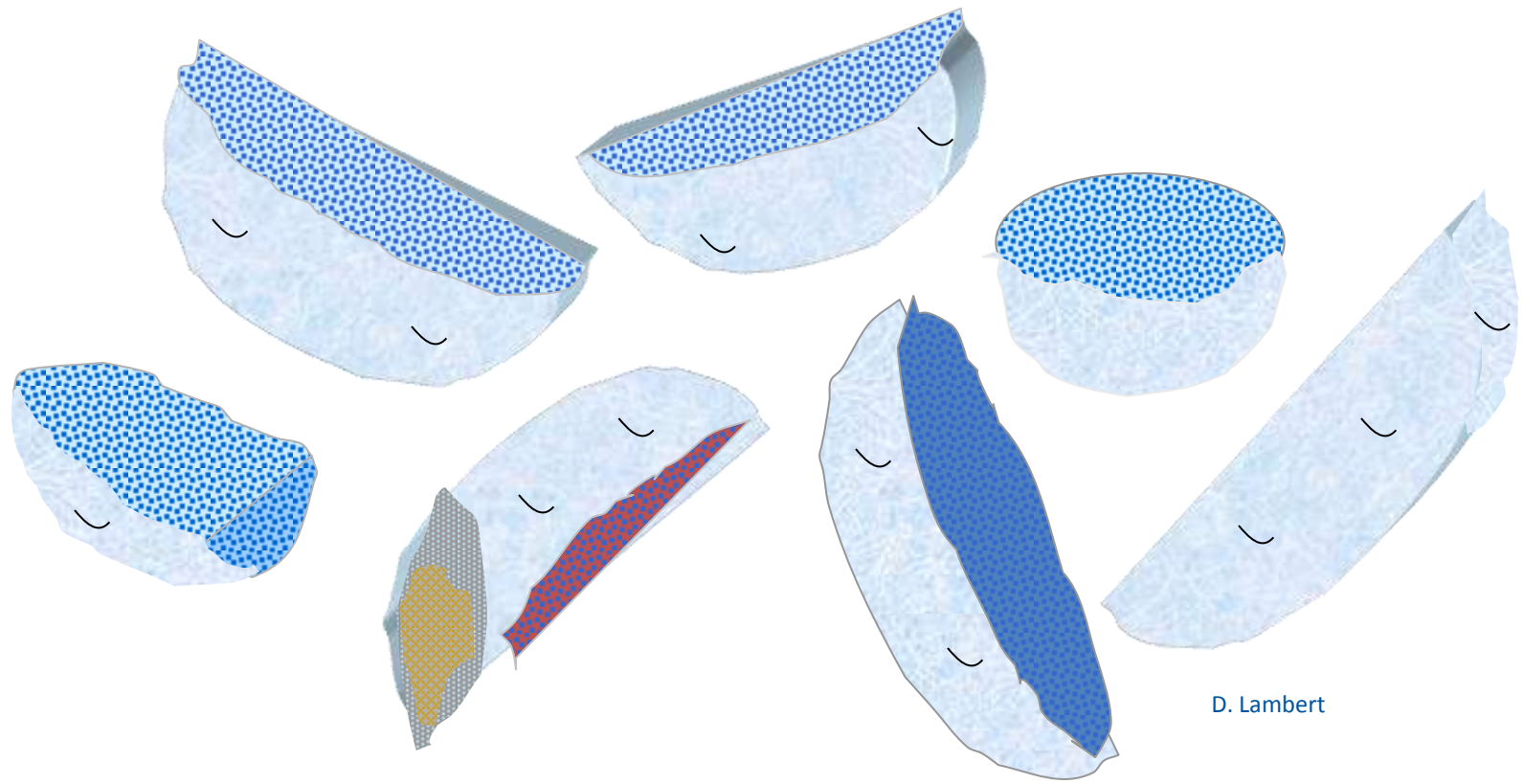
- Warm tubers to 45°F before handling
- Grade tubers slowly and carefully
- Grade before, during and after cutting

Cutting Seed Tubers

- Disinfect cutting equipment:
 - knives, rollers, sizers, containers, floor, skid-steer, wheels.
- Disinfect often.
- Disinfect especially between seed lots.

Treating Seed Tubers

- Apply a seed piece treatment to all freshly-cut surfaces.
- Apply a seed piece treatment to whole seed tubers.
- An uncovered surface is an unprotected surface.



**Seed treatment should be
applied immediately after
cutting**

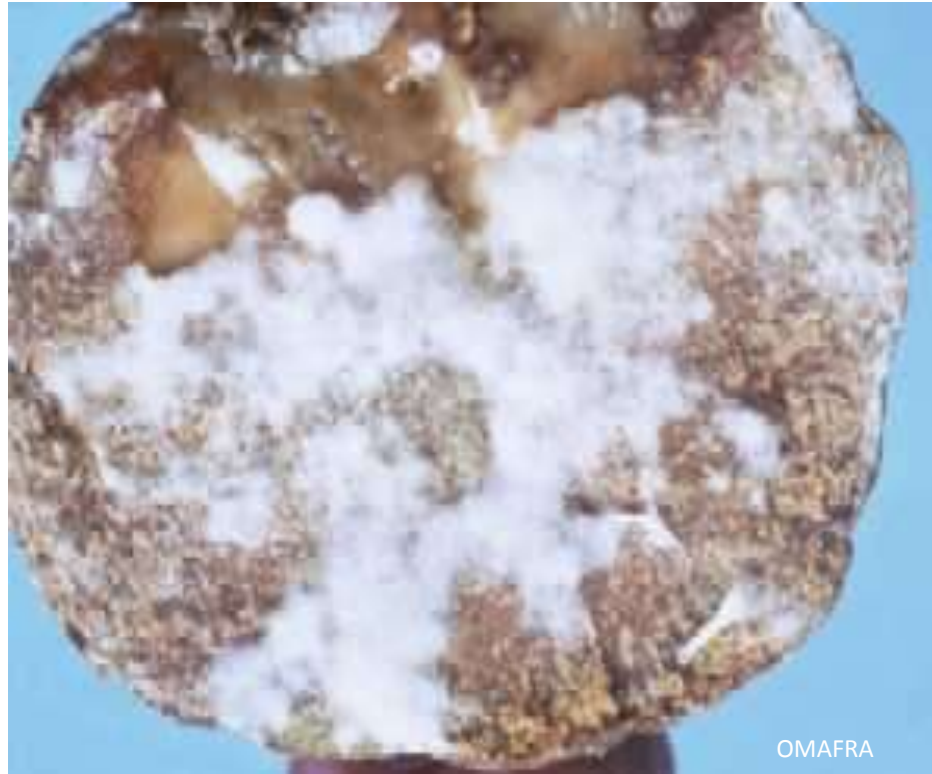
Seed Piece Treatment

- Apply immediately after cutting.
- Whole seed tubers need protection too.
- Only **mancozeb**-based products protect seed from late blight.
- Only **mancozeb-based** products reduce sporulation of late blight.
- No fungicide will make infected seed into healthy seed.

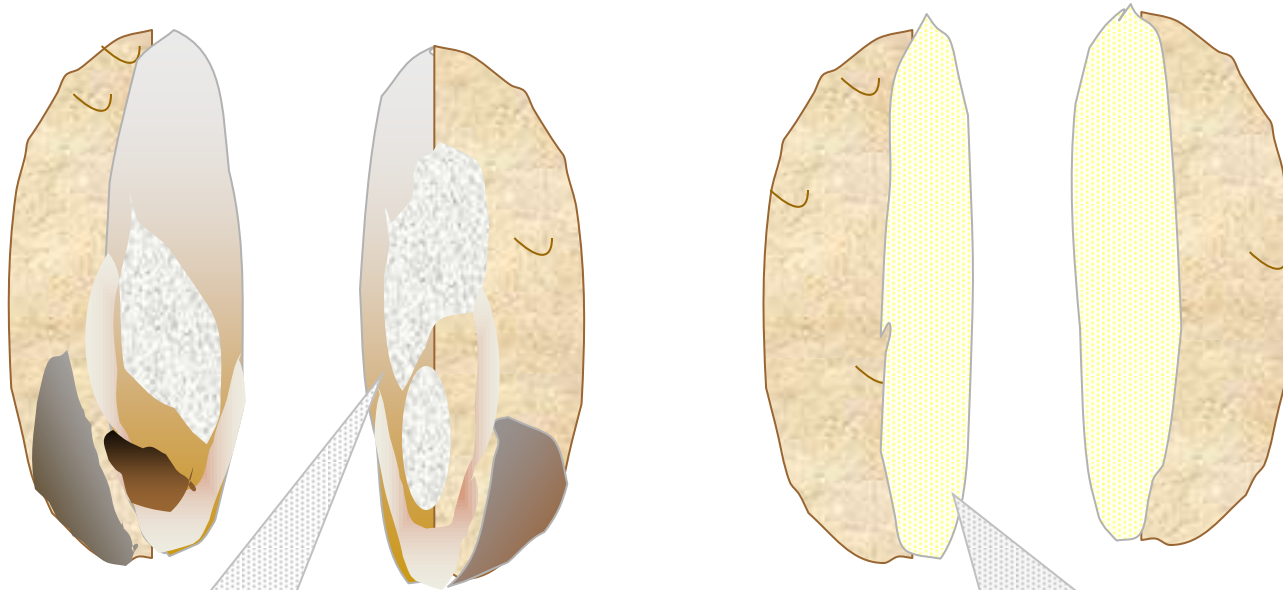
Cut, Treat, and Plant.....

- Cut and treat seed as close to planting as possible.
- Do not pre-cut and hold in a pile.
- Conditions for wound healing and holding seed before planting are ideal for late blight growth and spread.

Spores produced on the cut surface of seed pieces infect healthy seed



Seed Cutting

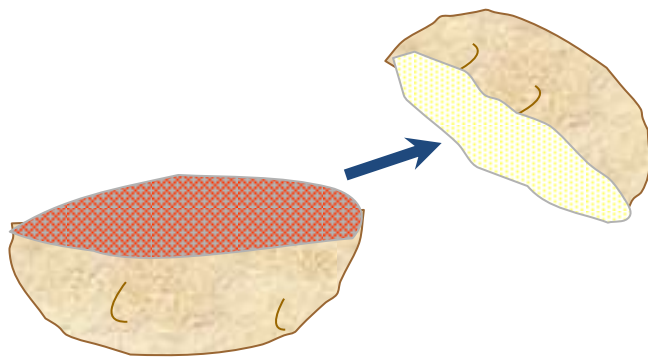


Increases
sporulation

Exposes infectable
surfaces

D. Lambert

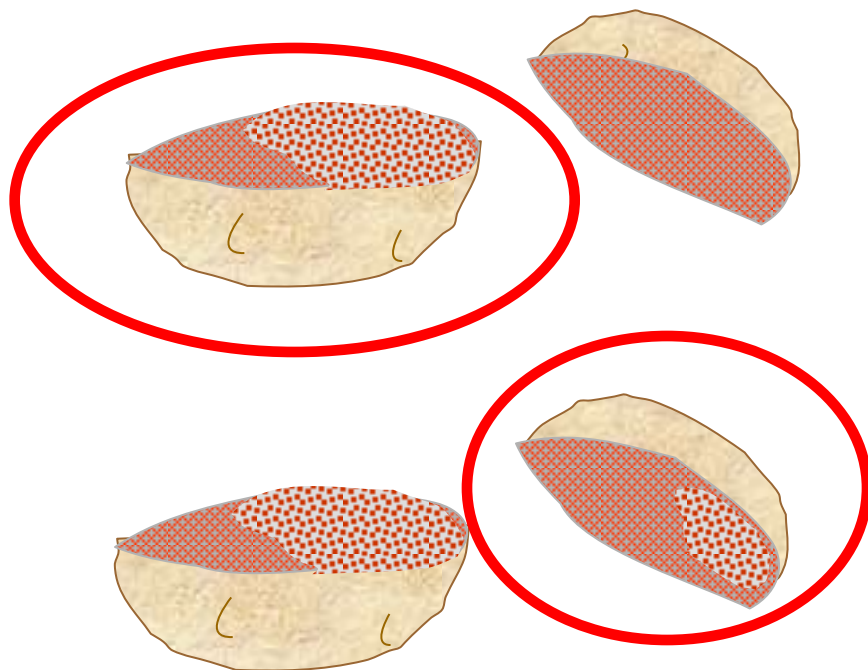
Seed pieces in a pile



tuber to tuber
8 hours

sporulation on 1°
14 hours

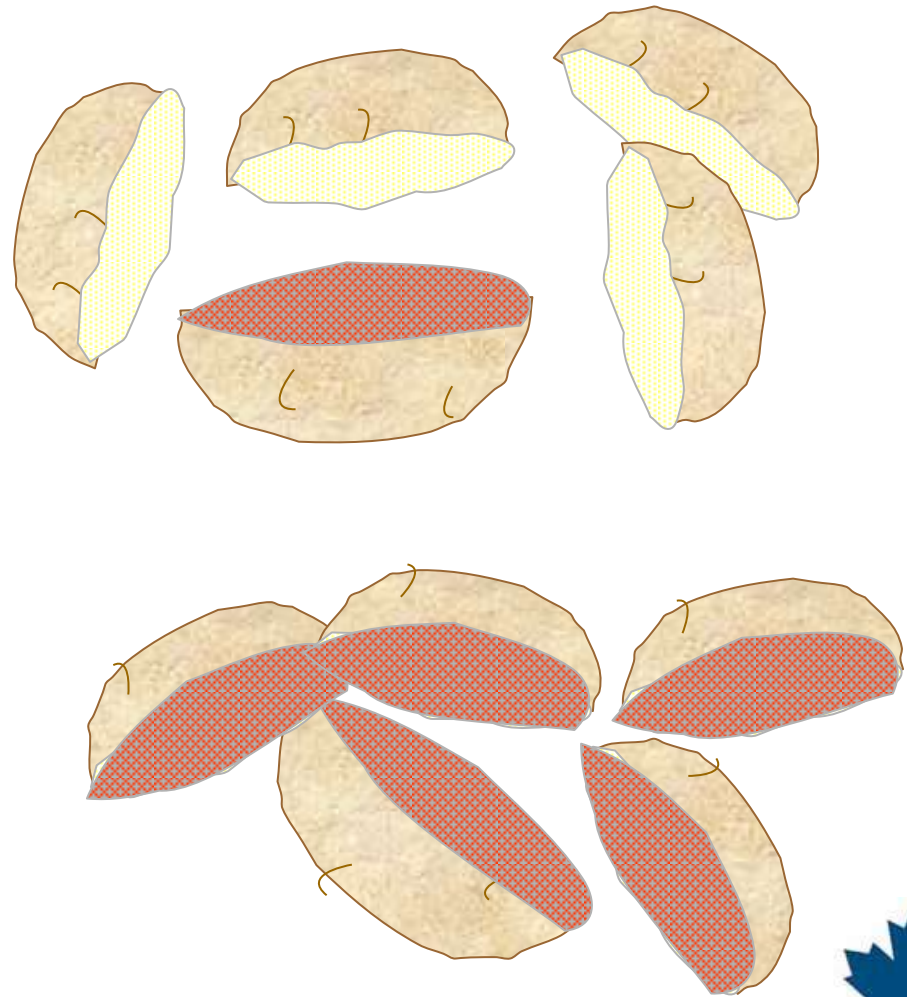
sporulation on 2°
4-7 days



D. Lambert

Transmission can occur

- During loading into truck
- During loading into planter
- During planting



Dispose of Infected Tubers

- Dispose of graded out infected tubers, pieces, slivers, sprouts etc properly and regularly.
- A forgotten pile will grow and produce spores.
- Night temperatures are not low enough to freeze potatoes solid.
- Destroy culls and waste potatoes every day.

Dispose of Culls

Alter cull potatoes and sprouts so they cannot support late blight spore production:

- Feed to livestock
- Bury
- Chop
- Compost
- Cover the pile with tarp.

Sprouts are not necessary for spore production.

Volunteers

- Destroy volunteer potatoes (fluroxypyr or dicamba mixes - Gavin Graham, NB Agriculture).
- Do not plant in fields where volunteers may be problem.



Planting & Site Selection

- Avoid planting **back- to - back** potatoes.
- Do not plant near alternate hosts.
- Know where wet areas are.
- Choose well-drained fields.
- Is the field downwind from a field with late blight in the previous year?
- Or downwind from a cull pile or rock pile?
- Mancozeb seed treatment does **NOT** move up stem to protect emerging or emerged plants.
- Plan to start spraying early.



Protect Against Late Blight

- Build a good hill.
- Spray @ 5 – 7 day intervals.
- Reverse the coverage pattern of the sprayer from one pass to the next.
- Maintain vigilance in scouting:

Scout Early . . . Scout Often

Protect Against Late Blight

Remember, When the crop is growing under ideal conditions, the canopy can . . .

DOUBLE IN FIVE DAYS

Therefore with a seven day schedule . . .

40% or MORE of YOUR FOLIAGE

could be unprotected between sprays

Protect Against Late Blight

- Call the Blight Hot Line
- Know the Severity Values for your production area

Protect Against Late Blight

- Be prepared to spray @ 80% emergence
 - Use a protectant product
 - Don't delay – the first three sprays are critical
- Calibrate your sprayer
 - Nozzles, pump pressure, booms, check for full coverage
- Follow the label rates

Factors affecting the efficacy of fungicides against late blight ...

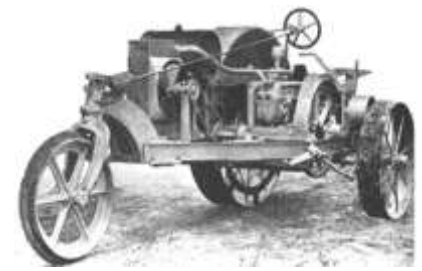
- **Timing of application.**
- **Volume:** 233 l/ha.
- **Nozzles:** Medium to Fine drop spectrum; Use new nozzles every year.
- **Pressure:** 100 psi or 690 kpa for all nozzles.
- **Boom:** Should be full before spraying.

ALWAYS READ THE LABEL



Tractor's Speed

Ground speed 6-8 mph



**Should be
adjusted to
provide
maximum
coverage**



Use water volume of 5 gpa
Avoid strips; alternate spray patterns
Use ground application to touch up edges or ground obstacles

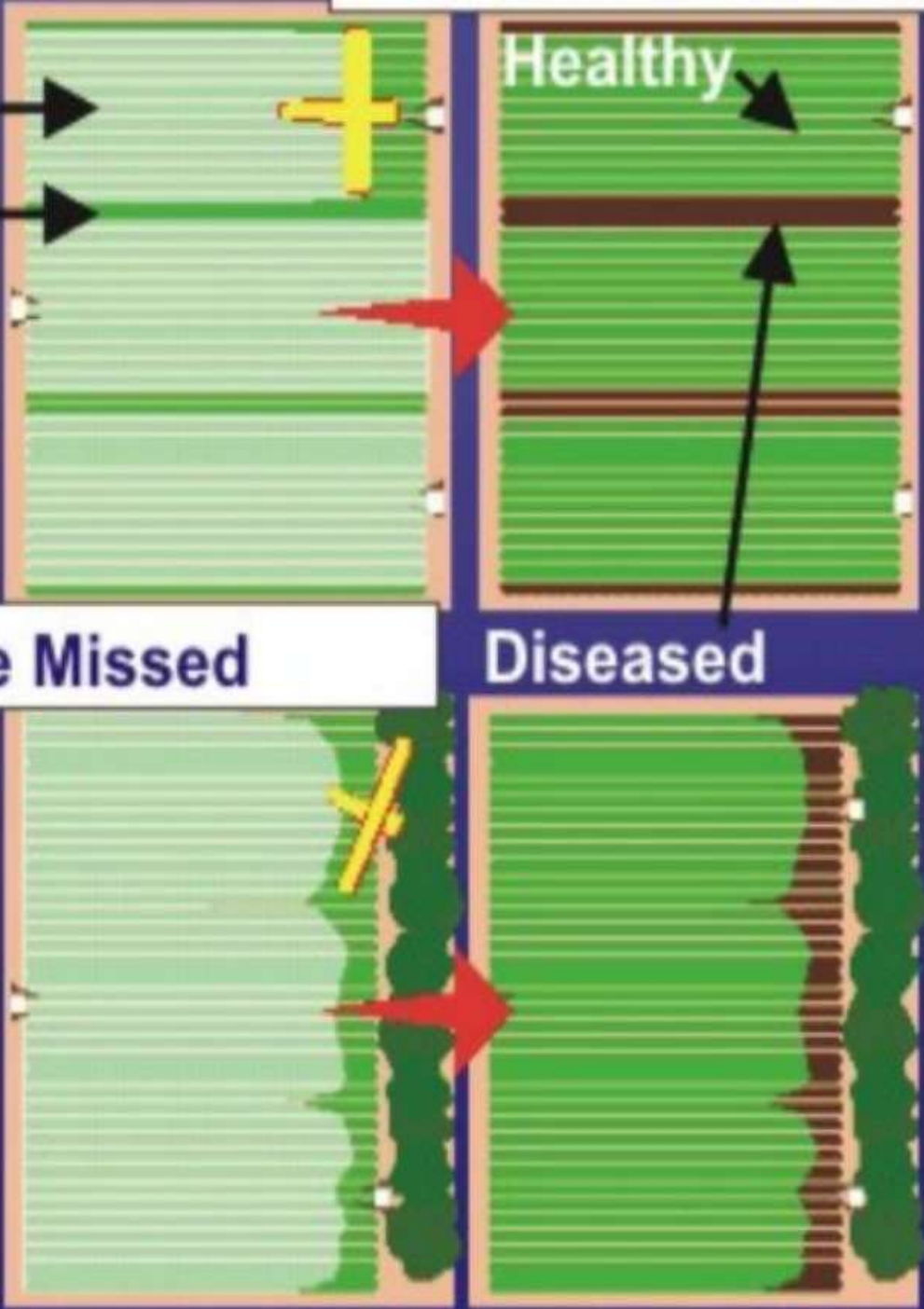
Coverage

Area Missed

Edge Missed

Healthy

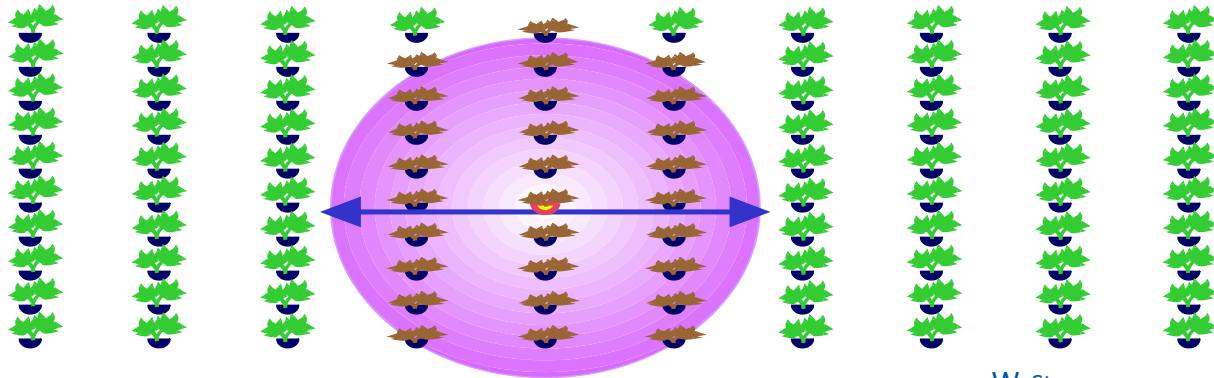
Diseased



W. Stevenson

When Late Blight is Present

- Immediately destroy infected plants and surrounding area (twice the size of the infected area - either side).



W. Stevenson

- Late in the season it is advisable to avoid excessive irrigation as tubers become infected with late blight when spores wash down through the soil from infected leaves.

When Late Blight is Present

- Incorporate a sporocidal product (cymoxanil) in a tank mix with a protectant (chlorothalonil or mancozeb)
- Maintain a 5 day spray schedule
- Spray hot spots last and disinfect equipment immediately
- Continue vigorous scouting
- Tell the Provincial Department of Agriculture. . .
and your neighbor,

This is a community disease that does not go away

Potato harvest and storage management to reduce storage losses due to late blight



You can **not** cure tubers from late blight, but you can minimize storage losses resulting from tuber infections!

Late Blight

(caused by *Phytophthora infestans*)

Map your field and locate any problem areas

- Map out your field, locate and flag any problem areas, and harvest these areas last.
- If the tubers must be stored, place them in an area that is readily accessible to allow easy removal from storage.

Kill vines well in advance

- Allow 2-3 weeks between topkill and harvest.
- Green living tissue (such as stems, which tend to resist topkill) may harbour viable spores that can be washed down to the tubers through cracks in the soil or contact tubers during harvest.
- Continue your regular fungicide spray program until the vines are completely dead.

Grade out any tubers showing late blight

- Leave infected tubers in the field as long as possible so they will decay or show signs of infection and will be easier to remove.
- The current recommendation is **not to store** potatoes if more than 5% late blight or other tuber rots are present.
- You may need extra people on the harvester or bin loader to remove as many visibly diseased tubers as possible.

Avoid conditions that are conducive to the spread of late blight

- Do not harvest during wet weather - if it is raining, stop harvesting.
- Handle tubers to minimize bruising - infection can occur through wounds.
- Remove as much soil and debris as possible - restricted airflow in storage leads to hot spots and tuber breakdown.

Minimize the potential for soft rot

- Blighted tubers are subject to secondary infections. Minimize the potential for soft rot by drying the tubers as quickly as possible.
- Continuous air movement (minimum 2 cfm/barrel or 1.2 cfm/cwt) for the first 30 days may be necessary.
- Do not wet the tubers going into storage.

Cool the pile to the holding temperature as quickly as possible

- Avoid harvesting tubers with a pulp temperature above 15 C (60 F).
- Harvest weather advisory (*e.g.* New Brunswick) can be helpful. The advisory includes:
 1. Soil temperature @ 6 inch depth.
 2. Soil moisture @ 6 inch depth.
 3. Tuber pulp temperature.
 4. Current air temperature.
 5. Overnight frost and/or rainfall.
 6. Brief weather forecast.

Do not overfill the storage

- Overfilling the storage hampers air flow and increases the chances of tuber breakdown from soft rot and pink rot.
- There should be at least 0.6 m (2 feet) between the top of the pile and the storage ceiling.

Wet conditions late in the season increase the risk of pink rot and pythium leak

- Tubers grown in areas where water accumulates can become infected with pink rot in the field.
- Pythium leak invades tubers through wounds.
- These diseases can hasten the spread of bacterial soft rot in storage through watery ooze from infected tubers.
- Good ventilation in storage is essential to control these diseases. With adequate air circulation, infected tubers will become mummified and not undergo a wet rot.

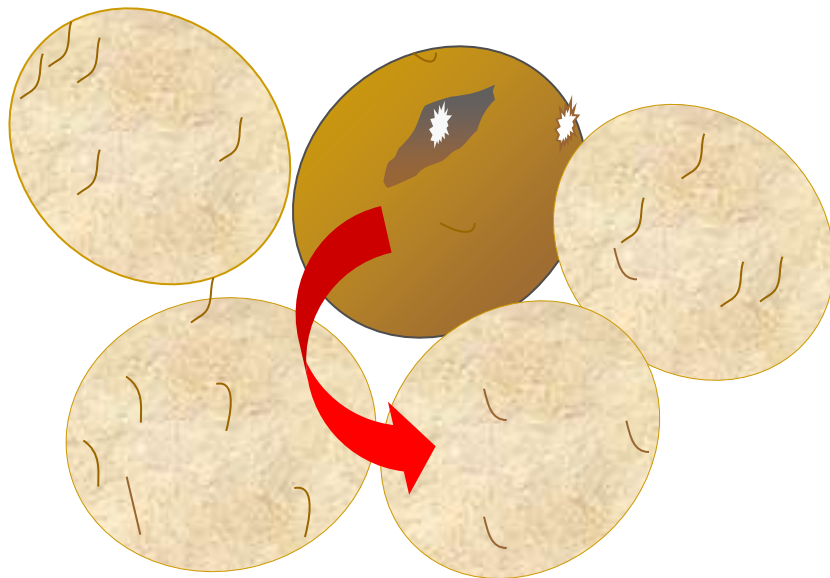
Fertilizers

Late season fertilizer applications
should also be limited

- Green and vigorous vines are difficult to kill.
- Immature tubers are more prone to skinning and therefore infection at harvest.

Harvest and Storage Checklist

- ✓ Map out the field and identify problem areas.
- ✓ Vines should be dead for at least two weeks before harvest.
- ✓ Harvest during dry periods; do not wet tubers.
- ✓ Harvest problem areas, low-lying areas and spray tracks last.
- ✓ Grade out infected tubers before storage.
- ✓ Make the pile as clean as possible, remove dirt and debris.
- ✓ Do not overfill the storage.
- ✓ Provide adequate ventilation to dry tubers and prevent secondary infections.
- ✓ Avoid free moisture in or on the pile.
- ✓ Monitor the pile closely for any signs of hot spots.
- ✓ Be prepared to move the tubers quickly if necessary.



D. Lambert

- **Blight transmission between whole tubers is unlikely under dry storage conditions.**
- **It is probable in wet piles / cull piles.**

Tuber-to-tuber spread of late blight

Interaction Between Pink Rot & Late Blight

- **Synergistic**

Late blight can pave the way to infection with pink rot.

- **Additive**

Infection with both diseases increases the level of rot in tubers.



Pink Rot vs. Late Blight

Freezing tubers may not kill the pink rot pathogen

- The pink rot fungus is more aggressive in tubers than late blight.
- The pink rot fungus is more resistant to drought and cold temperatures.
- The pink rot fungus grows much faster than the late blight fungus.

Summary

MANAGEMENT OF LATE BLIGHT

Management of Late Blight

RECOMMENDATIONS

- Assume that disease will be present.
- Test and plant only disease-free seed tubers.
- Inspect seed and remove any suspicious tubers.
- Use a mancozeb-based seed treatment.
Research suggests that this is effective at reducing the risk of late blight transmission during seed cutting and planting.
- Frequently disinfect seed cutting equipment.
- Cut and plant. Do not pre-cut.

Management of Late Blight

RECOMMENDATIONS

- Bury all cull piles according to guidelines.
- Check rock piles and last year's potato fields.
- Destroy volunteer potatoes.
- Report 'unburied' cull piles.
- If feeding culls to animals only supply enough for 1-2 days maximum.
- Frequently check predictions of disease forecasting system.

Management of Late Blight

RECOMMENDATIONS

- Closely monitor fields throughout the season
 - Scout areas of fields most likely to have high moisture for longer time period, low spots, along tree lines, etc...
- Keep an eye on home gardens.
- Immediately destroy **ALL** infected plants.
 - May mean killing a few plants, a small area or an entire field
- Notify neighbors of any issues.
- Report any case of Late Blight

Management of Late Blight

RECOMMENDATIONS

- Perform thorough sprayer check and calibration
- Initiate fungicide protection program **EARLY**
- Continue checking disease forecasting system and follow recommendations
- If needed, adopt an aggressive early season protection strategy
 - Shorten spray interval to 5 days
 - Apply **FULL** rates

Management of Late Blight

RECOMMENDATIONS

- Routinely verify sprayer performance and nozzle output
- Maintain coverage
- Build a good hill
 - Spore and zoospore mortality increases for every inch of soil over the tubers



CHC / CCH
Canadian Horticultural Council

Late Blight of Potato



Late blight, caused by *Phytophthora infestans*, is a serious potato disease that causes severe damage and storage losses. The pathogen can only survive between growing seasons as mycelium in living potato tissue. Infected tubers used for seed or discarded onto cull piles at farms and commercial storages, or infected volunteer potatoes that overwinter in the field in provinces with milder climates or where snow cover occurs early in the fall are sources of infection for the new growing season. Though late blight most commonly occurs in cool, wet climates, it can occur anywhere when irrigation or wet conditions combine with cool temperatures to favor disease development. The late blight pathogen does not require stressed plants in order to thrive and cause the disease. Under weather and crop conditions favorable to late blight, a field of potatoes can be defoliated in two to three weeks.

Disease Management

Good management includes sanitation, cultural practices, field monitoring and an effective fungicide spray program.

✦ Sanitation, Cultural Practices and Field Monitoring

1. Plant disease-free seed. Visually inspect seed potatoes within 24 hours of delivery. Cut a sample of tubers and look for the reddish, brown, dry rot characteristic of late blight tuber rot.
2. Test your seed for late blight before planting. Ask for a test certificate indicating freedom of late blight if buying seed.
3. Grade seed potatoes before planting. It is important that seed is graded after it is cut and any late blight tuber rot removed before planting. Infected tubers can be a source of early field infections.
4. Frequently disinfect seed cutting equipment (quaternary ammonium-based products).
5. Treat seed with a recommended seed piece fungicide immediately after cutting (mancozeb-based products).

This fact sheet is
available on the CHC
website at:
<http://www.hortcouncil.ca/en/projects-and-programs/potato.aspx>

For further information please contact:

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Thank You
Merci

