Spinach Diseases: Field Identification, Implications, & Management Practices

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Organic Seed Alliance Spinach Seed Field Day

23 May 2006, Sequim, WA

2006 International Spinach Conference

13-14 July 2006, La Conner, Skagit Co., WA

http://capps.wsu.edu/conferences/spinach/

Spinach Diseases

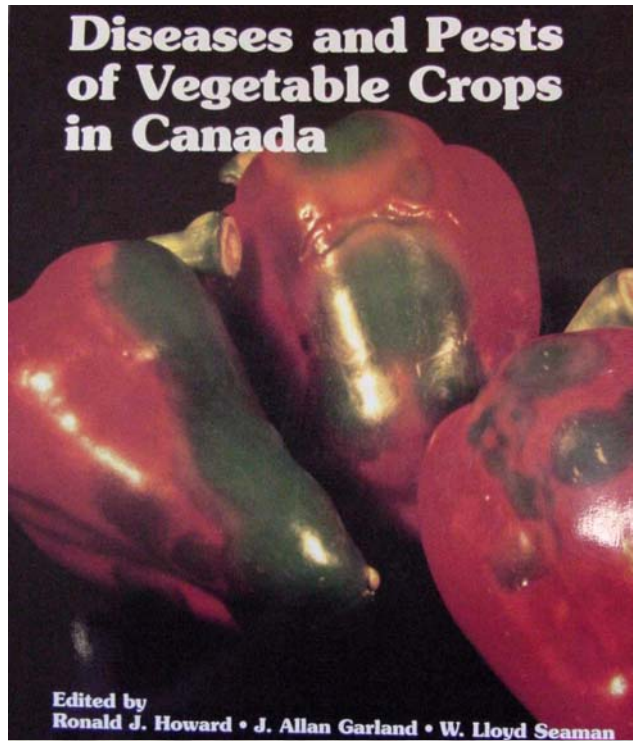
"Common Names of Plant Diseases: Spinach":
http://www.apsnet.org/online/common/names/spinach.asp

- 3 bacterial diseases (caused by 3 bacterial species)
- 14 fungal diseases (caused by ~26 species of fungi)
- 6 viral diseases (caused by >10 viruses)
- 1 phytoplasma disease
- Numerous abiotic disorders
  (physiological, nutritional, genetic, chemical, environmental, mechanical)

Diagnosis of Spinach Diseases

- Visual observation of symptoms
- Collate data on crop history, cultivar, pattern/timing of symptom development, etc.

- Microscopic examination
- Isolate pathogens
- Test plant tissues
  - ELISA (antibodies)
  - DNA or RNA
  - Nutrient tests (plants/soil)
- **WSU/OSU Plant Clinics**
  - http://www.puyallup.wsu.edu/plantclinic/
    Tel: 253-445-4582
  - http://www.bcc.orst.edu/bpp/Plant_Clinic/index.htm
    Tel: 541-737-3472



Spinach seedling diseases:

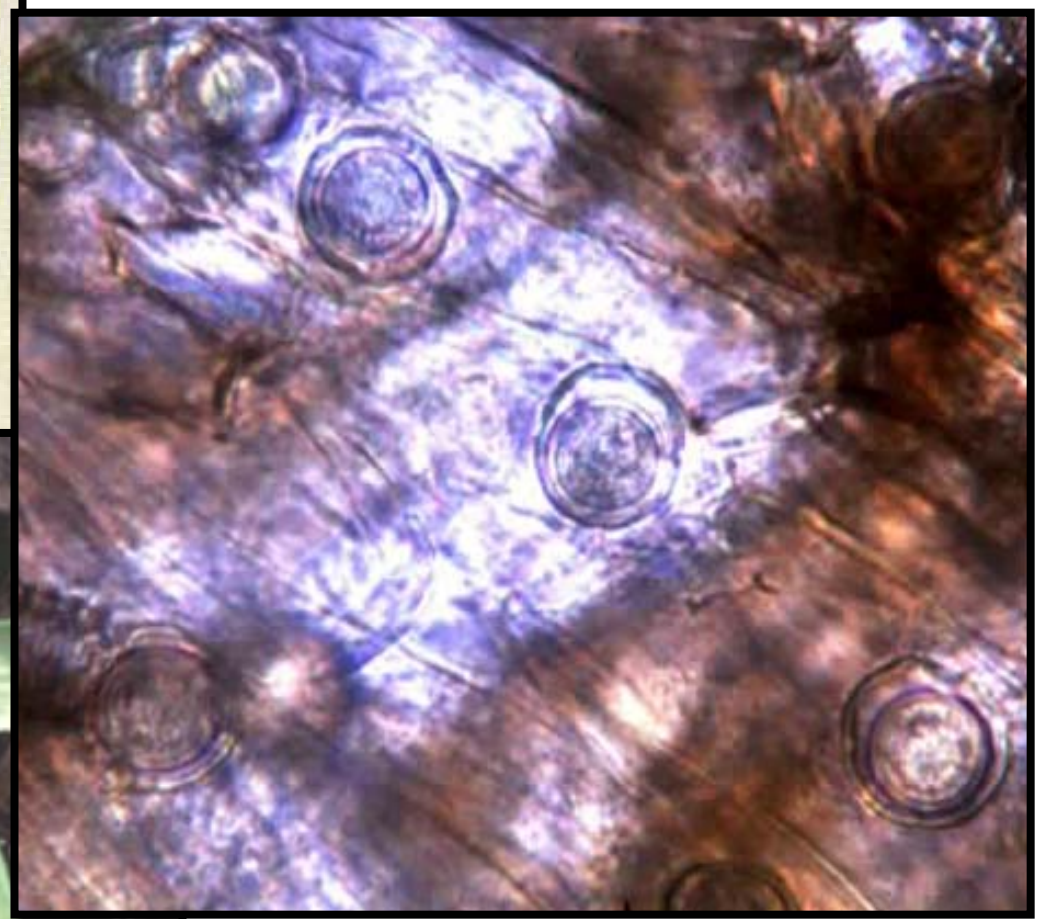
Seed rot
Seedling blight
Damping-off
(pre- & post-emergence)
Wilt

Seedling blight: *Fusarium oxysporum* f. sp. *spinaciae*

Photos by L.J. du Toit

Water mold seedling blights: *Pythium* spp., *Aphanomyces* spp.

Photos by J. Brantner



Seedling blight:
Rhizoctonia solani

Photos by L.J. du Toit

Management of seedling blights & damping-off:

- **Crop rotation (all soilborne pathogens)**
- **Promote rapid & vigorous germination & emergence**
    - avoid planting in poorly-drained soils (especially for *Pythium* spp.)
    - avoid planting in cool conditions (delay germination & emergence)
    - plant clean seed lots of high vigor
- **Plant partially resistant cultivars**
- **Spinach seed treatments**
    - only *F. oxsyporum* f. sp. *spinaciae* is seedborne
    - conventional fungicides effective vs. *Pythium*
    - few organic options: T-22 Planter Box (efficacy unknown)

Spinach leaf spot diseases in the PNW:

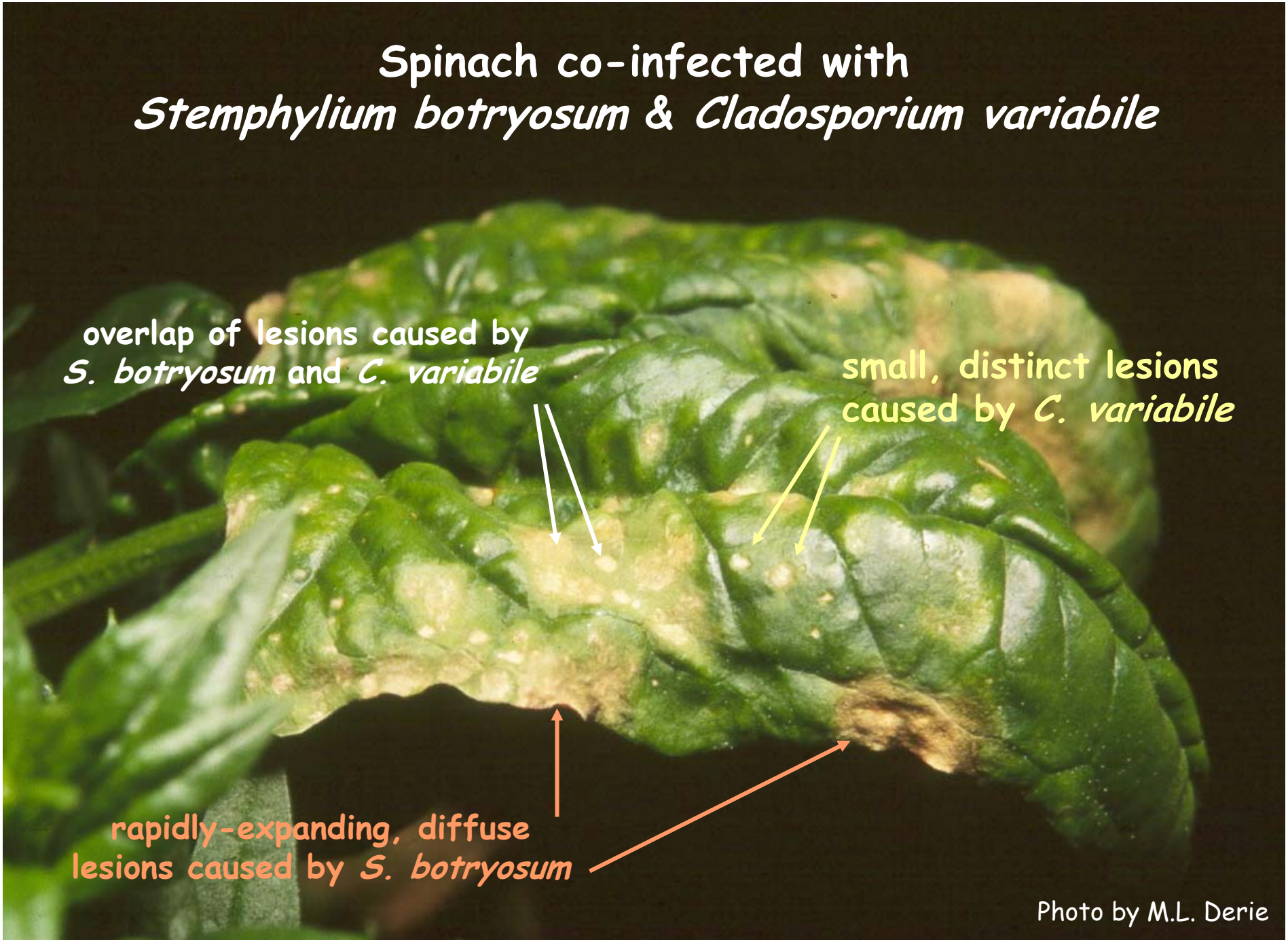
Cladosporium leaf spot
Stemphylium leaf spot
Anthracnose
Downy mildew

Cladosporium leaf spot:
Cladosporium variabile

Photos by L.J. du Toit

Stemphylium leaf spot:
Stemphylium botryosum


Photo by M.L. Derie
Cladosporium variabile
Stemphylium botryosum


Spinach co-infected with
Stemphylium botryosum & Cladosporium variabile
overlap of lesions caused by
S. botryosum and C. variabile
small, distinct lesions
caused by C. variabile
rapidly-expanding, diffuse
lesions caused by S. botryosum
Photo by M.L. Derie

Cladosporium variabile

Photo by R.L. Gabrielson

Stemphylium botryosum

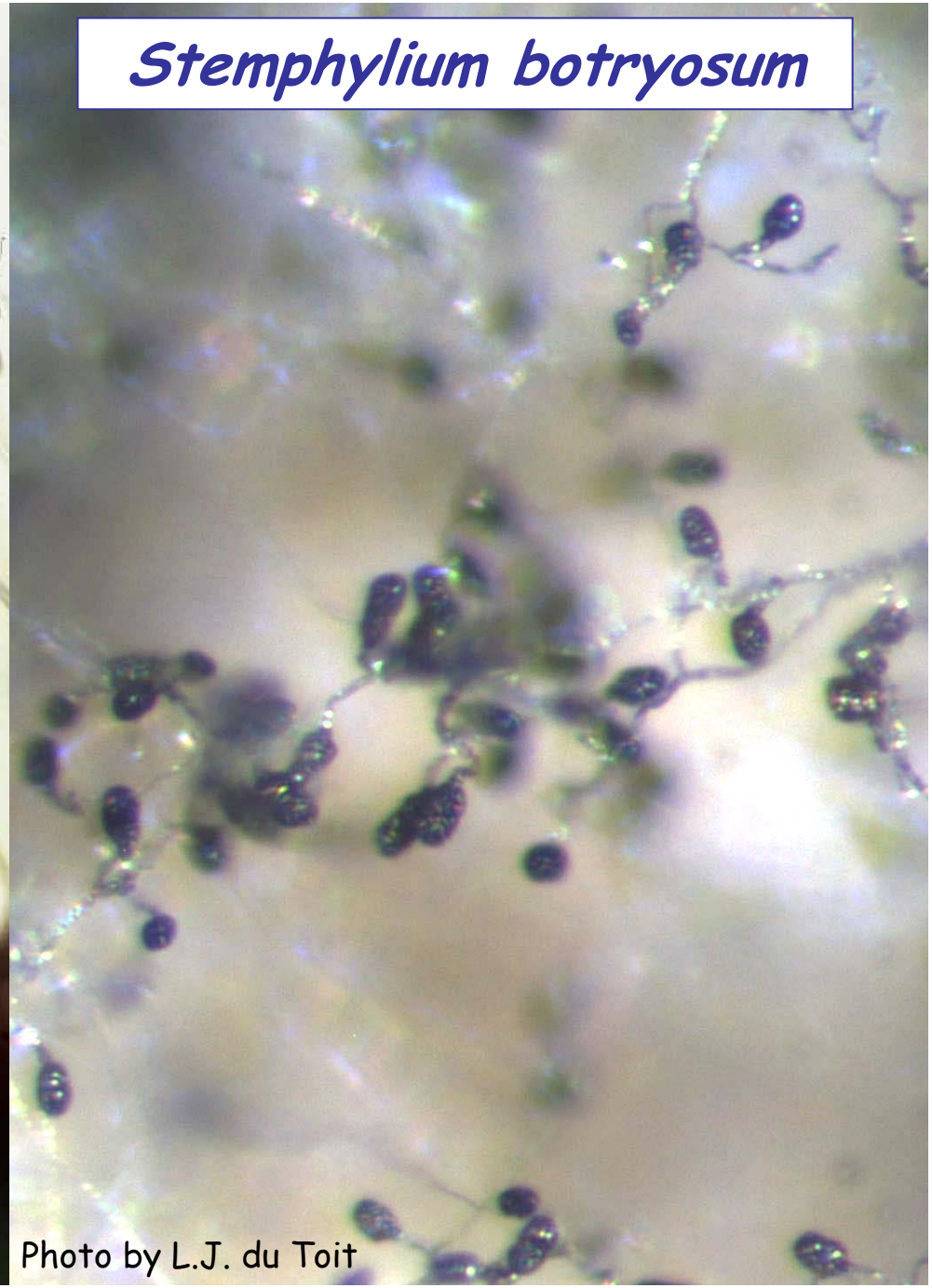
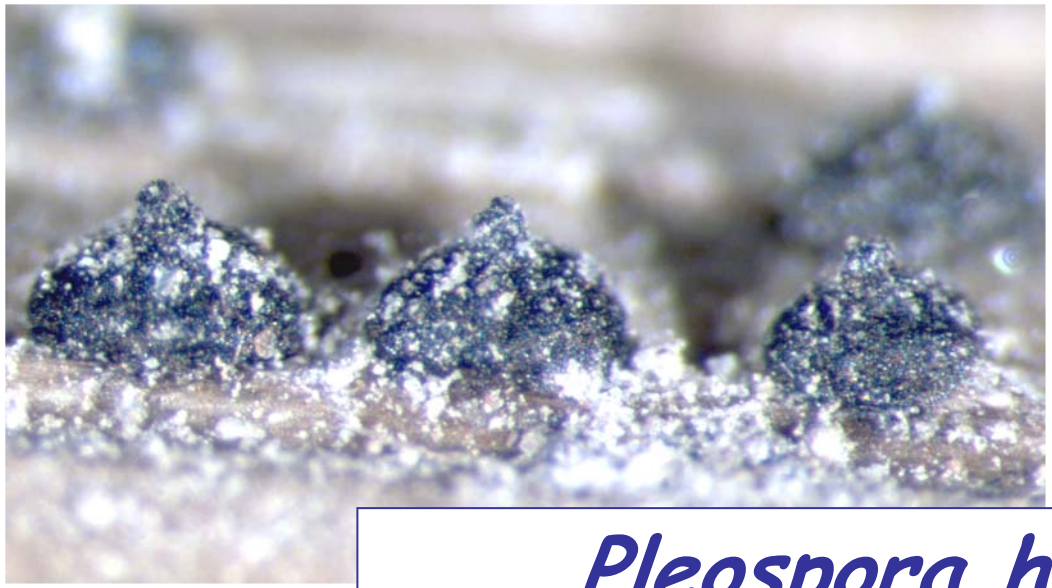


Photo by L.J. du Toit

Cladosporium variabile on volunteer spinach

Stemphylium botryosum on spinach seed stalk debris

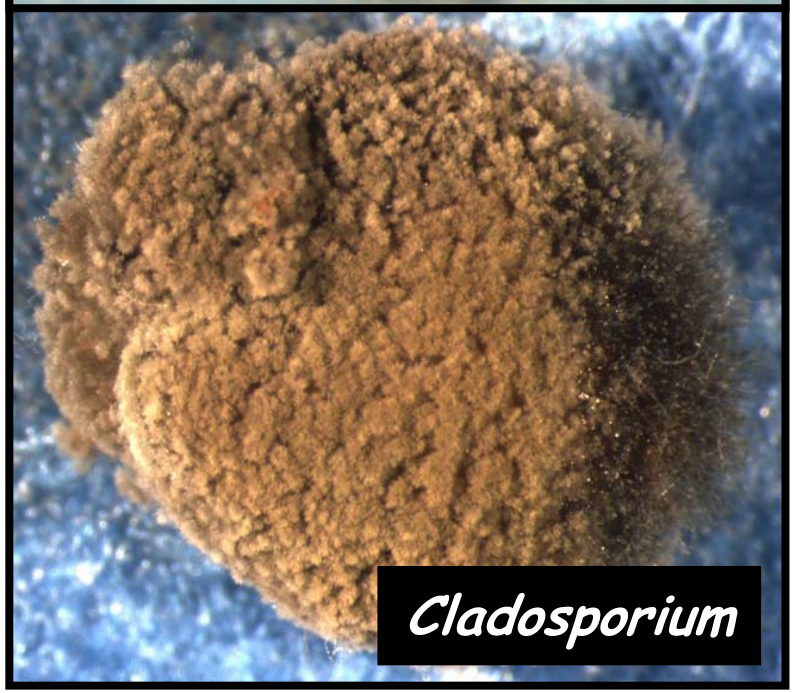


Pleospora herbarum

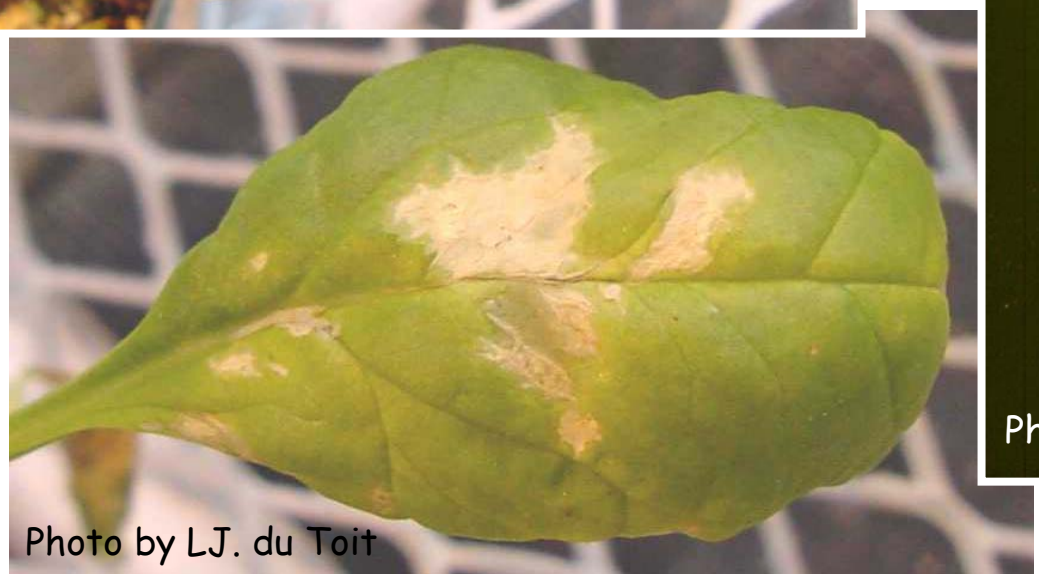
= sexual stage of *S. botryosum*

Photos by L.J. du Toit


Stemphylium


Cladosporium

Spinach anthracnose:
Colletotrichum dematium = C. spinaciae



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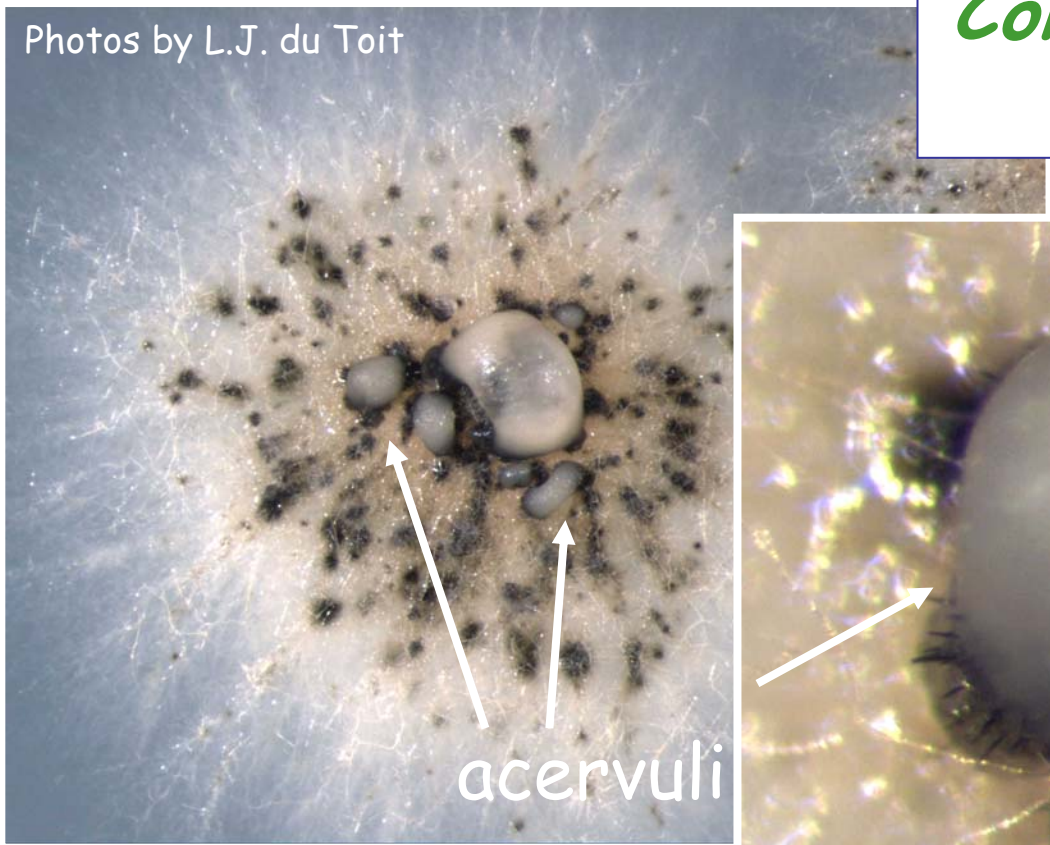
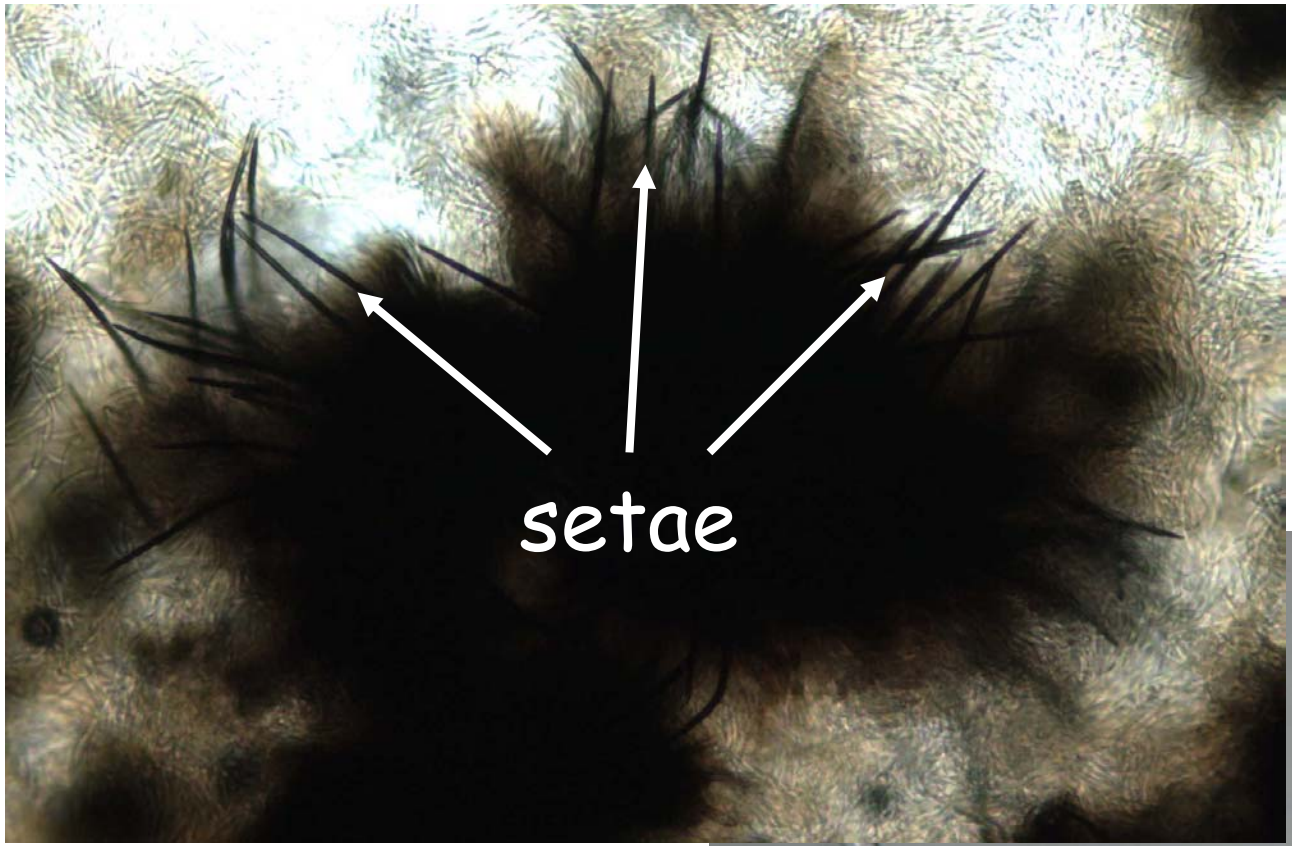
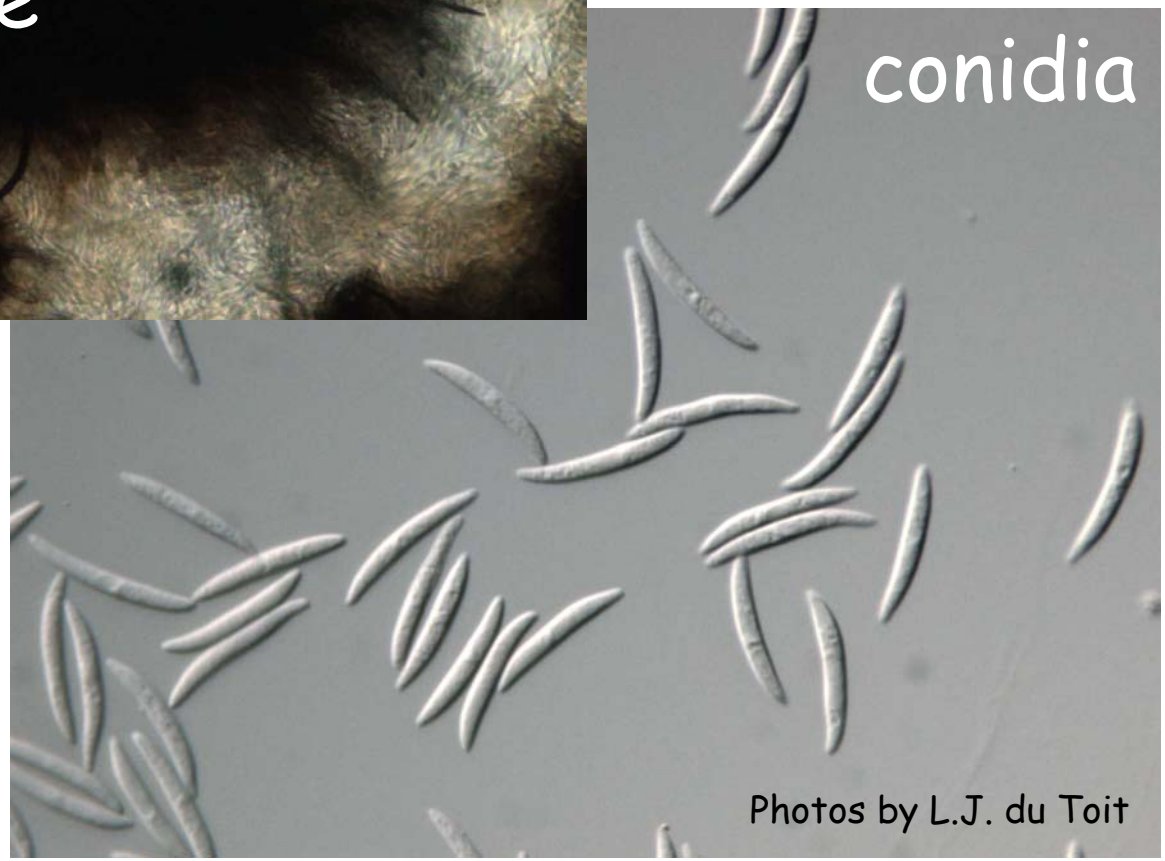
Colletotrichum dematium
= C. spinaciae

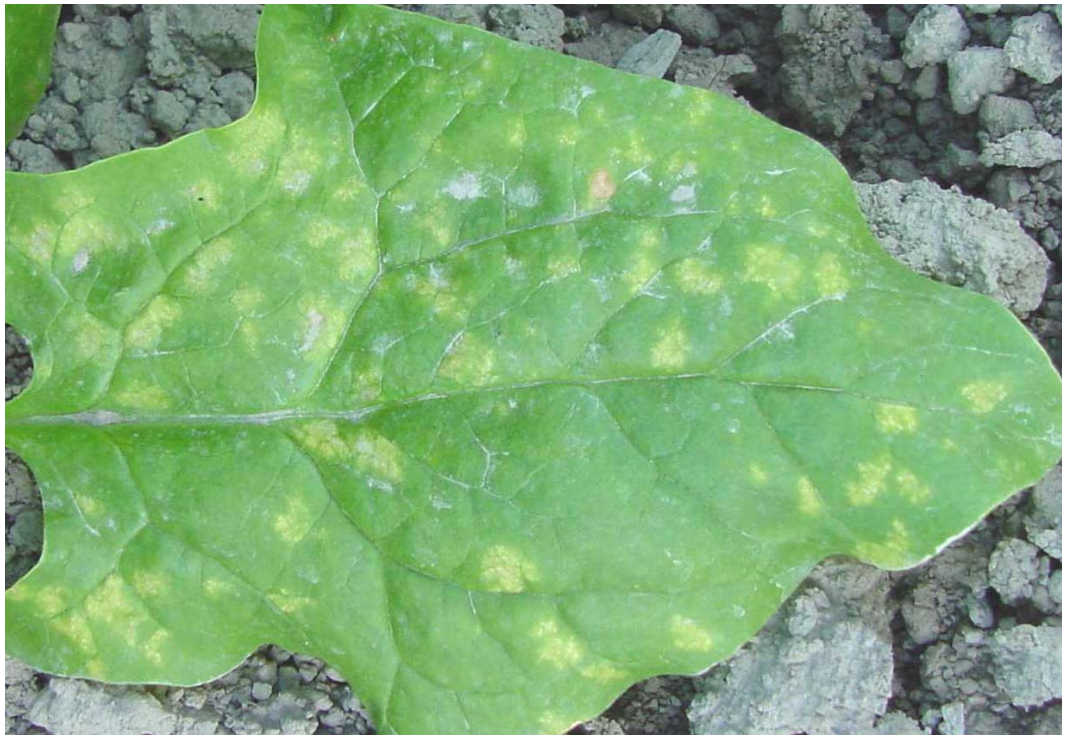


Spinach anthracnose: *Colletotrichum dematium*





Spinach downy mildew: *Peronospora effusa* 10+ races



Photos by L.J. du Toit

Cladosporium & Stemphylium leaf spots, anthracnose, & downy mildew

	Cladosporium variabile	*Stemphylium botryosum*	*Colletotrichum dematium*	*Peronospora effusa*
Leaf spot symptoms	Tan, circular, <5 mm, form dark margin	Tan, diffuse margin, rapidly expanding	Tan, distinct, coalesce, watersoaked	Yellow on top, blue-gray below
Spores in lesions	+ (older spots)	+ (in moist conditions)	+ (acervuli with setae)	+ (lower leaf surface)
Seedborne	+	+	+	+
Soilborne	-	-	-	-
Dispersal	Wind, seed	Wind, seed	Splashing water, seed	Moist & windy, seed
Overwinters	Volunteers, seed	Volunteers, debris, seed	Volunteers, seed	Volunteers, seed
Favorable conditions	Moist, cool (50-68°F)	Moist, 60-80°F, pollen	Wet, cool (50-68°F)	Wet, cool (50-68°F)
Host range	Chenopods?	Spinach	Spinach	Spinach

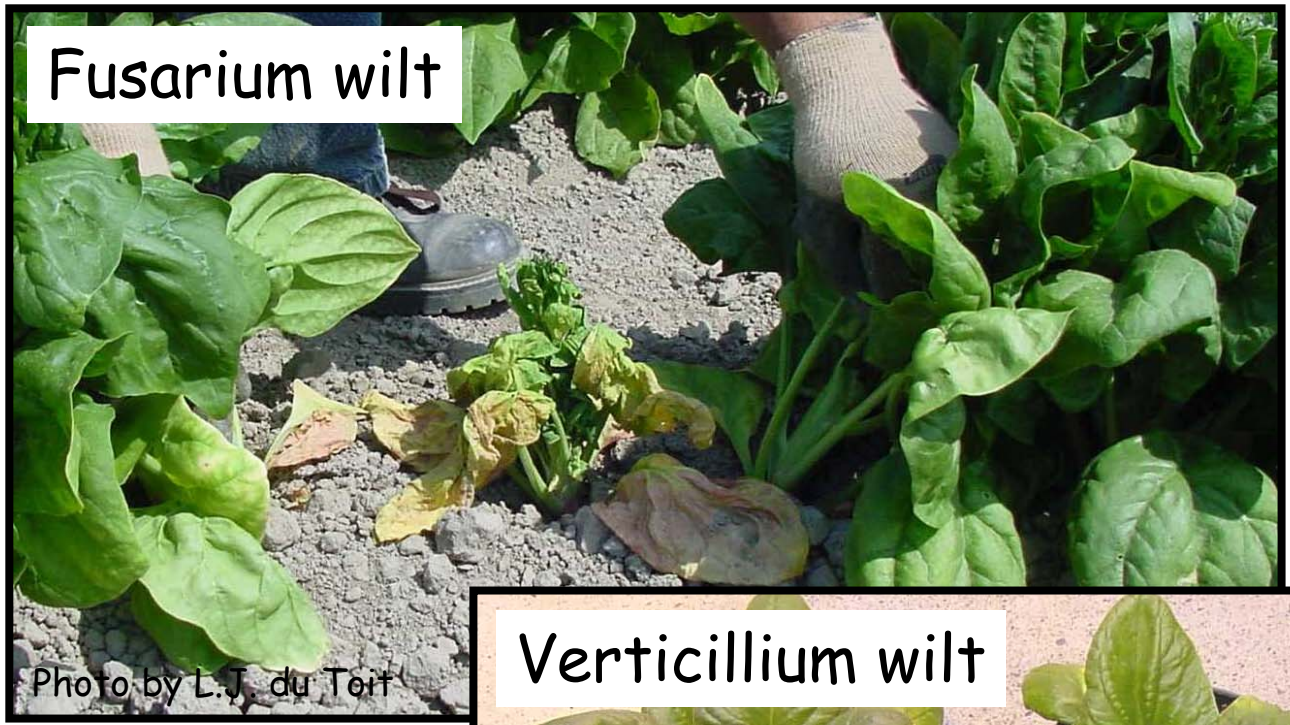
Management of fungal leaf spots & downy mildew:

	Cladosporium variabile	*Stemphylium botryosum*	*Colletotri-chum dematium*	*Peronospora effusa*
Rotation	2+ years	2-4 years	2+ years	2+ years
Avoid green bridge	disc volunteers in fall	incorporate residues in fall	disc volunteers in fall	disc volunteers in fall
Plant clean seed	+	+	+	+
Improve air circulation	+ (row spacing & orientation)	+	+	+
Resistant cultivars	partial	partial	partial	+ (10 races)
Seed treatments	Hot water, chlorine, Natural II	Hot water, chlorine (?), Natural II	Hot water, chlorine, Natural II	Hot water, chlorine (?), Natural II (?)

Fungal wilt diseases of spinach in the PNW:

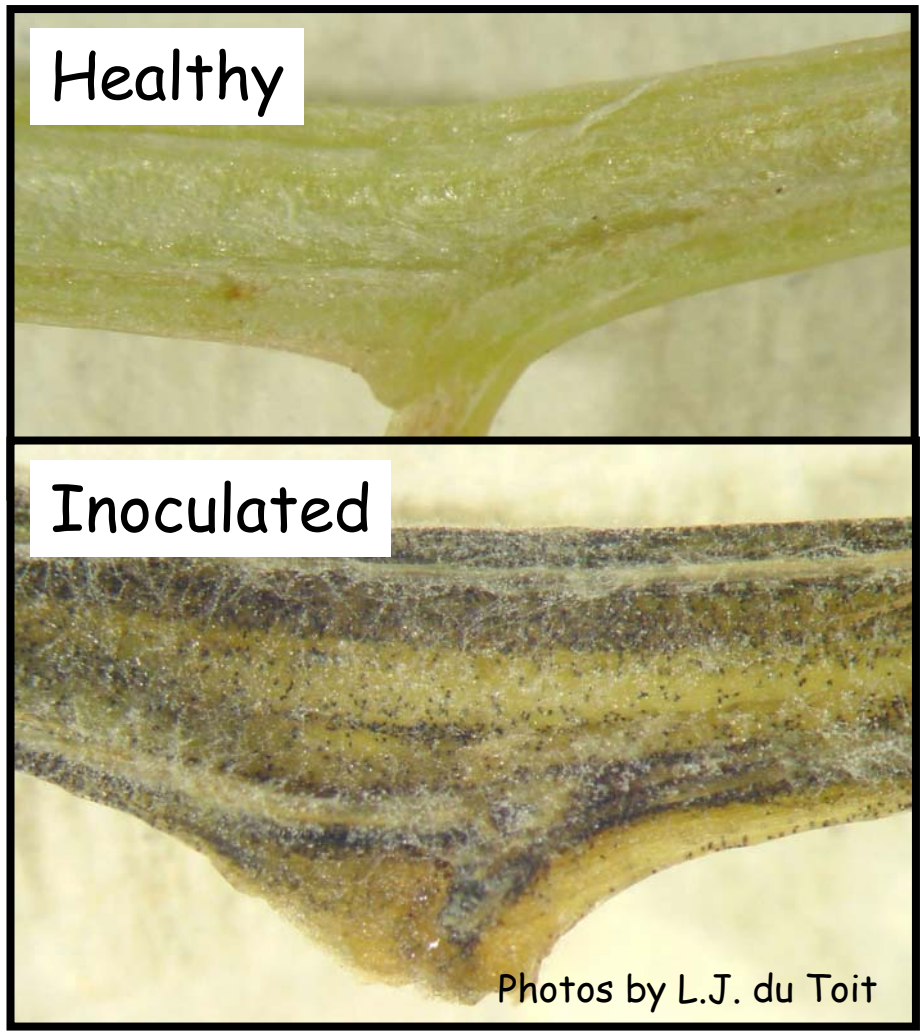
Fusarium wilt
Verticillium wilt

Fusarium & Verticillium wilts of spinach:
Fusarium oxysporum f. sp. *spinaciae* & *Verticillium dahliae*

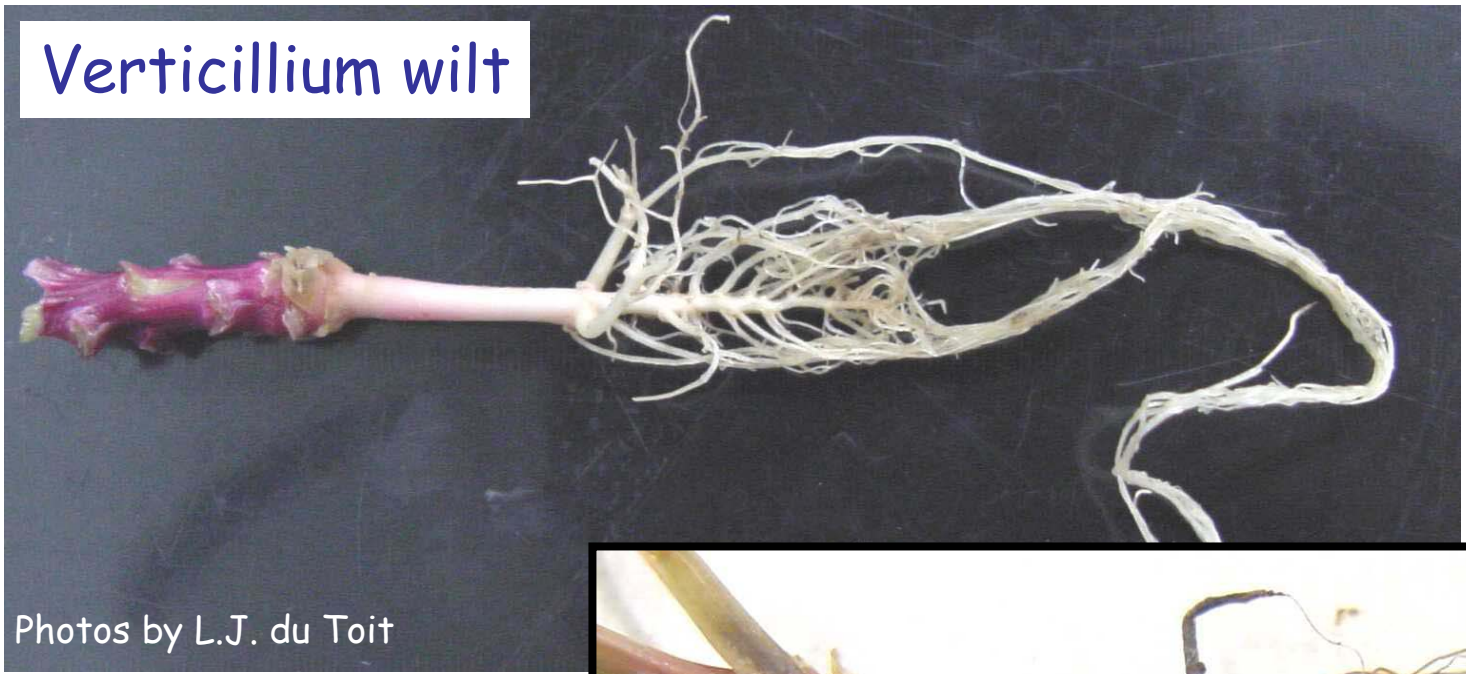


Verticillium wilt vs. Fusarium wilt of spinach

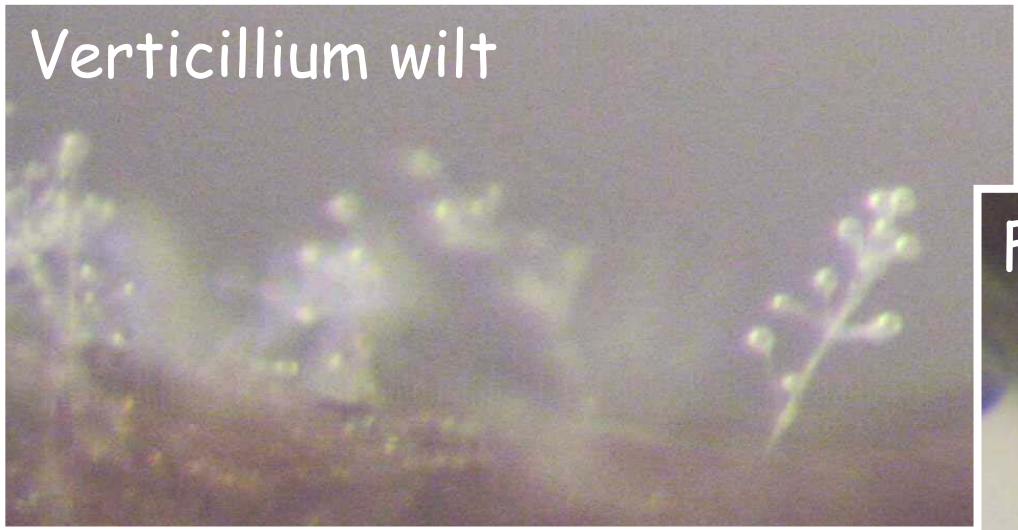
Verticillium wilt of spinach:
Verticillium dahliae



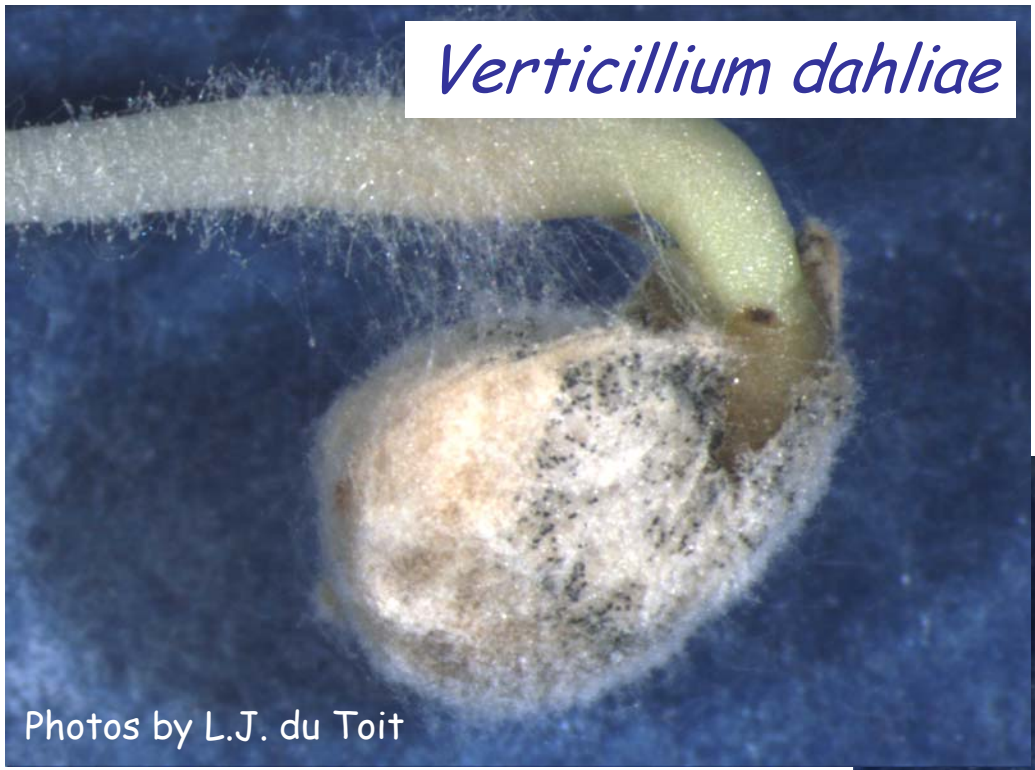
Verticillium wilt vs. Fusarium wilt of spinach

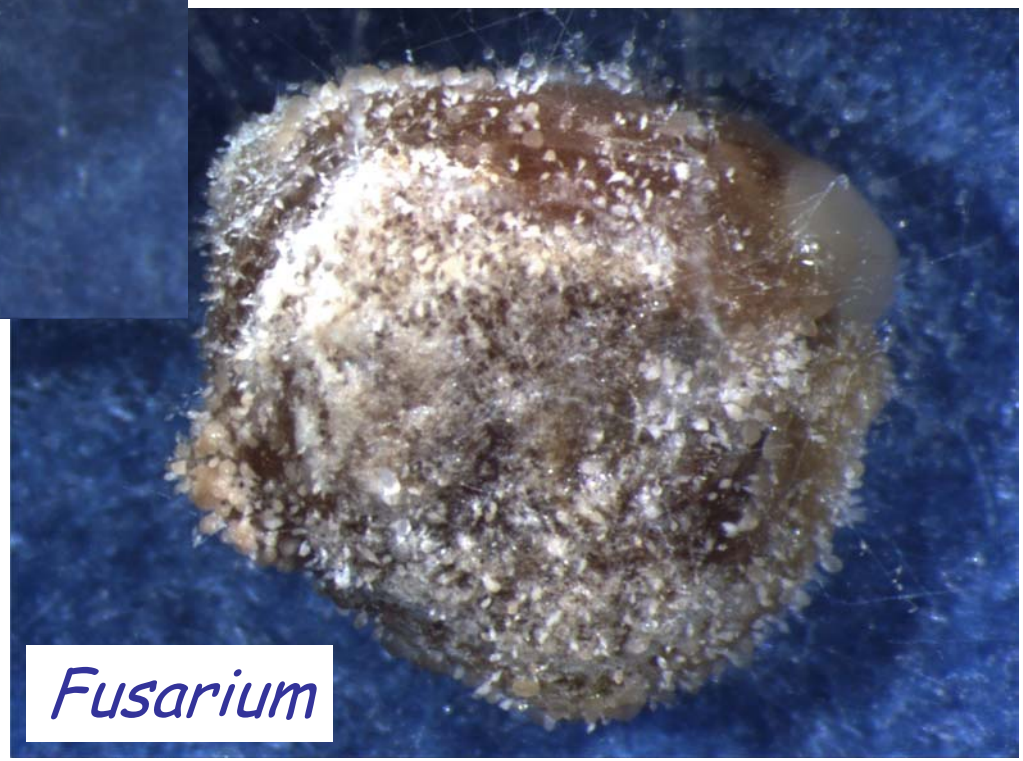


Verticillium wilt vs. Fusarium wilt of spinach



Seedborne wilt fungi of spinach





Spinach wilts:
Fusarium oxysporum vs. *Verticillium dahliae*

	Fusarium wilt	Verticillium wilt
Symptoms	Seedling & adult stages	Only after bolting
Foliar symptoms	General wilting; flaccid, grey-green foliage; death	Oldest leaves 1st; interveinal chlorosis then necrosis; death
Reddening of stem	+	+
External root discoloration	Black	None or light brown
Vascular discoloration	Black	Light brown
Seedborne/transmitted	+/+	+/+
Soilborne	+ (long-term)	+ (long-term)
Host range	Chenopodiaceae	**Broad**
Host resistance	Partial resistance	**?**

Management of spinach wilt diseases: *Fusarium oxysporum* vs. *Verticillium dahliae*

	Fusarium wilt	Verticillium wilt
Rotation	5+ years (resistant cv's) >10 years (susceptible cv's)	5+ years (avoid susceptible crops like potato)
Plant clean seed	+	+
Seed treatments	Hot water, Natural II?	Hot water, Natural II?
Minimize water stress	+	+
Resistant cultivars	Partial resistance (e.g., St. Helens, Jade, Chinook II, Skookum)	?
Planting time	Plant early (minimize transpirational stress during flowering & seed set)	Plant early?
Soil amendments	Lime (raise soil pH & Ca), green manures (mustards)	Green manures (mustards, corn, broccoli)?

Virus diseases of spinach in the PNW:

Cucumber mosaic virus (CMV)

Beet western yellows virus (BWYV)

Beet curly top virus (BCTV)

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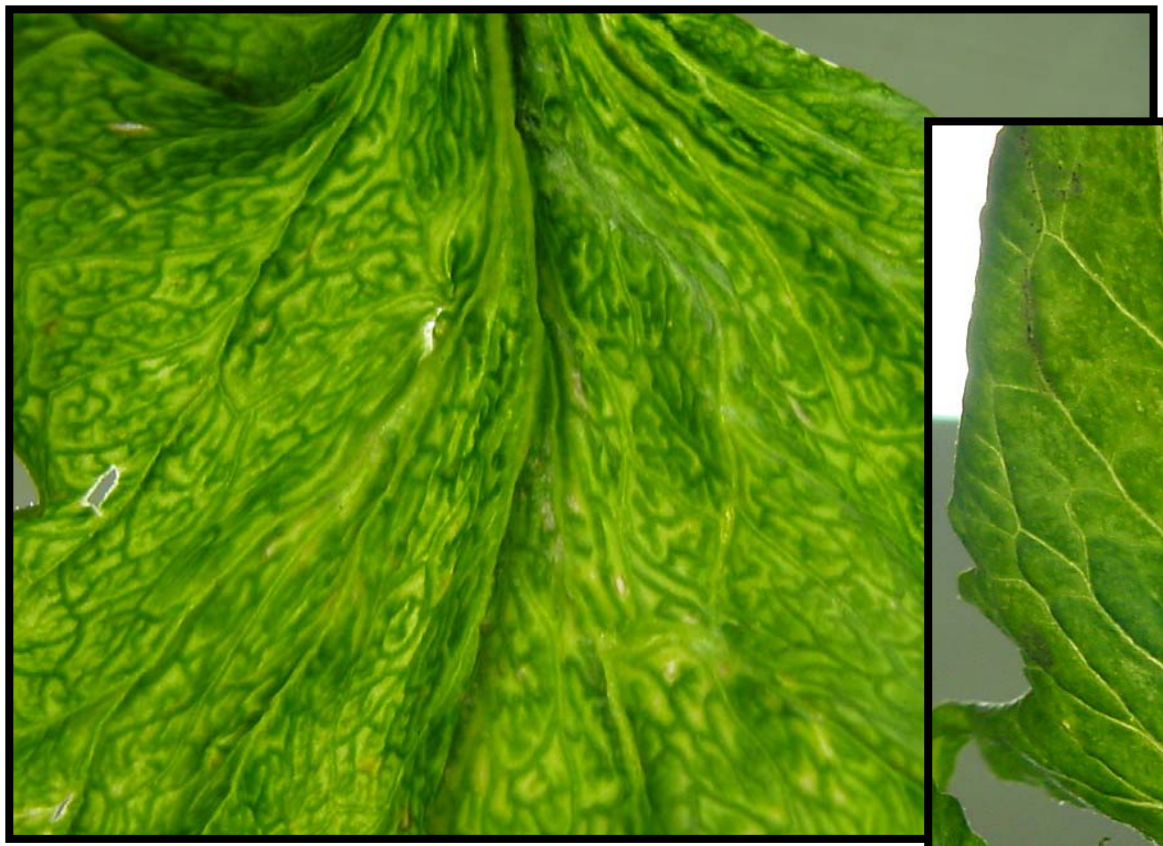
Cucumber mosaic virus (CMV)



Photos by L.J. du Toit

Virus diseases of spinach:
Cucumber mosaic virus (CMV)

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Virus diseases of spinach: *Cucumber mosaic virus* (CMV)

- crown leaves narrow, curled, wrinkled, margins roll in
- yellow & green mosaic on leaves, which may die
- stunting
- symptoms develop faster at high temperatures
- transmitted by many aphid species (non-persistently)
- very broad host range, including many vegetables (especially cucurbits)
- overwinters in perennial weeds, builds up in vegetables
- 2 main strains: subgroup I & subgroup II
- seedborne & seed transmitted (subgroup II only?)

Virus diseases of spinach:
Beet western yellows virus (BWYV)

- interveinal yellowing (old leaves 1st)
- thick, leathery, brittle leaves
- vectored persistently by aphids
- broad host range (many weeds)
- NOT seedborne

Beet curly top virus (BCTV)

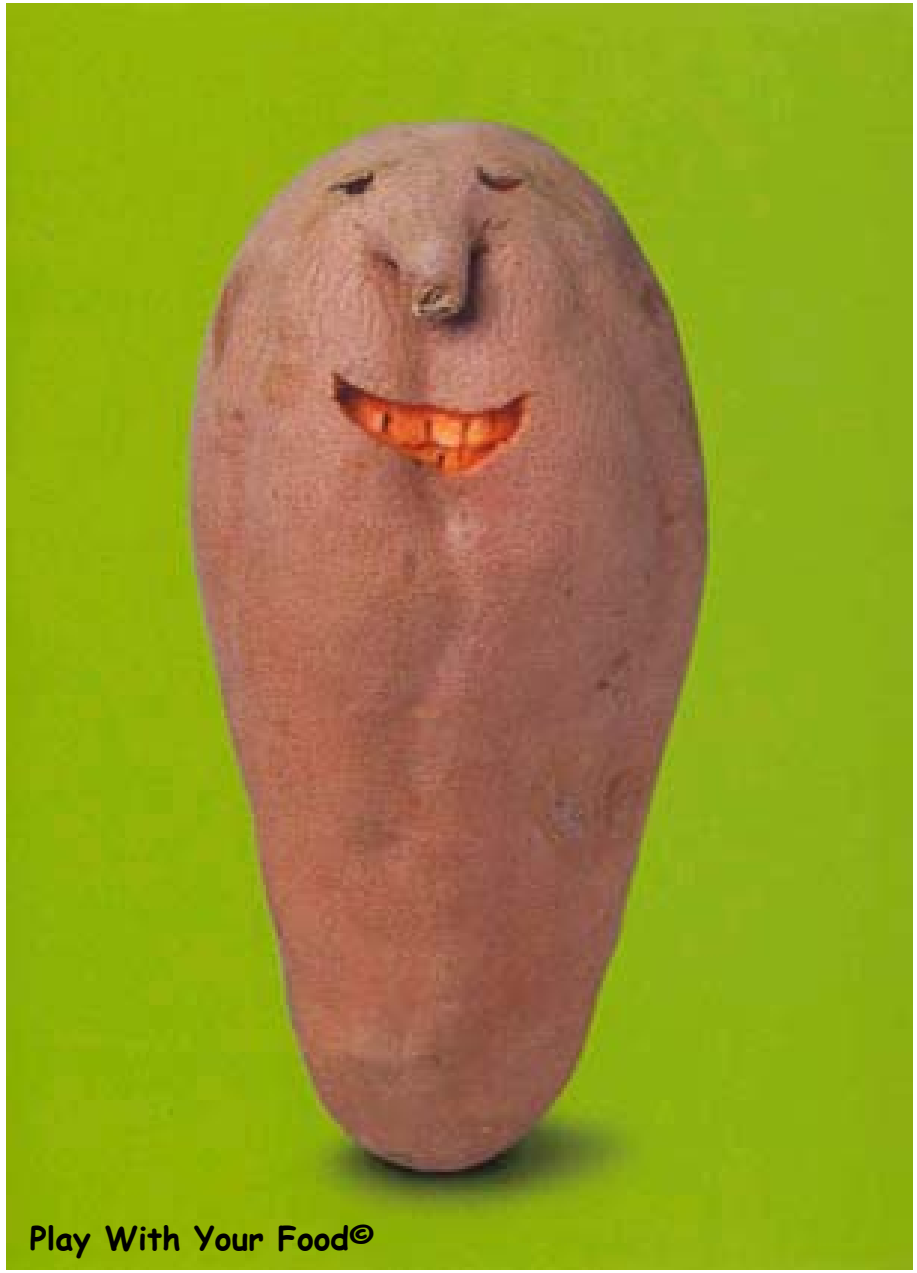
- vector = beet leafhopper
- very broad host range
- yellow & rolled leaves
- stunted or dead plants
- NOT seedborne

Management of virus diseases of spinach in the PNW:

	CMV	BWYV	BCTV
Rotation	+ (short term)	+ (short term)	+ (short term)
Avoid green bridges (spinach, other crop & weed hosts)	+	+	+
Plant clean seed	+	-	-
Do not harvest seed from infected plants	+	-	-
Seed treatments	Hot water?	-	-
Resistant cultivars	+	?	?
Control vector	Aphicides	Aphicides	?

Management of Spinach Diseases in Organic Systems

- Familiar with resistance of cultivars to specific diseases
- Familiar with prevalent diseases in your area
- Plant clean seed (certified, if possible)
- Diligently use sound cultural practices
  - appropriate crop rotations
  - row spacing & orientation
  - irrigation system & timing
  - avoid green bridges
    (weed hosts, volunteers,
    & alternative hosts)
  - remove/incorporate residues
  - minimize stress to the crop
- Monitor crops regularly
- Use local diagnostic resources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