MICHIGAN STRAWBERRY FACTS

Strawberry black root rot

Black root rot of strawberry can lead to yield losses ranging from 20-40%. However, the primary driver of this disease, along with its associated symptoms, are often influenced by various abiotic and biotic conditions, complicating its management and requiring a multifaceted approach.

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Key messages

- Temperature and the type of soil influences the main pathogen causing the disease and the prevalence of *P. penetrans*.
- This disease thrives in soils with high clay and silt, warm temperatures (~24°C or 75°F), and high moisture.
- Plants facing abiotic stresses such as poor drainage, soil compaction, and freezing temperatures are more prone to black root rot.
- Plant vigor declines in the first fruiting year and worsens before harvest. When uprooted, affected plants show blackened roots, often with no healthy white roots visible.

Pathogens

***Rhizoctonia fragariae*:** Kingdom: Fungi, Phylum: Basidiomycota, Order: Cantharellales
***Pythium* spp.:** Kingdom: Chromista, Phylum: Oomycota, Order: Peronosporales
***Cylindrocarpon* sp.:** Kingdom: Fungi, Phylum: Ascomycota, Order: Hypocreales
***Idriella lunata*:** Kingdom: Fungi, Phylum: Ascomycota, Order: Helotiales
Ramularia spp.: Kingdom: Fungi, Phylum: Ascomycota, Order: Capnodiales
***Pratylenchus penetrans*:** Kingdom: Animalia, Phylum: Nematoda, Order: Tylenchida

Introduction

Black root rot of strawberries has been associated with numerous pathogens, but research shows that the main drivers of the disease are the binucleate anastomosis groups (AGs) A, K, G, and I of *Rhizoctonia fragariae* Husain & McKeen, and the root-lesion nematode *Pratylenchus penetrans*. Infected plants suffer from severe root damage, reduced vigor, stunting, and a decline in productivity. While soil fumigation remains the most effective management tool, this article will compile additional strategies to mitigate the harmful effects of black root rot to strawberry production.

Disease and Symptoms

The primary aboveground symptoms of black root rot typically start with a decline in plant vigor during the first fruiting year, becoming more noticeable a few weeks before harvest. Other signs include reduced runner growth, numerous

Figure 1. A. Strawberry plants with black root rot showing reduced vigor and fewer runners, and **B.** Roots with a "rat-tail" appearance due to severe black root rot. (Pictures taken by Timothy D. Miles)

dead older leaves, and smaller-than-usual berries **(Figure 1A)**.

The best time to examine roots is around the time when the fruit begins to color. When digging up an infected plant, the root system will appear sparse, with a lack of feeder roots, often giving it a "rat-tail" appearance **(Figure 1B)**. Severely infected roots will be covered in black lesions, which progress from the outer root surface inward. Symptoms associated with *R. fragariae* include the rotting of feeder roots, often to the point of disintegration, and the development of sunken, well-defined lesions on the primary perennial roots.

Abiotic factors such as soil type and temperature play a critical role in determining the primary pathogen responsible for black root rot disease. For instance, the frequency of isolating specific *R. fragariae* anastomosis groups (AGs) has been shown to vary by sampling period; for example, in California, AG I was more commonly isolated from fall samples, while AG G dominated in spring samples. Sandy soils and temperatures below 20°C (68°F) are particularly favorable for *Pythium* spp. infections, while being highly sensitive to microbial activity and nutrient availability. Similarly, the root-lesion nematode *P. penetrans* **(Figure 2)**, a migratory endoparasite, thrives in sandy soils and cooler temperatures. It damages plant roots by feeding on root cells and migrating intra- and intercellularly, causing necrotic lesions. Aboveground symptoms of nematode infection are often mistaken for nutrient deficiencies or abiotic stress, making soil sampling for nematode diagnostics essential for accurate identification and quantification.

The damage threshold for *P. penetrans* in Michigan strawberry crops is believed to be around 50 nematodes per 100g of soil. However, this threshold can drop to as low as 10 nematodes per 100g of soil when *R. fragariae* is present. Despite this, the risk of black root rot based on varying inoculum levels of *R. fragariae*, and *P. penetrans*

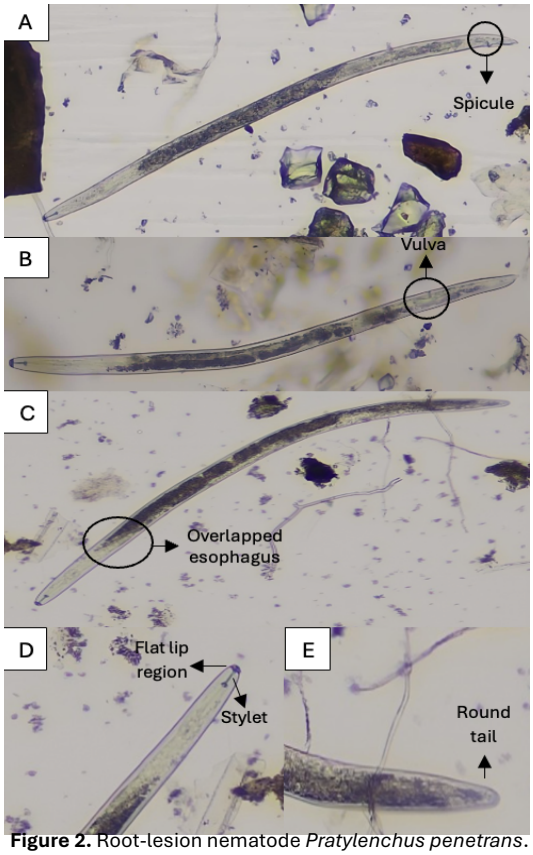

Figure 2. Root-lesion nematode *Pratylenchus penetrans*. **A.** male, **B.** female, **C.** juvenile, **D.** characteristic anterior parts, and **E.** characteristic posterior parts (Pictures taken by Luisa M. Parrado)

has yet to be fully established. It is thought that the feeding behavior of *P. penetrans* predisposes plants to infections by *R. fragariae* and the other pathogens involved, though the exact

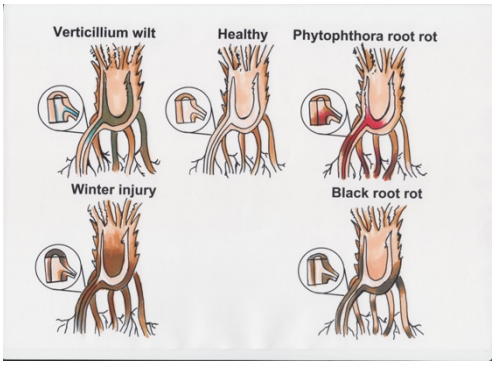

Figure 3. Characteristic symptoms of other root rot diseases and winter injury in strawberry crowns. (Illustration by Dr. Kerik Cox, Cornell University)

mechanisms of interaction between them remains unclear.
Accurately diagnosing black root rot based only on symptoms can be challenging due to its similarities with other root rots or abiotic stress **(Figure 3)**. Therefore, sampling is strongly recommended to confirm the presence of the pathogens responsible and to inform appropriate management decisions.

Disease Management

Once disease symptoms appear, there are no effective curative management options available. Currently, soil fumigation with active ingredients such as chloropicrin and 1,3-dichloropropene remains the most effective management tool, as these compounds are highly toxic to soil-borne pathogens. Post-planting applications of fungicides such as azoxystrobin and potassium phosphite have shown to improve plant longevity and maintain crop productivity but further on-farm trials are needed to fully validate the efficacy of these treatments. Black root rot is promoted by poor soil drainage, soils with low organic matter and abiotic stresses. Since no curative management tools are available, preventative measures that address these favorable conditions for the disease complex are crucial for reducing the risk of yield loss due to black root rot.

1. ***Site Selection:*** Avoid poorly drained soils, typically found in low-lying areas of the field. Instead, choose locations with adequate soil aeration and drainage. Since the pathogens involved in black root rot have a broad host range, select fields with no history of growing strawberries or other fruits and vegetables for at least three years. Soil sampling to assess *P. penetrans* levels is recommended to better evaluate the risk of black root rot.

2. ***Site Preparation:*** If the site has previously been planted with strawberries, implement a 3 to 5-year crop rotation program using cover crops and cash crops, while avoiding crucifers and legumes. To increase organic matter, cover crops such as ryegrass, sudangrass, or sorghum-sudangrass should be planted for at least one year before planting strawberries. If the site has poor soil drainage, strawberries should be planted on raised beds. This system will avoid excess water in the soil and compaction around the root system. Testing the soil for pH and nutrient levels is recommended to determine if there is a need to apply fertilizer before or at the time of planting.

   Pre-plant soil fumigation is a widely used method for controlling soil-borne pathogens, with reports showing that unfumigated fields may suffer yield losses of 20-40% due to black root rot. However, some reports indicate that fumigation can sometimes worsen the disease. Additionally, fumigation is not suitable for organic farming and does not support long-term soil health. Promising alternatives include Anaerobic Soil Disinfestation (ASD), and the use of cover crops combined with compost.

3. ***Measures to take at-planting:*** Although no strawberry varieties are resistant to black root rot, trials in Wisconsin and New York have shown that varieties such as Annapolis, Cavendish, and Glooscap exhibit greater tolerance to the disease compared to Honeoye, all of which are grown in Michigan. Additionally, it is advisable to avoid varieties susceptible to winter injury, as they are likely to be more vulnerable to black root rot. When purchasing plants, ensure the nursery follows reputable practices. Only select healthy plants with strong, white root systems.

4. ***Measures to take post-planting:*** Minimize abiotic stress to reduce the incidence and severity of black root rot. To do this, adjust irrigation to maintain proper soil moisture levels during both dry and wet conditions. Optimize fertilization based on annual soil

and tissue analysis to maintain strong plant vigor. In late fall, mulch plants with straw to protect against winter injury and soil heaving. Avoid soil compaction from farming equipment.

Conclusion

Black root rot is one of the most destructive disease complexes in strawberry production, primarily affecting older fields and causing substantial yield losses. Managing this disease is particularly difficult due to the involvement of multiple pathogens and complicating environmental factors. Currently, there are no resistant strawberry varieties or validated post-planting treatments. A 3- to 5-year crop rotation and pre-plant soil fumigation are the industry standards for managing black root rot. However, because the pathogens have a wide host range, it is critical to avoid rotations with crucifers, legumes, and other fruits and vegetables that can serve as hosts. By carefully following guidelines on site selection, site preparation, and best practices during and after planting, growers can significantly reduce the risk of yield losses caused by black root rot.

For more information about Small Fruit & Hop Pathology visit this web address: https://www.canr.msu.edu/smallfruitnhoppathology/