

Agronomic Spotlight

Spinach



PYTHIUM DAMPING-OFF AND ROOT ROT OF SPINACH

- » Pythium damping-off and root rot can reduce plant stands and yield potential of spinach plantings.
- » Several species of the water mold genus *Pythium* can cause damping off and root rot of spinach.
- » Cultural practices and fungicide applications can help manage damping-off of spinach.

Young spinach plants can be very susceptible to root disease problems, including damping-off and root rot, and these diseases can result in substantial reductions in plant stands. Damping-off and root rots of spinach can be caused by pathogens, including the fungi *Fusarium oxysporum* and *Rhizoctonia solani*, and several species of the oomycete (water mold) *Pythium*.^{1,2,3} *Pythium* species that commonly cause diseases on spinach include *P. ultimum*, *P. irregulare*, *P. aphanidermatum*, and *P. myriotylum*.^{1,4,5}

Pythium pathogens can cause both pre- and post-emergence damping-off of spinach. With pre-emergence damping-off, spinach seed and seedlings are infected, wilt, collapse, and often rot before they emerge, leaving gaps in plant rows. In post-emergence damping-off, seedlings exhibit stunted growth and other symptoms that can result in plant death.^{1,3}

SYMPTOMS

Symptoms of pre-emergence damping-off can only be seen by digging up seeds and non-emerged seedlings in the gap areas of the planted row. Seeds and seedling tissues are water-soaked and rotted, usually brown in color.² Seedlings with post-emergence damping-off will show stunted growth, yellowing of lower leaves, wilting, plant collapse, and eventually plant death. The roots of affected seedlings show water-soaking and brown to black discoloration. On older seedlings, the upper areas of tap roots can be girdled by necrotic lesions, and the tips of roots can become necrotic. Eventually, the entire root system may become rotted.^{1,2} The symptoms of damping-off and root rot caused by *Pythium* spp. can be difficult to distinguish from the symptoms caused by *Rhizoctonia solani* and *Fusarium oxysporum*, so sending samples to a plant clinic for diagnosis may be required to determine the causal agent(s). Damping-off symptoms can also be similar to those caused by abiotic factors, such as overwatering.^{1,2}

CYCLE AND CONDITIONS

Pythium species that affect spinach are usually soil inhabitants, able to survive in the absence of spinach plants by colonizing other plants, growing on organic matter, and producing persistent resting structures. Most *Pythium* are not highly host-specific and have wide host ranges. Once present in a field, they can be difficult to eradicate.⁴

Young plants are most susceptible to infection by *Pythium* spp., and as plants age, infections may be limited to root tips and feeder roots.⁴

Some soil fumigation treatments can reduce soil populations of *Pythium*, and steam treatments can be used to lower inoculum levels in greenhouse systems. Disease severity can be affected by soil texture, irrigation practices, pathogen populations, and the varieties of spinach planted. Damping-off is usually favored by warm conditions, soils that are heavy and poorly drained, low areas of the field where water collects, and consecutive spinach crops or short crop rotation sequences.^{1,2} Soil pH, light intensity, and the presence of other microorganisms may also affect the levels of damping-off and root rot.⁴ Spinach is a cool-season crop that grows best when soil temperatures are between 59° and 64°F (15° to 18°C), and the severity of damping-off is usually higher at temperatures outside of this range, depending on the pathogen involved. *Pythium ultimum* grows best in culture at temperatures between 77° and 86°F (25° and 30°C), so spinach damping-off is usually more severe when soil temperatures are above 64°F when *P. ultimum* is involved.⁴

MANAGEMENT

Although some differences in the severity of *Pythium* pre-emergence damping-off have been observed among spinach varieties, acceptable levels of resistance have not yet been identified in spinach. Studies evaluating damping-off resistance in spinach have found inconsistent results and differences among seed lots and trials using the same varieties.⁴ Research is being done to help standardize screening techniques to better identify and characterize resistance in spinach.

Practices that promote even, rapid germination and strong growth of spinach seedlings can help reduce the incidence and severity of damping-off and root rot. Growers are advised to plant into well-prepared seed beds in locations with well-drained and aerated soils and to plant when soil moisture and temperature levels favor rapid germination and growth. If applying compost, choose material that is thoroughly composted. Schedule irrigation frequency and duration to prevent excessively wet, saturated soils. Avoid consecutive cropping, and, if possible, rotate to non-host crops, which can be difficult with these species of *Pythium* because they have a very wide host range.^{1,2,3,4}



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Fungicides can also be used to help manage damping-off and root rot caused by *Pythium* species. Choose fungicides with active ingredients that are effective against water molds, such as *Pythium*, *Phytophthora*, and *Aphanomyces*. Active ingredients that are effective against true fungi, such as *Rhizoctonia solani* and *Fusarium oxysporum*, may not be effective against *Pythium* species. Fungicide seed treatments can help protect seed and young seedlings from damping-off. Active ingredients that are registered for use on spinach include mefenoxam. However, resistance to mefenoxam has been documented in some populations of *Pythium*. Fungicides that contain mefenoxam, metalaxyl, cyazofamid, and propamocarb HCL can also be used for pre- and post-plant in-furrow, in-row, or chemigation treatments to help manage damping-off and root rot of spinach caused by *Pythium* species.^{1,2,3,4,5}

Several biological control products are also registered for use on spinach to help manage damping-off and root rot. Actinovate® AG Biological Fungicide (*Streptomyces lydicus*) can be applied as a soil drench at planting. Double Nickel® LC (*Bacillus amyloliquefaciens* strain D747) can be sprayed in a band or applied as a drench at 4- to 6-week intervals during the growing season. Mycostop® Biofungicide (*Streptomyces* strain K61) can be applied as a seed treatment, and Rootshield® Plus+ WP Biological Fungicide (*Trichoderma harzianum* strain T-22, *Trichoderma virens* strain G-41) can be applied through chemigation or as an in-furrow spray at planting.³

Sources

¹Koike, S., Gladders, P., and Paulus, A. 2007. Vegetable diseases: A color handbook. Academic Press. Ppg 370-371.

https://books.google.com/books/about/Vegetable_Diseases.html?id=iPgTGhaGRl4C

²Koike, S. and LeStrange, M. 2009. Damping-off and root rot. Spinach pest management guidelines. UC IPM.

<https://ipm.ucanr.edu/agriculture/spinach/damping-off-and-root-rot/#gsc.tab=0>

³2025. Spinach (*Spinacia oleracea*)-damping-off. Pacific Northwest Pest Management Handbook.

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⁴Magnée, K., Postma, J., Groot, S., Gort, G., Lammerts van Bueren, E., and Scholten, O. 2022. Evaluation of damping-off tolerance in spinach cultivars in field soils and in a standardized lab assay with *Pythium ultimum*. Plant Health Progress 23(2): 174-187.

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⁵Y.-A. Chen, H.-H. Chu, and C.-L. Wang. 2024. Root rot of spinach caused by *Pythium myriotylum* and *P. aphanidermatum* in Taiwan. Plant Disease 108:1900.

<https://doi.org/10.1094/PDIS-02-24-0350-PDN>

Websites verified 3/10/2026

For additional agronomic information, please contact your local seed representative.

Performance may vary, from location to location and from year to year, as local growing, soil and environmental conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on their growing environment. The recommendations in this article are based upon information obtained from the cited sources and should be used as a quick reference for information about vegetable production. The content of this article should not be substituted for the professional opinion of a producer, grower, agronomist, pathologist and similar professional dealing with vegetable crops.

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