Damping off in spinach

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What causes damping off?

Usually, one or several of the following soil borne fungal pathogens cause damping off in spinach: *Pythium* spp, *Phytophthora* spp, *Fusarium* spp and *Rhizoctonia* spp. If more than one pathogen are involved, pathologists talk about a "damping off complex".

Other fungi such as *Verticillium* spp can cause spinach to wilt and die off, but generally only in older plants such as in seed crops.

What are the signs and symptoms? What conditions favour the disease?

Symptoms include, poor growth, stunted, yellowing plants, death of seedlings (Figure 1 and Figure 2), wilting of older plants, poor germination and brown or black, rotted roots and crowns. Symptoms can depend on which pathogens are involved (Table 1).

Figure 1: Plants wilting and roots rotting 17 days after sowing (typical damping off symptoms). (Source: Donna Lucas)

Figure 2: Damping off root rot complex in spinach. (Source: Dr. Len Tesoriero)

Table 1: Pathogens causing damping off and symptoms (from Ekman, Tesoriero and Grigg, Horticulture Australia, 2014)

PATHOGEN CAUSING DAMPING OFF	SYMPTOMS
Pythium and Phytophthora	Pre-emergence damping off can cause brown, gelatinous rotting within the seed coat. If seeds do germinate, crop emergence is poor. Seedlings are stunted, yellowing and wilted and they tend to fall over or collapse and die. Water soaked lesions appear on the stem below the cotyledons and the upper part of the tap root, near the soil junction. Pythium infections of the root growing tips can result in excess branching of the root system above the infection.
Fusarium spp	General plant wilting and associated yellowing, foliage loses colour and eventually dies. Roots and vascular tissues turn black (called "browning").
Rhizoctonia solani	Dry, sunken cankers with a sharply defined margin develop near the soil junction soon after seedlings emerge. Plants wilt and collapse. More advanced seedlings may send out new shoots from below the diseased area.

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In Figure 3 the lettuce plants on the right are infected with *Pythium* in a lab experiment; plants on the left are healthy. Note the difference in roots (colour, number, length and mass). This highlights the importance of assessing roots in the field, rather than just the leaves. Crop leaves might look healthy but be stunted due to root disease.

The conditions that favour damping off can depend on the pathogens causing the disease.

Wet conditions favour damping off caused by *Pythium*, *Phytophthora* and *Rhizoctionia* (Table 2). These fungi produce spores or sclerotia (hard resting structures) that can survive in the soil for extended periods. The fungi can also survive on plant trash.

Acidic soils low in organic matter favour damping off caused by *Fusarium* (Table 2 and Figure 5).

Figure 3: Pythium in lettuce. (Source: Dr. Len Tesoriero)

Table 2: Conditions that favour pathogens causing damping off

CONDITION	PYTHIUM SPP	PHYTOPHTHORA SPP	RHIZOCTONIA SOLANI	FUSARIUM SPP
Wet soil conditions above field capacity for extended periods or periodic wetness	Y	Y	Y	
Wet and cool soils	Y	Y		
Wet and warm soils	Y			
Moist and warm soils e.g. above 15°C			Y	Y
Poor air circulation preventing soil and plant surfaces to dry off	Y	Y	Y	Y
Reduced Tillage			Y	
Acidic soils low in organic matter				Y
Physical damage at soil level e.g. wind, transplanting or insect damage – when combined with wet soil conditions			Y	

Figure 4: Bare patches in spinach, typical of damping off. (Source: Donna Lucas)

How do the fungi spread?

The fungal pathogens associated with damping off are widely distributed in soil and/or water. Both *Pythium* and *Rhizoctonia* are spread by irrigation water, rain, contaminated soil on equipment, and movement of infected plant materials.

Susceptibility and severity

All stages of spinach can be infected but emerging plants and young seedlings are most susceptible. The two main types of damping off are pre-emergence and post-emergence. Damping off can cause stunted growth through to plant death and bare batches in paddock (Figure 4). It can affect a few plants through to large areas within a crop.

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Figure 5: Fusarium wilt in spinach. (Source: Dr. Len Tesoriero)

How to diagnose damping off

Seedling plants collapsing or falling over is a typical symptom, often in patches. Each disease has unique symptoms on the roots and root tips. The most accurate diagnosis is by sending a fresh sample to a pathologist. Knowing the causal pathogen can aid selection of effective management and control strategies.

How to manage damping off

1. Get site specific advice.
2. Susceptibility is related to soil and environmental conditions. Damping off typically occurs in wet / compacted / poorly drained soil. Therefore:
   a. Sow in well-drained soil
   b. Avoid risky paddocks (e.g. a known history of damping off, poorly drained soils, poor soil condition) especially for crops grown during the high risk periods.
3. Monitor and manage crop nutrition. Stressed or slow growing crops (especially during establishment) are more susceptible to damping off.
4. Use nitrate forms of N fertiliser for management of *Fusarium*. Ammonium based N fertilisers can foster *Fusarium*.
5. Keep soil pH above 6.5 especially to avoid the risk of *Pythium.*
6. Optimal irrigation scheduling and soil moisture monitoring. Avoid over-watering. Prevent flooding and saturated soil – particularly for *Pythium*.
7. Rotation with a diverse range of species. Consider diversity in cover crop species as well. Preferably 3-4 years between spinach crops.
8. Look after soil health by maintaining good carbon levels, minimising tillage (except for *Rhizoctonia* management) and management of soil moisture and drainage.
9. Testing or disinfection of irrigation water.
10. Use a systems approach – limit crop stress, e.g. from poor nutrition, soil compaction etc.

What to try – if economically viable

- Cover crops and biofumigants.
- Solarisation.
- Microwave treatment.
- Use of good quality organic amendments.
- Use of approaches and inputs that support good crop establishment.
- Good weed control to avoid hosts. When weedy paddocks are prepared for sowing spinach the decomposing organic matter can be a host for Rhizoctonia and Pythium. Avoid decomposing plant tissue.
- Optimise fungicide types, application methods and timing. Use different activity group chemicals for each disease to manage fungicide resistance.
- Seed dressing.
- Farm hygiene and sanitation. Minimise soil, water and equipment movement from infested fields to clean sites.
- Seed quality - It may be worthwhile re-grading seed (gravity table) and sowing the larger seed, especially when conditions are not optimal. Older or physiologically aged seed is slower to germinate and therefore more prone/susceptible to disease.
- Good nursery practices for transplants where seedlings are used rather than direct-seeded crops.
- Enable good drainage (surface drainage and good soil structure).

What to look out for in the future

- Biopesticides (some are registered in USA, some may become available in Australia)
- New fungicides including seed treatments.

For more information

Resources are available on the Soil Wealth – ICP website (http://www.soilwealth.com.au) including:

- **Pests, Diseases and Disorders of Babyleaf Vegetables – a field identification guide**
- **Managing soilborne diseases - fact sheet**
- **How to control *Pythium* in vegetable crops – webinar recording**
- **Summer cover crops - fact sheet**
- **Winter cover crops - fact sheet**
- **Biofumigation - fact sheet**
- **Preharvest effects on the quality of babyleaf spinach - fact sheet.**