



Wallonie

The Potato diseases

An overview

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Armstatehydromet and Ministry of Agriculture
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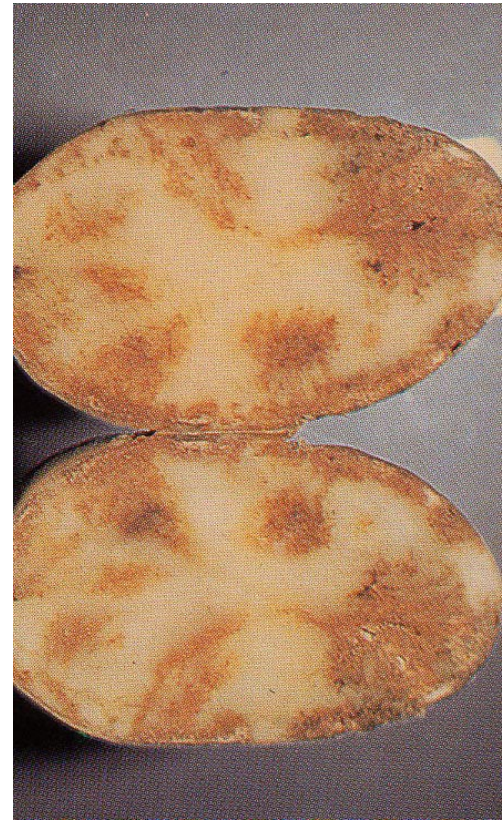
Late Blight

Symptoms



Late Blight

Symptoms



Late Blight

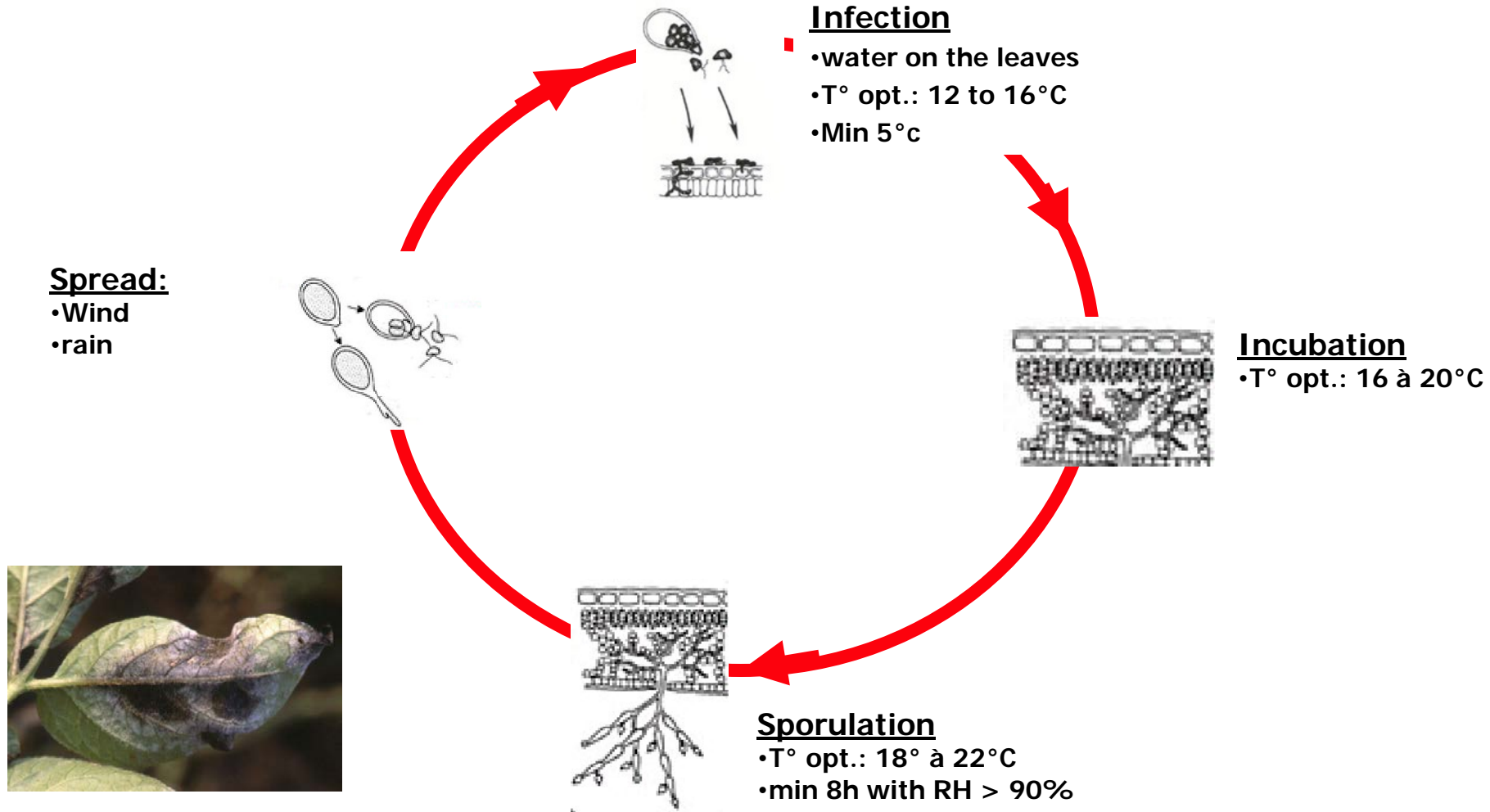
Causal organism.

Phytophthora infestans (Mont.) de Bary



Late Blight

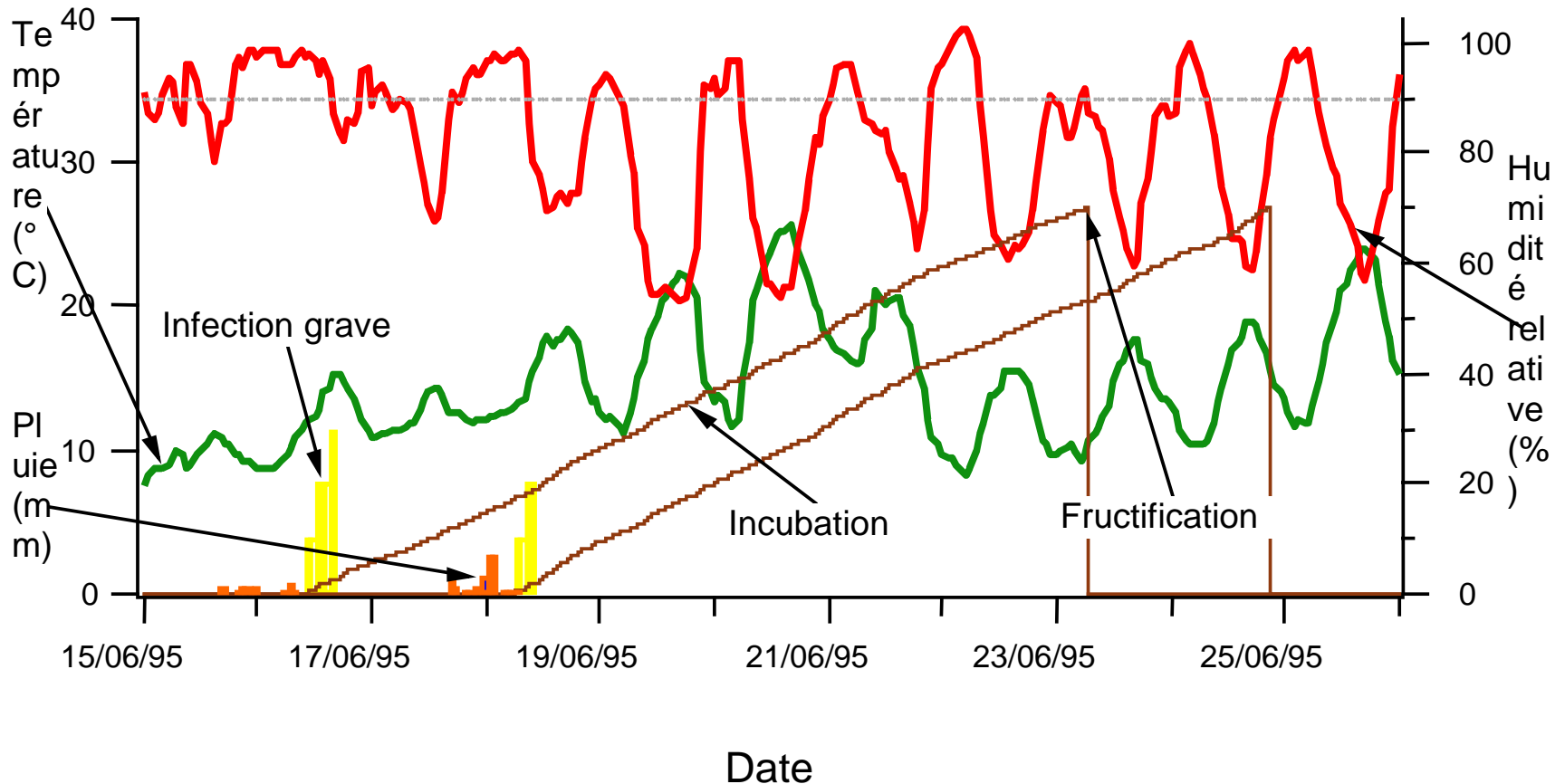
Epidemiology.



Late Blight

Epidemiology - Decision Support System.

Station de SOMBREFFE, N°27



Late Blight

Control.

- Inoculum destruction:
 - waste potatoes in piles
 - regrowing potatoes in fields (volunteers)
 - primary infection sources in fields
- Adequate hilling to have good tubers cover
- When possible, to use resistant varieties

Late Blight

Control.

■ Fungicides spraying:

- contact fungicides (without retroaction)

 - remanence: 7 days

 - dithiocarbamates, chlorothalonil, fluazinam, cyazofamide+heptamethyltrisoxane (Ranman)

 - very good action, but susceptibility to rain washing (except Ranman), applications to be repeated to protect the new leaves in the fast growing stage.

- translaminar fungicides with possible retroaction

 - remanence: 7 to 10 days

 - cymoxanil, dimetomorphe

 - unsusceptibility to rain washing

Late Blight

Control.

■ Fungicides spraying:

- systemic fungicides with possible retroaction

- remanence: 15 days

- metalaxyl, benalaxyl, mefenoxam, propamocarb

- unsusceptibility to rain washing

- to use when the crop is growing fast (new leaves every day), but not more than 3 times a season (resistant phytophthora strains selection)

- to use when many heavy rains

!! Control with fungicides must be preventive

Early Blight

Symptoms



Early Blight

Symptoms

-Lesions on leaves:

→ concentric rings

→ chlorotic around but not always

-Lesions on tubers:

→ dark, sunken,

→ brown and corky flesh

Early Blight

Causal organism.

- *Alternaria solani* (E. & M.) Jones & Gront
- *Alternaria alternata* (Fries) Keissler

Early Blight

Epidemiology

-Surviving and infection propagation:

- in soil, crop debris, infected tubers
- primary infection on the older leaves
- primary infection can be invisible on young plants in active growth
- secondary infection often occurs as plant ages, after blossoming and is then well visible
- plants that lack vigor or are maturing are predisposed to the pathogen

Early Blight

Epidemiology

-Favourable weather:

- cycles of rains after dry period
- high temperatures and high humidity

-Unfavourable weather:

- cool and humid weather

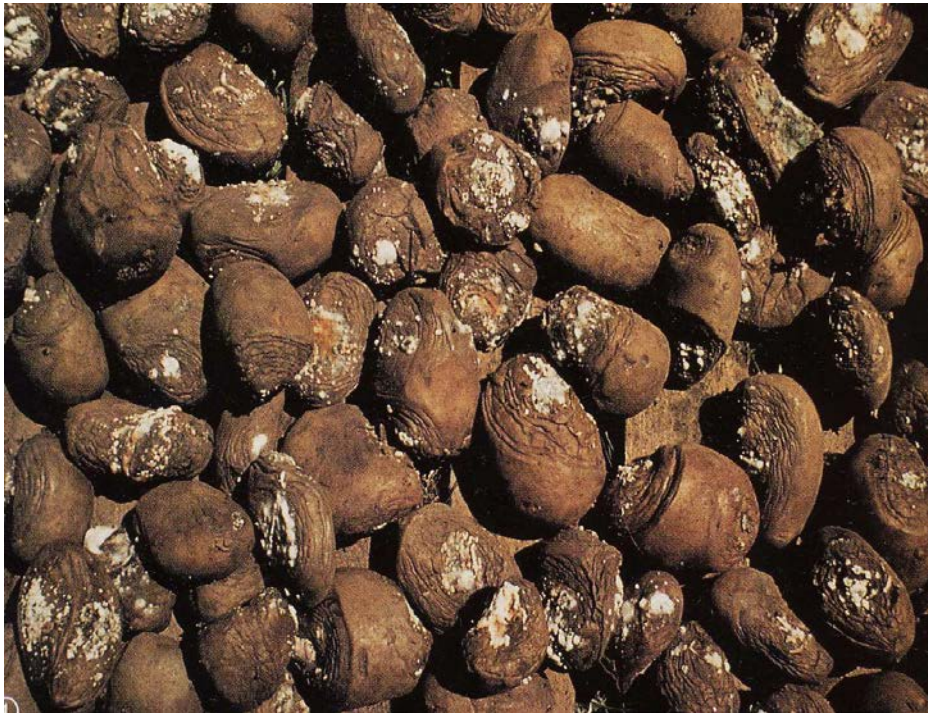
Early Blight

Control

- Long rotations:
 - without any susceptible crop.
- Proper fertilization and mineral balance in the growing and senescing plants
- Spraying fungicides:
 - dithiocarbamates, chlorothalonil, azoxystrobin.
 - when used against late blight, these fungicides are also effective against *Alternaria*, especially after flowering stage (second spores generation)
- Do not wound the tubers at the harvest.

Fusarium Dry Rots

Symptoms



Fusarium Dry Rots

Symptoms

- On tubers:

- dry rot affecting tubers in storage and planted seed tubers,
- no visible symptom at the time of harvest,
- first symptoms visible at harvest wounds a few weeks after storage: little brown lesions,
- lesions slowly enlarge and periderm around the lesion sinks down and wrinkles, often in rings.
- internal necrotic areas are shades of brown, the older attacked tissues being mummified,
- cavities can develop,
- when the conditions are favourable (humidity in storage), a secondary infection by *Erwinias* can develop and turn the dry rot in a wet rot.

Fusarium Dry Rots

Symptoms

- In field:

- plantation of infected seeds turns often in bad emergence and decay of the mother tubers by over infection by *Erwinias*
- plants develop one single stem, small and unvigorous

Fusarium Dry Rots

Causal organism.

- *Fusarium solani* var. *coeruleum* (Sacc.) Booth
- *Fusarium sulphureum* Schlecht

Fusarium Dry Rots

Epidemiology

-Surviving and infection propagation:

- in soil for several seasons, but,
- primary inoculum is generally borne on the seed tuber surface,
- present in the soil that adheres to the surfaces of the harvested tubers,
- containers and equipment contamination,
- infection enters wounds made in the harvest handling

Fusarium Dry Rots

Epidemiology

-Favourable conditions:

- wounds
- tuber susceptibility increases during storage, and reach the maximum in the spring when seeds are prepared for planting,

-Favourable climate conditions:

- 15 to 20°C
- high relative humidity

Fusarium Dry Rots

Control

- Avoid field infections:
 - harvest tubers with a hard skin: minimum 2 weeks after the foliage burning,
 - use all precautions with machinery and equipment to prevent wounding
- Promote the wounds healing after harvest:
 - store temporarily (2 weeks) the tubers at 15 to 20°C
 - high humidity and good ventilation early in storage
- Desinfect regularly the handling material and the storage house.

Fusarium Dry Rots

Control

- Seeds tubers entering in the storage house must be treated with fungicides:
 - imazalil 100 g/l (0,15l/to)
 - thiabendazole 500 g/l (0,065l/to)
 - or a mix (imazalil + thiabendazole)
 - Ultra Low Volume technique.
- Avoid seeds cutting before planting or do that in a proper way.

Black Scurf-Rhizoctonia Canker

Symptoms



Black Scurf-Rhizoctonia Canker

Symptoms



Black Scurf-Rhizoctonia Canker

Symptoms

- In field, at the level of plants:
 - leafroll and chlorosis at the top of the plants, erected leaves, purple pigmentation of the leaves are signs of problems in stems, may be due to rhizoctonia attack,
 - aerial tubers,
 - brown lesions on stems (sprouts) below the soil level,
 - brown lesions on the stolons resulting in tubers malformations
 - some times it is possible to observe the fructifications at the stems base in the form of a white mantle of powdery appearance.

Black Scurf-Rhizoctonia Canker

Symptoms

- On tubers:

- black and dark sclerotia on the surface,
- some time, you may observe the « dry core » symptom:
rhizoctonia invades the lenticels (high RH), little brown and round lesions on the tuber skin of which the center becomes empty.
- tubers malformations, many tubers of little size.

Black Scurf-Rhizoctonia Canker

Causal organism.

- *Rhizoctonia solani* Kühn

Black Scurf-Rhizoctonia Canker

Epidemiology.

-Attacks can have two origins:

- soil, in which the fungus stays for long time in vegetation debris
- tubers, on which the fungus stay in the form of black sclerotia

-Favourable conditions:

- no rotations
- planting of infected tubers
- low soil temperature and high moisture level at the time between planting and emergence

Black Scurf-Rhizoctonia Canker

Control.

- Use tubers without sclerotia,
- Planting when the soil temperature is sufficiently high to promote rapid emergence,
- Use pre-sprouting tubers (rapid emergence),
- Long rotations.

Black Scurf-Rhizoctonia Canker

Control.

- Tubers disinfection before planting with fungicides:

- flutolanil 460g/l (0,2 l/to)
- Pencycuron 250g/l (1 l/to)
- fludioxonil 100g/l (0,25l/to)
- azoxystrobine 250g/l (6l/ha, soil, before plantation, or at planting time in the row, 22,5ml/100 m)

Silver Scurf

Symptoms



Silver Scurf

Symptoms

- Only on tubers:

- infections are well visible if you wash the tuber,
- light silvery blotches of various sizes on the tuber skin,
- if tuber is covered on a large percentage of its surface, it may shrivel during storage from excessive water lost
- under the binocular, you will observe black conidiophores.

Silver Scurf

Causal organism

- *Helminthosporium solani* Dur. & Mont.

Silver Scurf

Epidemiology

- Transmission from infected seed tubers.
- Transmission from the non disinfected handling material or storage houses.
- Need a high level of humidity for infection:
 - min. conditions for infection are 3°C and 90% RH.
- Generally the level infection increases during storage.

Silver Scurf

Control

- Avoid the use of contaminated seeds.
- Reduce the delay between the foliage burning and the harvest.
- Apply a good drying of the harvested tubers before to store them (good ventilation)
- Avoid condensation in the storage houses and on the tubers.

Silver Scurf

Control

- Disinfect warehouses and ventilation system after the storage period:
 - formol (30% formaldehyde) 5l / 100l H₂O
 - bleach (12° Cl) 10l / 100l H₂O
 - quaternary ammonium (different types)
- Eventually, treat the tuber seeds before planting:
 - mancozeb 2kg/to, before plantation
 - imazalil 100g/l 100ml/to, after harvest and before plantation

Powdery scab

Symptoms



Powdery scab

Symptoms

- There are no above-ground symptoms.
- Roots and stolons: small galls forming on them, occasionally
The galls resemble those of root knot nematodes (*Meloidogyne sp.*)
- Tubers:



Scab form



Canker form

Powdery scab

Causal organism

- *Spongospora subterranea* (Wallr.) Lagerh

Powdery scab

Epidemiology

- Powdery occurs wherever potatoes are grown but is mainly of importance in cool temperate climates
- Cystosori comprise a mass of resting spores: can survive in soil for more than 10 years
- In response of the presence of host crop, spores within the cystosori germinate, releasing the zoospores which, in presence of water, swim to the host and infect it.
- Production of secondary zoospores able to infect new plant tissues of which tubers in formation

Powdery scab

Epidemiology

- Infections occurs at temperatures between 9 and 17°C and is dependant on a high soil water content.

Powdery scab

Control

- Where soil temperatures are high and the climate dry, there is no risk of infection: but the use of irrigation in such climate can favour the infection.
- Irrigation must be used carefully especially when the tubers are initiating (susceptible phase)
- In cooler and humid climate, choose free draining soil with a good structure (no soil compaction)
- Select fields without history of powdery scab presence
- Use healthy seeds

Potato Virus Y

Symptoms



Potato Virus Y

Symptoms



Potato Virus Y

Symptoms



Potato Virus Y

Symptoms

- Symptoms vary widely with the strain type and the variety:
 - weak symptoms: light mosaics (PVYⁿ)
 - severe symptoms: crinkle, necrosis,... (PVY^o)
- Symptoms vary in severity if the infection is a:
 - primary infection: infection of the year (generally light)
 - secondary infection: infection originated from the mother tuber (generally more severe)

Potato Virus Y

Causal organism

- *Potato Virus Y*, potyvirus
- Different groups and strains:
 - PVY^o
 - PVYⁿ (PVY^{ntn}, PVYⁿ Wilga)
 - PVY^{n:o} : recombinants n + o
 - PVY^c

Potato Virus Y

Epidemiology

- Transmission to the daughter tubers by the infected mother tuber.
- Transmission from plant to plant by many aphids species .
- Non persistent way of transmission:
 - aphid catches the virus rapidly (no need for a feeding hole)
 - aphid is immediately infectious and transmits the virus when he is going to visit another plant
- Important role of PVY sources, especially the secondary infected plants in the field.

Potato Virus Y

Control

- Control of Virus Y is very important in potato seeds production.
- Avoid the use, for multiplication, of too infected potato seeds lots (more than 2% of infection).
- Avoid contaminated area (consumption potato fields) for the multiplication of potato seeds.
- Use resistant varieties if possible.

Potato Virus Y

Control

- Early roguing in the multiplication fields is very important to reduce the infection pressure in the field itself: eliminate all the plants with symptoms of PVY.
- Protection with paraffinic mineral oils is more efficient than the use of insecticides:
 - 7 to 10 liters /ha and per week in 2 applications
 - be care of the phytotoxicity of mineral oils, especially in the case of hot weather.

Potato Leaf Roll Virus

Symptoms



Potato Leaf Roll Virus

Symptoms

- Primary symptoms:

- young leaves stand upright, roll and turn slightly pale. Some times (depending on the cultivar), they turn pink or reddish starting at the margins. Later these symptoms may spread to the lower leaves.

- Secondary symptoms:

- the symptoms are visible when the emergence is completed: lower leaves rolled, higher leaves slightly pale
- leaves make a crisp when pressed
- all the plant is stunted.

Potato Leaf Roll Virus

Causal organism

- *Potato Leaf Roll Virus* , Luteovirus

Potato Leaf Roll Virus

Epidemiology

- Transmission to the daughter tubers by the infected mother tuber.
- Transmission from plant to plant by aphids feeding on potato:
 - *Myzus persicae*, *Macrosiphum euphorbiae*, *Aphis nasturtii*, *Aulacorthum solani*, *Myzus ascalonicus*, *Rhopalosiphoninus latysiphon*.
- Persistent way of transmission:
 - aphid catches the virus after a long feeding hole,
 - aphid is not immediately infectious, latency.

Potato Leaf Roll Virus

Control

- Control of PLRV is very important in potato seeds production.
- Avoid the use, for multiplication, of too infected potato seeds lots (more than 2% of infection).
- Avoid contaminated area (consumption potato fields) for the multiplication of potato seeds.
- Use resistant varieties if possible.

Potato Leaf Roll Virus

Control

- Early roguing in the multiplication fields is very important to reduce the infection pressure in the field itself: eliminate all the plants with symptoms of PLRV.
- Protection with insecticides is efficient:
 - pyrethrinoids (Cypermethrin, deltamethrin, bifenthrin,...)
 - carbamates (Pirimicarb: be care for the aphid resistances)
 - neonicotinoïds (imidacloprid, thiamethoxam, systemics)
 - pymetrozine (systemic, translaminar)
 - acetamiprid (systemic)
 - thiacloprid (systemic)
 - flonicamid (systemic)

Potato Virus X

Symptoms



Potato Virus X

Main characteristics

- Transmission by contact between plants, between people and plants, between machines and plants
- Incidence on yields not important, except if infection by virus X is combined with other virus infection (PVY+PVX - PVA+PVX)
- Control: avoid the use of infected lots in multiplication programs.

Potato Virus S

Symptoms



Potato Virus S

Main characteristics

- Visual detection not easy: sometimes, rugosity, slight deepening of veins. Need ELISA tests to be detected.
- Transmission by contact and, for certain strains, by aphids.
- Incidence on yields not important.
- Control: avoid the use of infected lots in multiplication programs.

Potato Virus A

Symptoms



Potato Virus A

Main characteristics

- Symptoms: mild mosaics (primary infection) to more severe mosaics in which the light colored areas alternate with areas of darker than normal green.
- Transmission by aphids, on a non persistent way.
- Control: the same measures as those adopted for PVY have to be taken.

Potato Virus M

Symptoms



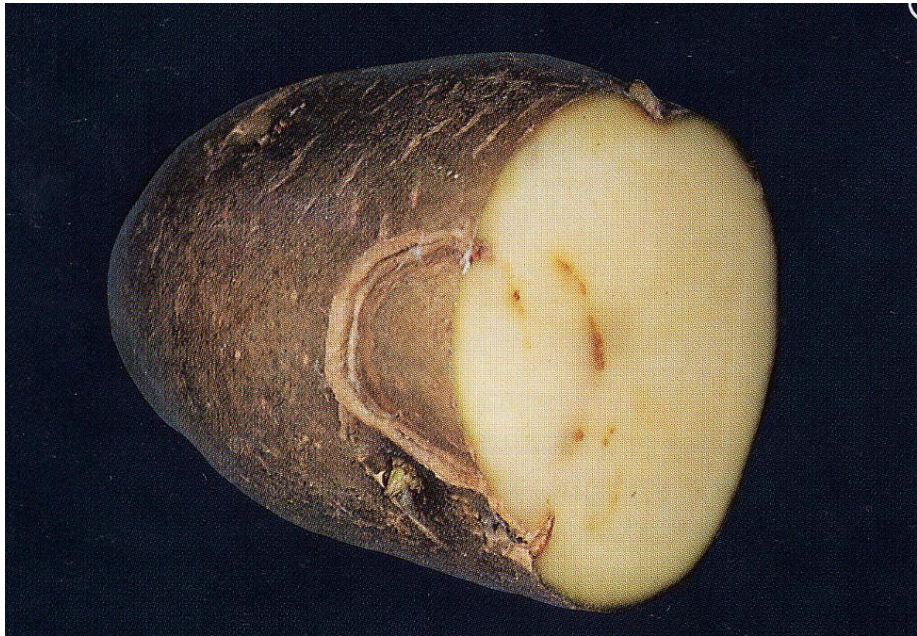
Potato Virus M

Main characteristics

- Symptoms: rolling of leaves, mosaics, leaflets deformation and edges twisting
- Transmission by aphids, on a non persistent way.
- Control: the same measures as those adopted for PVY have to be taken.
- More important in Eastern Europe than in West Europe where he is practically unknown

Tobacco Rattle Virus

Symptoms



Tobacco Rattle Virus

Main characteristics

-Symptoms:

- on leaves: rare, only at temperatures < 20°C, bright yellow blemishes in arc and rings,
- on tubers: common symptoms are concentric rings, alternating living and necrotic tissue but also small necrotic flecks.

-Transmission by nematodes (*Trichodorus-Paratrichodorus*) feeding directly on tubers.

-Incidence of TRV is highest in sandy soils.

Tobacco Rattle Virus

Main characteristics

-Control: avoid sandy soils contaminated with nematodes and susceptible varieties.

Common Scab

Symptoms



Erumpent scab



Russet scab

Common Scab

Symptoms

- Causal agent: *Streptomyces* sp.
- Symptoms may vary from superficial corlike layer (russet scab) to an erumpent scab.
Symptoms forms depend on the species (*S. scabiei*, *S. europaeiscabiei*, *S. stelliscabiei*, *S. reticuliscabiei*), on the potato variety, on the pedo-climatic conditions.

Common Scab

Epidemiology

- Soils have been infected with infected potato seeds.
- All tuberous crops can be a refuge for Streptomyces (radish, carrots, turnip, sugar beet,...)
- The early tuber setting is a critical stage for the infection.
- Dry and airy soils at this moment is favourable for the contamination. Soil temperature of 19 to 24°C is favourable for the contamination (erumpent scab).

Common Scab

Epidemiology

- Wet soil, unairy, t° of 13 to 17°C are favourable for the russet scab.
- A lot of varieties are susceptible to the erumpent scab. This is not the case for the russet scab.

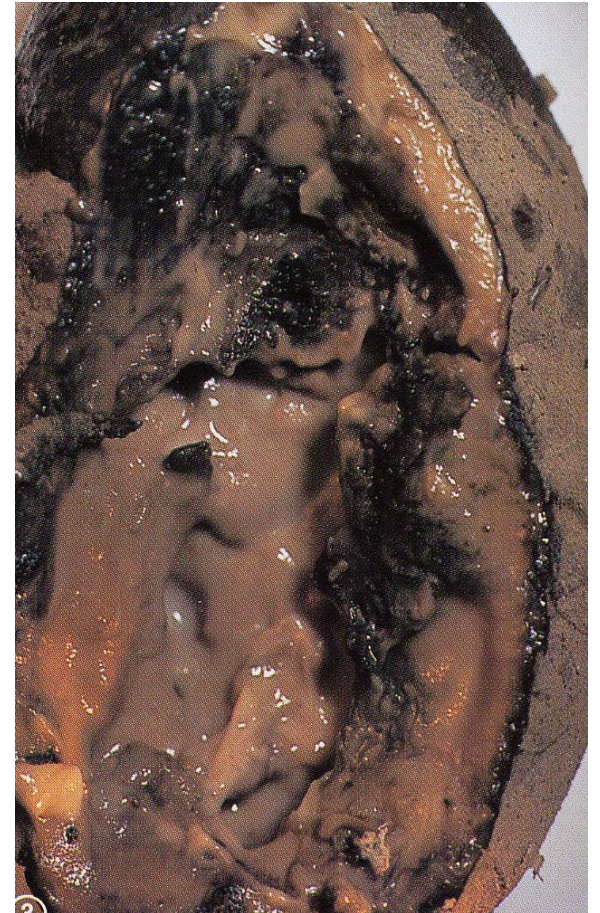
Common Scab

Control

- Long rotations without susceptible crops.
- Avoid liming the soil or do that just after the potato crop.
- Avoid planting potatoes just after a permanent grass.
- Apply irrigation (Erumpent scab) just at the moment of tuberization initiation or moderate this for 4 to 6 week after tuberization initiation (Russet Scab).

Bacterial soft rots

Symptoms



Bacterial soft rots

Symptoms



Bacterial soft rots

Symptoms

-On plants in field:

- infected plants are stunted and discolored (yellow).
Leaves tend to roll. It can be only one of all the plant stems.
- stems wilting, dry light brown lesions on leaves
- typical blackleg symptom at the stem foot.
- often, the mother tuber is completely rotten.

Bacterial soft rots

Symptoms

-On tubers:

- tubers can be affected by rot while in storage, or in the soil before harvest.
- Infection occurs through lenticels and wounds or through the stolon when the infection is transmitted by the mother tuber.
- wet rot, cream color, healthy tissues are well delimited from the attacked ones.
- characteristic foul smell.

Bacterial soft rots

Causal organisms

- *Pectobacterium atrosepticum* (*Erwinia carotovora* var. *atroseptica*)
(Northern Europe, cool climate, 18 to 24°C)
- *Pectobacterium carotovorum* (*Erwinia carotovora* var. *carotovora*)
(All climate types, 24 to 34°C)
- *Dickeya* sp. (*Erwinia chrysanthemi*)
(Adapted in more warm climate, 28 to 36°C)

Bacterial soft rots

Epidemiology

- The primary inoculum is borne on or in seed tubers. After being planted, the seed piece will decay and release large number of bacteria in the soil. Bacteria will survive all the season in the rhizosphere of the host and will be able to invade daughter tubers trough lenticels or wounds
- Bacteria may move in the soil with water and contaminate adjacent plants

Bacterial soft rots

Epidemiology

- Infections are often latent without symptoms. Seed tubers are stored in unfavourable temperature for the disease development (3-4°C) but, after the storage, when the tubers are in more suitable conditions (transport, plantings in wet soils), the bacteria population on the tubers can increase rapidly and causes the decays.
- Optimal temperatures for *Pectobacterium atrosepticum* are about 20°C: often in cool climates. Classical black leg.

Bacterial soft rots

Epidemiology

- Optimal temperatures for *Pectobacterium carotovorum* are a little higher: 25°C. Can be observed everywhere. Stems rottings, black leg, rotten tubers.
- Optimal temperatures for *Dickeya sp.* are higher: 30°C
Well adapted in warm climates but often observed in west Europe. Dry necrotic lesions on foliage, wilting, rotten tubers
- Wet soils with a lack of oxygen favour the diseases.

Bacterial soft rots

Control

- Use healthy seeds. There is a clear relation between the level of seeds contamination and the possible disease development in fields (humid and hot climate).
- Make the harvest in a proper way: good skin set, reduce the wounds, harvest dry tubers.
- Avoid condensation during storage.
- Clean stores, boxes, machinery between seasons.

Potato cyst nematodes



Potato cyst nematodes

Symptoms

- Parts of the field where plants haven't the same standing than the plants in other parts
- On the root system: presence of cysts and/or females
- Sometime on tubers, presence of necrotic lesions

Potato cyst nematodes

Causal organisms

- *Globodera rostochiensis* (Golden potato cyst nematod)
- *Globodera pallida* (Pale potato cyst nematod)

Potato cyst nematodes

Life cycle

- Hosts: *Solanum spp.* mainly (Potatoes, Tomatoes, aubergines)
- Different pathotypes (Ro1 to 5, Pa1 to 3): the pathotypes are recognized by their inability to multiply on specific potato cultivars.
- From eggs within cysts present in the soil, and under the stimulus of host roots exudates, formation of juveniles which invade the roots. Females remain attached on the roots while males, in moving vermiform, fertilize them.

Potato cyst nematodes

Life cycle

- After fertilization, the males die and the females remain attached to the roots while eggs develop within them
- When females are fully mature, they die and form the cyst which contain the eggs (500 eggs/cyst)
- The cysts drop from the root surface into the soil and remain dormant (for many years) to act as a source of inoculum for future crops.

Potato cyst nematodes

Control

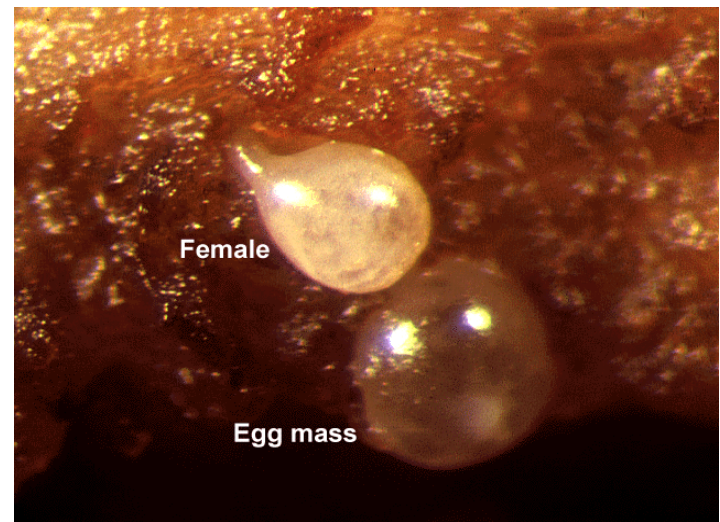
- Potato cyst nematodes are major pests of the potato crop in cool-temperate climates: submitted to quarantine measures
- Problem more serious if resistant cultivars not available
- 2t/ha of lost for every 20 eggs/g of soil
- Crop rotation with non host plants: 7 year without any solanaceous crops
- Use of resistant potato cultivars and nematicides together to keep the populations levels below economic thresholds

Potato cyst nematodes

Control

- Use of certified seeds
- Soil sampling in case of production of seed potatoes
- In fields known as free from nematodes:
 - soil sampling at regular intervals to ensure early detection
 - be sure that the used potato seeds are free (sampling and lab assays)
 - ensure a good rotation system
- Avoid soil transportation from infected fields to healthy ones
- Get rid of volunteer potato plants between two potato crops

Root-knot nematodes

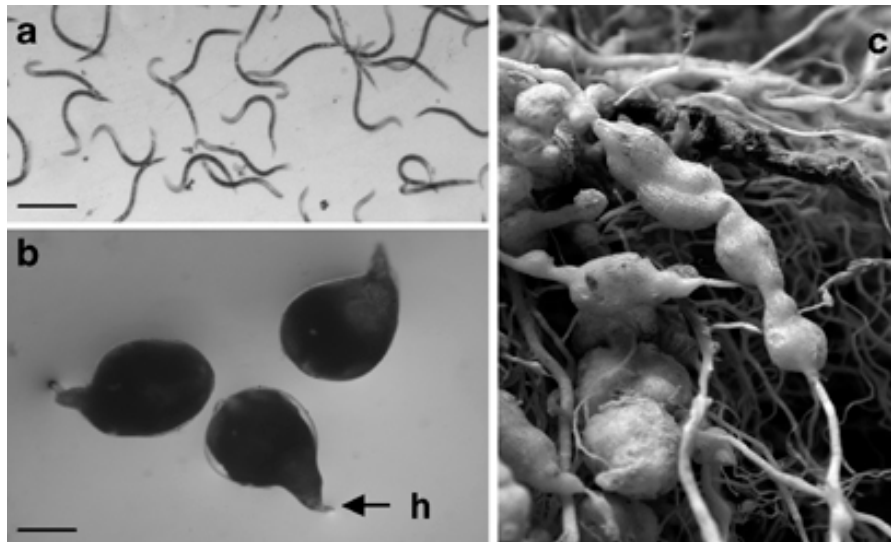


Root-knot nematodes

Causal organisms

- *Meloidogyne* spp.

- *M. javanica*, *M. incognita*, *M. arenaria*...: in the tropics and mediterranean basin
- *M. hapla*, *M. chitwoodi*, *M. fallax*: mediterranean basin and temperate regions



Root-knot nematodes

Symptoms

- Slow / stunted growth of plants, yellowing of the leaves, wilting of the plant despite of adequate soil water content, premature senescence
- Presence of galls on the roots and on tubers (swellings)
- Presence of necrotic spots or discoloration in the flesh



Root-knot nematodes

Life cycle

- Second stage juveniles of nematodes hatch from eggs laid in either the soil or plant tissue and seek the tips of roots for invasion.
- When established in the root tissue, the nematodes feed on the plant cells and grow
- The infected cells are stimulated to divide and enlarge, forming the galls
- There are 3 different moults. At the final development stage, the body of the female changes into a spherical shape while the male remains vermiform

Root-knot nematodes

Life cycle

- Under good climatic conditions, and 3 to 4 weeks after entry into roots tissues, females commence egg laying (can produce up to 2000 eggs)
- Eggs hatch in warm moist soils or can survive at least a year without hatching.
- These nematodes have a wide host range (polyphagous)

Root-knot nematodes

Control

- The wide host range means that control of this pest is difficult
- *M. chitwoodi* and *M. fallax* are quarantine pests in West Europe
- Good hygiene is the key part of managing those pests:
 - use of healthy seeds (certified)
 - make a sanitary vacuum cleaning of the infected fields without any plants during 12 months
 - use in the rotation of species that are resistant against the nematode: for this identify what kind of nematode species you have to face (cereals in case of *M. arenaria*, *M. javanica* or *M. incognita*)
 - use of nematicides in order to reduce the nematode populations