**Viral / Virus-like Diseases**

**Aster Yellows**

- Virus-like organism (phytoplasma)
- The organism is not visible

- Hosts
  - More than 300 different plants in 48 families
    - carrot, celery
    - cucurbits (pumpkin, squash, melons)
    - herbs & spices
    - eggplant, lettuce
    - onion, garlic, leeks
    - parsley, pea
    - pepper, potato, tomato

**Aster Yellows in Romaine lettuce**

Photo by P. Northover
Aster Yellows in Romaine lettuce

Aster Yellows in Carrots

Photo by P. Northover

Witches' Broom / Proliferation of shoots

Aster Yellows in Carrots

Photos by P. Northover

Hairy roots

Aster Yellows in Carrots

Photos by P. Northover

Conditions Favouring Disease Development

- Presence of insect vectors (Aster leafhoppers)
- Pathogen also overwinters in perennial plants

Aster Leafhopper

Photo by P. Northover

Management Strategies

- Control insect vectors
- Control weed and perennial host plants within crop and around field margins
- Avoid planting crops near fields of other susceptible crops
- Use quality, high generation seed potatoes and virus-free plant material
Late Blight

- **Phytophthora infestans**
- Affects all aboveground parts, plus infects tubers
- Requires living tissues to overwinter

### Serious disease of Solanaceous plants
- **Primary Hosts**
  - Potatoes
  - Tomatoes
- **Secondary Hosts**
  - Eggplant, peppers, petunia
  - Solanaceous weeds (nightshade, wild tomato)

### Primary Hosts
- Potatoes
- Tomatoes

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- Eggplant, peppers, petunia
- Solanaceous weeds (nightshade, wild tomato)

Life Cycle of Late Blight

- Needs free water for germination
- **A2 mating type not in WCan**
- US-11 & US-24 in AB this last season

- Dark, water-soaked lesions
- Lesions may have a yellow edge

- Become brown & brittle within a couple of days
- Lesions are not contained by leaf veins

- Lesions move in from leaf tip or margin
- LB on tomato

Lesions move in from leaf tip or margin

Photo by R. Howard
Sporulation may occur under moist conditions – on older lesions.

Lesions may also develop on stems, tomato fruit or potato tubers.

Plants may be rapidly defoliated & die.

Disease may spread to healthy tubers in storage.

Rot may have a reddish-brown colour.

Disease develops rapidly in field.

Rot penetrates deeply.

LB on tomato fruit
### Conditions Favouring Disease Development

- Moderate temperatures & wet/humid conditions
  - 16-21°C day / 10-16°C night
- Extended periods of leaf wetness (dew, irrigation) favour spore germination & lesion development

### Conditions Favouring Disease Development cont’d

- Disease transfers from infected living tissues
- Tubers (seed potatoes, cull piles)
- Volunteer potatoes or weeds
- Transplants (tomatoes)
- Spores are spread through wind, rain/water splash (many miles - 50+)

### Management Strategies

- Preventing overwintering on living tissues or introduction of infected materials
- Apply protective applications of fungicides
- Control volunteers and Solanaceous weeds
- Adjust plant density to reduce humidity
- Water using drip or flooding to reduce wetting foliage

### Management Strategies

- Dispose of infected material as soon as detected
- Bury / freeze infected tissues
- Tarp compost piles
- Top kill to reduce tuber infection
- Cull potato tubers heavily before storage
- Late blight is a “community disease”

### Early Blight

- *Alternaria solani*
- Very common disease
- **Hosts**
  - Potato
  - Tomato
  - Pepper
  - Eggplant
  - Solanaceous weeds
Concentric Rings
Limited by veins

Photo by R. Howard

Tuber lesions
Yellow border

Photos by R. Howard

Conditions Favouring Disease Development

- Persists on crop residues, in the soil, on infected tubers and on other hosts
- Spores are spread by contact of leaves with soil or through wind or water splash
- Cool, moist or dew-forming nights favor spore formation
- Disease development greatest at 20°C
- More prevalent on older leaves and vines and on stressed plants
- Wounded tubers can become infected

Management Strategies

- Dispose of infected vines
- Maintain good soil fertility
- Maintain a 2–3 year crop rotation
- Ensure tubers are fully mature when harvested
- Don’t harvest when soil is wet
- Avoid mechanical injury during harvest
- Application of registered chemical fungicides can slow disease development and protect plant tissues

SCLEROTINIA ROT / WHITE MOLD
Sclerotinia Rot (White Mold)

- **Sclerotinia sclerotiorum**
- **Hosts**
  - Carrots, lettuce, celery, beans, cole crops, potatoes, peas, cucurbits, solanaceous crops, various weed species (e.g. cruciferous)
- **A.K.A Lettuce Drop, Cottony Soft Rot**
- Pathogen causes a range of diseases in various crops
- Disease of field and storage
- Most serious disease of stored carrots

**Conditions Favouring Disease Development**

- Soil-borne sclerotia (hard mycelial bodies) produce mycelium, which infect plant tissues
- Sclerotia can also produce spores, which can infect weak, damaged or dying tissues in high and prolonged humidity conditions
- Spread occurs between carrots in storage
- Storage infections develop from field infected tissues
- Dirty pallet boxes can also cause infection
- Temperatures 13-18°C are optimum (but can develop above 0°C)
- Free moisture & RH greater than 92% favour disease

**Management Strategies**

- Maintain a 3-5 year rotation
- If possible, remove infected debris from growing areas
- Trimming canopy / Control weeds
  - Improves air flow & reduces leaf wetness & RH
  - Weeds = alternate hosts
- Ensure good air circulation and good soil drainage
Management Strategies

- Rapidly cool harvested crops & store crops such as carrots at constant 0°C
- Ensure storage areas and containers are properly sanitized, to remove any sclerotia that may adhere to surfaces
- Preventative chemical sprays are available to protect various crops

Clubroot

- *Plasmodiophora brassicae*
- Host Crops
  - Cruciferous (Brassica) crops
  - Canola, Cole crops (cabbage, broccoli, cauliflower, rutabaga, etc)
  - Cruciferous weed species (stinkweed, wild mustard, flixweed, etc)

- Resting spores are viable for up to 18 years
- Disseminated by:
  - drainage water
  - with soil that clings to seed, equipment, shoes, tools, and transplants
  - in contaminated manure
  - in contaminated irrigation water

Conditions Favouring Disease Development

- Resting spores germinate in the presence of susceptible roots and water
- Often more severe on wet, acidic soils
- Soil temperatures of at least 16-21°C are required for resting spore germination
### Management Strategies

- Ensure rigorous sanitation is practiced
  - Ensure that all equipment or personnel leaving an infected field are free from potentially contaminated soil
  - Do not remove straw or plant material from an infected field and spread it elsewhere
- Minimize soil erosion
- Ensure good soil drainage
- Maintain a higher soil pH (above 7), with pH adjustments made by liming the soil

### Management Strategies

- Follow a 5 to 7 year rotation between cruciferous crops
- Control cruciferous weeds
- Avoid applying contaminated manure (animals fed contaminated cull plants or pastured in infected crops)
- Avoid using contaminated irrigation water
- Use only healthy transplants for spring planting
- A transplant fungicide application may help to prevent infection – follow label instructions

### Botrytis (Grey Mold)

- **Botrytis cinerea**
- **Hosts**
  - Wide range of crops
- **Same pathogen causes a range of diseases in different crops**

![Botrytis Cinerea](Photo by L. Hausher)
Grey mould – extensive spore formation

**Conditions Favouring Disease Development**

- Occurs during periods of moderately warm, humid weather
- Invades tissues when cool and humid & when there are prolonged periods of leaf wetness
- Poor air flow
- Affects weak, soft, aged, senescing, damaged or dying plant tissues
- Spores produced rapidly

**Management Strategies**

- Ensure fields are well-drained
- Ensure there is good air flow/ventilation within the crop canopy
- Maintain plant health / Avoid stressed plants
- Avoid excess nitrogen (soft, weak plants)
- Remove trash piles
- Water when plants can dry quickly
- Apply registered fungicides

**Botrytis Neck Rots**

- *Botrytis* species (*B. aclada*, *B. byssoidea*, *B. squamosa*)
- One of most common storage diseases of onions
- Hosts
  - Onion
  - Shallots
  - Leek
  - Garlic
  - Chives

Definite margin

“Cooked” appearance

Photo by P. Northover
Fungal growth evident in neck area of stored onions

Conditions Favouring Disease Development

- Overwinter as sclerotia on cull piles, onion debris, unharvested bulbs and soil
- Germinate under moist conditions
- Spread is rapid during wet seasons and ripening and harvest periods
- Injury (bruising / damage) during harvest can increase incidence
- Does not spread bulb to bulb

Management Strategies

- Remove sources of inoculum such as cull piles, unharvested crops
- Maintain minimum 2-year rotations
- Keep fields separate from each other
- Ensure proper curing of mature bulbs
- Grade out damaged, bruised or thick-necked onions before storage
- Store onions at 0°C and 65-70% RH

Rhizoctonia

- Rhizoctonia solani
- Hosts
  - Wide range of host crops
  - Potatoes
  - Cruciferous vegetables
  - Other
- Causes a range of diseases
  - Damping off
  - Wirestem (cruciferous veggies)
  - Black Scurf (potatoes)
  - Creater Rot (Cruciferous root crops)
  - Bottom Rot (cabbage)
  - Rhizoctonia canker (potatoes)
**Conditions Favouring Disease Development**

- Overwinters as sclerotia on tubers and in the soil
- Sclerotia germinate and mycelium infect tissues
- No spores are produced
- Cold and wet soils
- Short rotations

**Management Strategies**

- Plant clean seed tubers
- Plant into soil and in conditions which favour rapid emergence and good plant growth
- Ensure minimum 3 year rotations
- Seed treatments can control seed-borne inoculum, but will not protect shoots from soil-borne inoculum
- Avoid overwatering

**POWDERY MILDEW**
Powdery Mildew

- *Erysiphe* species
- **Hosts**
  - Cruciferous crops
  - Lettuce
  - Peas
  - Rhubarb
  - Cucumbers
- Can’t survive without live host tissues
- Each species is very host specific
- Spread may not be noticeable until most of the field is infected

**Conditions Favouring Disease Development**

- Develops in the spring & fall
- Windborne spores are the main means of spread
- Warm, dry weather (15-27°C; inhibited by rainy, wet conditions) but conditions of high humidity
- Poor air flow and shade due to dense shelterbelts or dense plant canopies
- Cleistothecia (sexual spores) provide overwintering

**Management Strategies**

- Use resistant cultivars if they are available
- Ensure rotation to non-susceptible crops
- Ensure adequate air flow and ventilation within crop canopy
  - adequate plant spacing
  - removal of any element that creates high humidity conditions
- Remove & destroy infected plant parts and crop debris
**Management Strategies**

- Control non-crop hosts plants (weeds, volunteers, etc.)
- Timely application of registered chemical controls (ensure rotation of chemical groups, if possible)
- Regular wetting of the leaves can reduce disease development (not a guaranteed control)

**Non-pathogenic Diseases**

**HERBICIDE INJURY**

- Most vegetable crops are susceptible to injury from low levels of herbicides
- Timing and level of exposure will determine degree of injury

**Herbicide Injury**

- Drift (high or no wind)
- Soil residues
- Contaminated water supplies
- Contaminated manure from treated hay
- Over or misapplication
- Improper spray tank cleaning

**Symptoms / Damage**

- Distortion of plant parts
  - Twisted growth
  - Strapping
  - Curled or cupped leaves or stems
  - Poor or spotty emergence
- Abnormal growth habits
- Malformed tubers
- Death of tissues
- Whole plant death
- Scale of problem in field will vary

- Picloram damage – curled/cupped/strapped leaves
- Triasulfuron (Odyssey) damaged tubers
- Killex drift damaged tomatoes
Management Strategies

- Know the chemical history of the land you are using (3-5 years)
- Avoid overspraying or overlapping
- Have frequent contact with neighbours or those growing on adjacent pieces of land
- Know the history of manure or other materials that are being spread on your land

Physiological Disorders

- Hollow heart / Hollow Stem
- Growth Cracks
- BER
- Tip burn

Insects

Insects That Carry Pathogens

ASTER LEAFHOPPER
**Aster Leafhoppers**

- *Macrosteles quadrilineatus*
- Hosts
  - More than 100 plant species in at least 40 families
  - Spring cereals & grasses - preferred hosts
  - Major impact on lettuce, carrots, celery, and other vegetable crops
- Feeding of adults doesn't cause economic damage
- Transmission of Aster yellows is more critical

**Monitoring**

- Yellow sticky traps can be used starting in early spring
  - Spraying should commence when adults are found on traps
  - Sweeping can determine adult numbers & changes in populations
  - Aids the decision-making process

**Management Strategies**

- Chemical sprays should be applied when adults are 1st detected
- Plow fields immediately after harvest to remove infective material and breeding areas
- Control weeds which serve as alternative inoculum source
- Reflective materials have been suggested to repel leafhoppers somewhat

**Cutworms**

- Range of species
- Affect a wide range of vegetable crop hosts
- Adults = moths
- Subterranean caterpillars
- Feed above ground at night
  - Feed on plant parts and stems at or near ground level
- Overwinter as eggs on plant debris
Red-backed Cutworm

Distinctive “C” shape

Found by nighttime walks or shallow digging
Watch for plants that collapse or have signs of feeding damage

Monitoring

Naturally occurring predators, parasites or pathogens can reduce populations
Apply registered chemical controls in the late evening or at night
Contact with pest is typically required
Ensure good canopy penetration

Management

Fleas

Phyllotreta cruciferae (crucifer flea beetle)
Hosts
- Canola, mustard, cole crops, radish, rutabaga, turnip
- Cruciferous weeds

Other species occur
- Specific to other crops

Flea Beetles
Monitoring

- Look for shot hole damage on cotyledons
- Estimate average % damage to cotyledons per 100 plants - control at 25%

Management Strategies

- Later or delayed seeding or use of transplants can help plants to withstand injury
- Control cruciferous weed hosts
- Irrigation during adult activity can reduce populations somewhat
- Fabric covers can protect plants
- Apply registered chemical controls
CABBAGE (ROOT) MAGGOT

Cabbage (Root) Maggot

- **Delia radicum**
- **Hosts**
  - Cruciferous crops and weeds
- **Typically one generation per season in AB**

Monitoring

- Use **sticky traps or sweep nets** in spring to watch for adult flies
- Pull **sample plants** from across the field, ensuring tap root is left intact
- Look for **signs of larval tunneling**, with channels evident on the outside of the root

Management Strategies

- Make control decisions based on the influence of weather on egg and larval survival – hot, dry weather favours reduced egg/larva survival
- Apply **registered chemicals** after transplanting – typically a drench application
- Tillage prior to seeding or winter can reduce survival of pupae
- Control **cruciferous weed species** to reduce overwintering sites
Colorado Potato Beetle

- *Leptinotarsa decemlineata*
- **Hosts**
  - Solanaceous crops (potato, tomato, eggplant)
  - Solanaceous weeds (nightshades, wild tomato)
  - Cabbage
  - Pepper
  - Pigweed, thistle, lamb’s quarters
- One of most important pests of potato in Canada
- Single generation per season

Monitoring

- Begin monitoring early in season when plants begin to sprout - look for larvae and adults
- Inspect 10 feet (3m) of row in minimum 10 locations, regardless of field size
- Record the number of plants in each section with at least 1 larval colony (determine total for 10 sites)
- Potatoes are most sensitive to feeding damage around peak flowering

Management Strategies

- Chemical treatment at 10% defoliation (potatoes can tolerate up to 20-25%)
- Ensure rotation between chemistry to avoid development of resistance
- Crop rotation can reduce populations
## Caterpillars

**Imported Cabbageworm**
- *Pieris rapae*
- Cabbage looper
- *Trichoplusia ni*
- Diamondback moth
- *Plutella xylostella*

**Hosts**
- Cruciferous crops and weeds
- Other host crops depending on the pest
- More than one generation will occur in all areas
- Not known to overwinter on the prairies (but does as a pupa everywhere else)

## Symptoms / Damage

- Larvae chew holes in the leaves and render heads unmarketable
- Larval frass (poop) is notable and is a contaminant of leaves and flower heads
- Presence of larvae is unacceptable in marketed product

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**Imported Cabbageworm – adult butterfly**

**Imported Cabbageworm – larvae, feeding damage & frass**

**Cabbage Looper adult moth**
Management Strategies

- Natural predators and viruses will reduce populations
- Biological and chemical controls are registered for control - adhere to application timings and rates for effective control

Other Common Insects

2-spotted Spider mites
Lycus Bug / Tarnished Plant Bug
Aphids
**WEEDS**

**Impact of Weeds**
- **Competition**
- Reduced crop survival / vigour (especially in establishment years)
- Reduced yields
- **Alternate hosts** for disease & insect pests
- Create environment conducive to disease/insect growth & development
- **Negative customer perception**
  - Sloppy appearance
  - Poorly managed operation

**Weed Management Strategies**
- Control weeds before planting (1-2 year)
- Manage weeds as best as you can
- Annual weeds – prevent seed set/maturation
- Plastic mulch
- Manage the between-row spaces (adjust spacing to allow for equipment movement)

**Weed Management Strategies**
- Registered chemicals are effective & available
  - Chemical applications must be carefully timed to avoid damaging plants
  - Consider soil duration of applied products (impact on following crops)

**PEST MANAGEMENT REGULATORY AGENCY (PMRA) E-LABEL SEARCH**
http://pr-rp.hc-sc.gc.ca/ls-re/index-eng.php

**QUESTIONS???