

Understanding Plant Fungal Leaf Diseases in Nurseries



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Powdery mildew



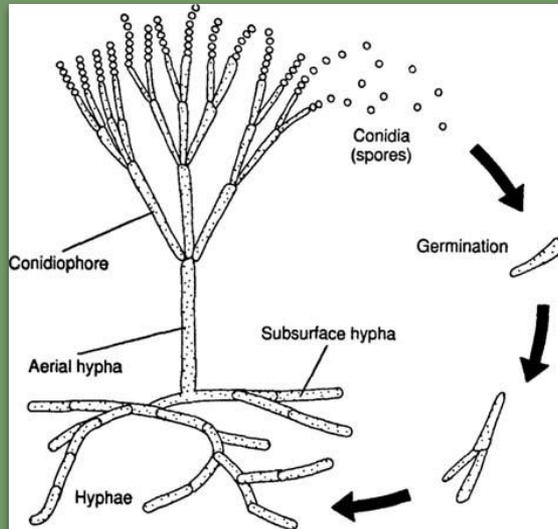
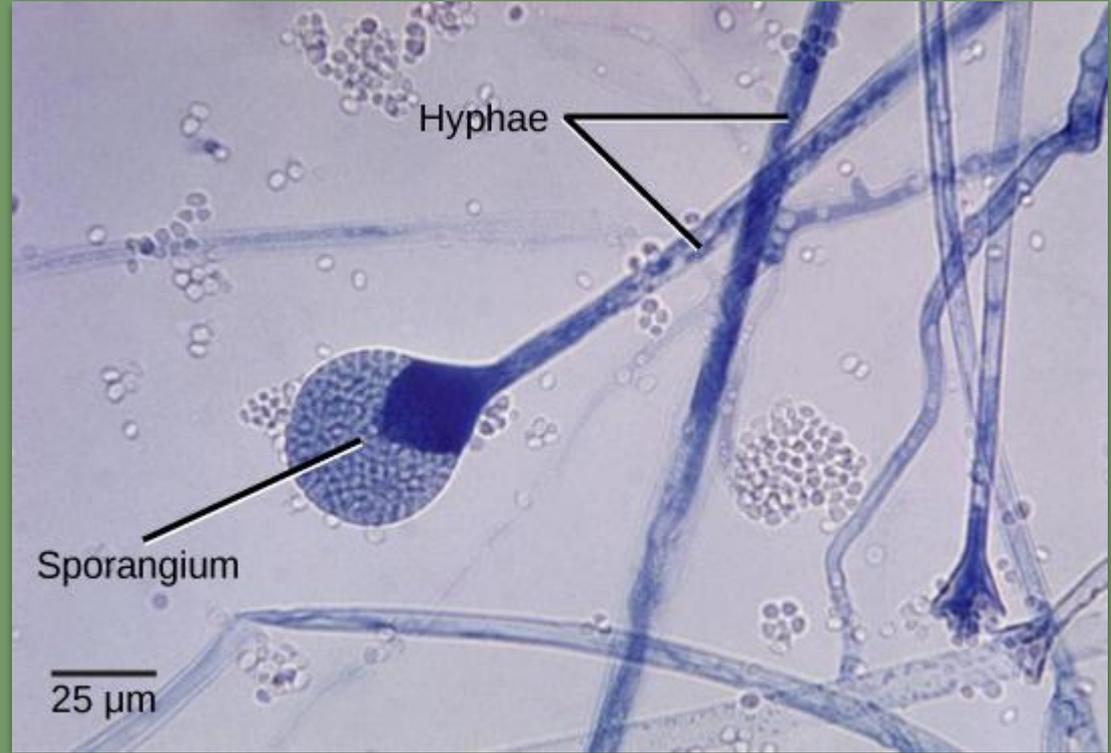
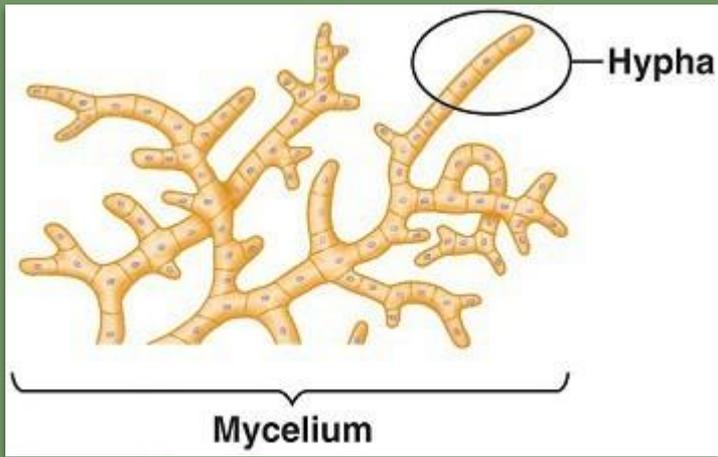
Fungal rust on oregon oxalis



Fungal rust

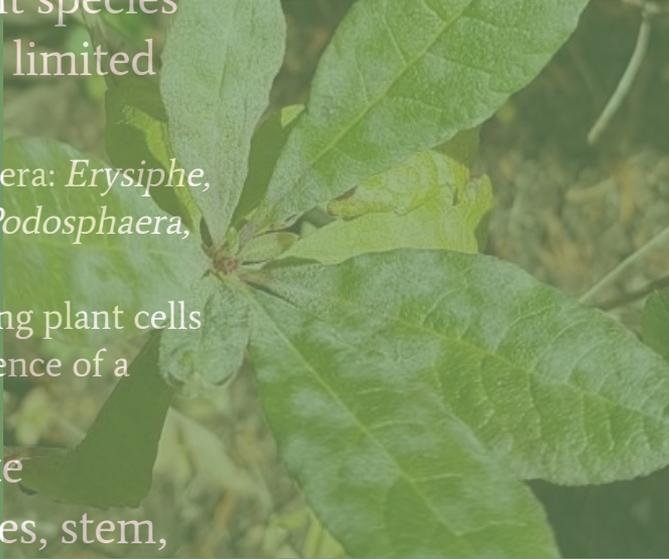
Brief Introduction to Fungi

- Fungi are eukaryotic organisms that lack chlorophyll – making them taxonomically distinct from plants
- Fungi are heterotrophs – obtains nutrients from complex organic substances (as opposed to fixing their nutrients from the atmosphere as plants do)
 - they digest organic matter externally before absorbing it
- Fungi grow from tips of filaments (**hyphae**) that make up a complex, radically expanding network (**mycelia**) which is the body of the organism (**thallus**)
- Reproduction
 - Mycelium produces spores on hyphae
 - Spores are produced in sporangia (sac-like sporophores)
 - Asexually produced spores (**conidia**) are typically formed terminally on special, spore-producing hyphae (**conidiophores**)



Powdery Mildew – Causes and Description

- Caused by multiple different species of fungi that generally have limited host ranges
 - Powdery mildew causing genera: *Erysiphe*, *Microsphaera*, *Phyllactinia*, *Podosphaera*, *Sphaerotheca*, and *Uncinula*
 - Biotrophic fungi: feed on living plant cells and barely survive in the absence of a living crop
- Appears as a powdery, white substance covering the leaves, stem, or fruit
 - This is actually a result of large numbers of microscopic **conidia**



Powdery Mildew – Environment and Infection Process

- Thrives in humid conditions and stagnant air
 - Can be caused by plants growing too close together
 - High relative humidity promotes germination of spores, but inhibits spore production – overall effect is negligible
- Pathogen overwinters in plant debris and within buds of infected plants
- Conidia are the main means of dispersal (dispersed by wind)
 - In greenhouses, dispersal of spores over small distances mainly occurs through workers clothing
- Fungal spores germinate on leaf surfaces, where germ tubes grow and branch out
 - **Haustoria** are produced from which fungus penetrates plant cell and takes up nutrients from epidermal layer of plant cells
 - Doesn't require moisture for infection
- Powdery mildew is rarely fatal, but it causes stress and weakens plants
 - Stressed and weakened plants are much more susceptible to other diseases
 - Photosynthesis can be inhibited when the fungus covers leaf surfaces

Powdery Mildew – Management Strategies

- Watering – deeply, in the morning when possible, avoid watering from overhead
 - NO overhead irrigation, keep foliage dry
- Remove infected plant material and destroy it
 - Continually remove dead leaves from soil to prevent an area for fungus to overwinter
- Neem oil – coats leaf surface and suffocates fungus
- Baking soda – 1 tsp in water, spray mixture onto affected leaves
 - pH level creates unsuitable environment for the fungus to reproduce and spread
- Do not provide excess nitrogen, since this promotes the disease
 - Remove affected plants from fertilizing regime
- Prevention
 - Extra silicon and/or calcium nutrition hardens the cell wall and makes it harder for fungi to enter the leaves

Leaf Spot – Causes and Description

- Very common, caused by multiple species of fungi (some attack specific host plants and others will attack a wide range)
 - Leaf spot causing genera: *Cercospora*, *Alternaria*, *Anthracnose*, *Ascochyta*, *Corynespora*, *Cylindrocladium*, *Cylindrosporium*, *Didymella*, *Entyloma*, *Fabraea*, *Marssonina*, *Phyllosticta*, *Pleospora*, *Ramularia*, *Septoria*
- Spots are variable, but generally white to grayish-white and enclosed by reddish-brown, brownish, or yellowish margins
 - It is possible to see evidence of fungal pathogens (mycelium) at the center of some spots
- Spots first appear on adaxial surfaces, then become apparent on abaxial leaf surfaces



Leaf Spot – Environment and Infection Process

- Infection process requires water on the leaves or a prolonged period of high humidity
 - Prolonged period could be 12 - 24 hours
 - Leaf spots often mature in 1 - 2 weeks
- Spores are dispersed by splashing rain, wind, personnel working with infected, wet plant material, insects, or mites
- Spores can germinate in water or in the natural leaf openings
 - Hydathodes, lenticels, stomata
- The cycle of spore production and infection can repeat any time weather conditions are favorable
- Pathogen can survive winter in infected leaf debris
- Favorable conditions include humidity and after a rainfall (or overhead watering)
- The pathogen can cause leaves to drop prematurely, however it is generally considered an aesthetic concern
- Leaf spot can turn into a blight in which case tissue death can progress until the entire lamina is dead
- Blight or continual defoliating should be indications of a more concerning infection



Leaf Spot – Management Strategies

- Avoid overhead watering and keep the foliage as dry as possible
 - Apply irrigation only to roots and potting material
 - Water early in the day, if possible
- Prune dead leaves and stems **AND** remove dead plant material from the soil of pots as well
- Reduce stress on plants
 - Plants already experiencing stress are more likely to be susceptible to the pathogen and more likely to experience worse symptoms
- Avoid fertilizing infected plants



Rust – Causes and Description

- Rust fungi are obligate parasites, meaning they can only grow on a living host
- Rust pathogens have the most complex life cycles of all fungal plant pathogens with up to five different spore stages that occur over at least two different host species
- Spores are identifiable as powdery pustules that initially appear on the abaxial side of a leaf
 - Spore are yellow to orange-red and brown



Rust – Environment and Infection Process

- Rust pathogens thrive in cool and damp conditions
 - Germination and infection requires water on the leaf surface for several hours
- Rust spores germinate on leaf surfaces and enter through the stomata or form a special organ to penetrate the cuticle and epidermis
 - Pathogen will penetrate plant cells and use a **haustorium** to absorb nutrients
- Rust spores are wind, rain, and splash dispersed during multiple stages
 - Some spores will remain close to the plant in fallen debris or dead material to overwinter
- A heavy rust infection can cause leaves to fall prematurely, which will prevent natural hardening of shoots and buds, resulting in lower outplanting success
- The fungus will destroy leaf tissue, reducing plant photosynthetic capacity and in some cases plants may be killed

White Pine Blister Rust

- Cause: *Cronartium rubicola* – a fungus introduced to North America in the 1900s
- Hosts: all North American white pines/five-needle pines
- Alternate Hosts: currants and gooseberries (*Ribes*) and occasionally *Pedicularis* and *Castilleja* species
- Impact: Affects trees of all ages and sizes, can effectively eliminate white pines from certain ecosystems
 - Branch and stem cankers eventually lead to entire tree death
 - Premature defoliation occurs on *Ribes* but otherwise there is little damage
- Concern: High



Rust – Management Strategies

- Regularly check plants, especially in Spring, paying close attention to the underside of leaves
- Avoid overhead watering and keep the foliage as dry as possible
 - Apply irrigation only to roots and potting material
 - Water early in the day, if possible
- Prune dead leaves and stems **AND** remove dead plant material from the soil of pots as well
- Reduce stress on plants
 - Plants already experiencing stress are more likely to be susceptible to the pathogen and more likely to experience worse symptoms
- Potentially beneficial to begin fungicide application at the first appearance of rust
- Considerations for terminating a plant if infection cannot be managed?

Generalized Management Strategy

- Regular check plants for signs of infection
- Always avoid overhead irrigation and try to avoid splashing or wetting foliage
- Prioritize spacing of plants to promote quick drying and air circulation
- Prune dead leaves and stems **AND** remove dead plant material from the soil of pots as well
- Practice sanitary handling techniques – wash hands in between touching infected plants, take caution when watering and handling wet plants
- Reduce stress on plants
 - Plants already experiencing stress are more likely to be susceptible to the pathogen and more likely to experience worse symptoms
- Avoid fertilizing infected plants
- Monitor and assess damage from fungal infection before deciding to use chemical control (neem oil or a fungicide)

Vocabulary

- Abaxial = the bottom side of the leaf
- Abscission = “programmed self-pruning”
- Adaxial = the side of the leaf towards the sun, top side of the leaf
- Chlorosis = yellowing of leaf tissue due to a lack of chlorophyll
- Conidia = a spore produced asexually by various fungi
- Haustoria = a slender projection from the hyphae of a parasitic fungus, enabling parasite to penetrate tissue of its host and absorb nutrients
- Lamina = refers to the entire flat and extended section of the leaf, i.e. the leaf blade

References

Adam, S. (n.d.). *Leaf spotting fungi*. Penn State Extension. Retrieved March 6, 2023, from <https://extension.psu.edu/leaf-spotting-fungi>

Brien, R. (2021, March 10). *Rust plant disease - how to identify and treat rust fungal problems*. Gardening | Landscaping | Plants | My Garden Plot. Retrieved March 7, 2023, from <https://www.mygardenplot.com/rust-plant-disease/>

Douglas, S. M. (n.d.). *Fungal leaf spots of trees and ornamentals*. CT.gov. Retrieved March 7, 2023, from <https://portal.ct.gov/CAES/Fact-Sheets/Plant-Pathology/Fungal-Leaf-Spots-of-Trees-and-Ornamentals>

Encyclopædia Britannica, inc. (n.d.). *Fungus*. Encyclopædia Britannica. Retrieved March 6, 2023, from <https://www.britannica.com/science/fungus>

Encyclopædia Britannica, inc. (n.d.). *Powdery mildew*. Encyclopædia Britannica. Retrieved March 6, 2023, from <https://www.britannica.com/science/powdery-mildew>

Fungal spots, blights, and blotches. Visit Missouri Botanical Gardens. (n.d.). Retrieved March 5, 2023, from <https://www.missouribotanicalgarden.org/gardens-gardening/your-garden/help-for-the-home-gardener/advice-tips-resources/pests-and-problems/diseases/fungal-spots>

Grabowski, M. (2018). *Leaf spot diseases of trees and shrubs*. UMN Extension. Retrieved March 7, 2023, from <https://extension.umn.edu/plant-diseases/leaf-spot-diseases-trees-and-shrubs>

References

Libretexts. (2022, June 9). *24.1b: Fungi Cell Structure and function*. Biology LibreTexts. Retrieved March 6, 2023, from [https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_General_Biology_\(Boundless\)/24%3A_Fungi/24.01%3A_Characteristics_of_Fungi/24.1B%3A_Fungi_Cell_Structure_and_Function#:~:text=Most%20fungi%20are%20multicellular%20organisms,of%20hyphae%20is%20a%20mycelium.](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_General_Biology_(Boundless)/24%3A_Fungi/24.01%3A_Characteristics_of_Fungi/24.1B%3A_Fungi_Cell_Structure_and_Function#:~:text=Most%20fungi%20are%20multicellular%20organisms,of%20hyphae%20is%20a%20mycelium.)

Pegg, K., Manners, A., Cooke, T., & Coates, L. (2018, July). *Rust diseases - horticulture*. Nursery Papers. Retrieved March 8, 2023, from <https://www.horticulture.com.au/globalassets/hort-innovation/resource-assets/ny15002-nursery-paper-july-2018.pdf>

Powdery mildew: Koppert global. Koppert. (n.d.). Retrieved March 5, 2023, from <https://www.koppert.com/challenges/disease-control/powdery-mildew/#:~:text=Life%20cycle%20and%20appearance%20of%20Powdery%20mildew&text=Fungal%20spores%20germinate%20on%20the.epidermal%20layer%20of%20plant%20cells.>

Rust diseases. Rust Diseases - an overview | ScienceDirect Topics. (n.d.). Retrieved March 7, 2023, from <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/rust-diseases>

Rust fungi. Rust Fungi - an overview | ScienceDirect Topics. (n.d.). Retrieved March 7, 2023, from <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/rust-fungi>

White Pine Blister Rust. U.S. Forest Service. (n.d.). Retrieved from https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5302971.pdf