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Pythium Root Rot on Hydroponically Grown Basil and Spinach

Waterborne diseases that infect roots are a common production issue in hydroponic production. Several species of the water mold, Pythium, attack greenhouse crops. Basil and spinach are susceptible to economically devastating levels of Pythium root infection in hydroponics. In this article we will present symptoms of Pythium infection and management strategies.

Many Pythium species, are generalists, meaning they can attack a wide range of plant species. *Pythium aphanidermatum* and *Pythium dissotocum* are two species commonly reported in hydroponics. Both species can produce zoospores, a mobile propagule that can propel itself through water.

Figure 1. Roots from basil growing in hydroponic rafts (deep water culture) exhibiting root discoloration from Pythium root rot. Photo: Neil Mattson, Cornell University

Symptoms of Pythium Root Rot

As Pythium infects and colonizes roots it can lead to a visible discoloration (browning) and decay of the root system (Figures 1 and 2). Overall root system development may be poor with few lateral roots or root hairs (Figure 1). Often the outer portion of the root (cortex) sloughs away leaving behind the inner part of the root (steele). This leads to the characteristic "rat tail" appearance of Pythium infected roots. The root system can eventually turn slimy and black.

Shoots of affected plants may not initially show symptoms of Pythium infection, however the plants may be reduced in overall size (Figure 3). As the disease progresses, plants may become severely stunted and leaves may be chlorotic (yellow) which is often mistaken for nutrient deficiency when but is really caused by poor root system development (Figures 4-6). Plants may also wilt due to inability of the root system to support plant water needs. At first, wilting may take place during only the hottest, brightest time of the day, but eventually wilting may become permanent.

Figure 2. Roots of baby leaf spinach growing in a Speedling tray in raft hydroponics infected with Pythium root rot. Notice discolored roots with poor branching. Photo: David de Villiers, Cornell University

Figure 3. Baby leaf spinach infected with low levels of Pythium root rot. Notice slightly discolored roots. No shoot symptoms are evident but overall plant size may be somewhat reduced. Photo: David de Villiers, Cornell University

Figure 4. Leaves of baby leaf spinach infected with *Pythium aphanidermatum* (A) are chlorotic and greatly reduced in size compared to uninfected control plants (B). Photo: Ted Alhanti, Cornell University

Figure 5. Hydroponic basil infected with Pythium root rot demonstrating chlorosis (yellowing) of leaves as well as stunted plants. Photo: Neil Mattson, Cornell University

Figure 6. Hydroponic basil showing varying degrees of plant stunting and chlorosis due to infection from Pythium root. Photo: Neil Mattson, Cornell University

Management

Once plants are infected, Pythium can be very difficult to control. Therefore the best approach to Pythium management is adopting a suite of practices that reduce or eliminate exposure to the disease organism, restrict its spread, and promoting environmental conditions that reduce disease proliferation.

Exclusion and Sanitation

There are several ways Pythium can enter greenhouse operations, including from: water (especially surface water sources), soil and plant residue from workers' shoes, air-borne dust, greenhouse tools, previously infected plants/seedlings, and some container media. Follow good hygiene practices to limit entry such as: foot baths to sanitize shoots and boots, sanitization of tools, and inspection of new plant material prior to transplanting. If the water source is found to harbor waterborne disease a treatment system should be installed. Container media with organic matter (such as peat, coir, compost, etc.) can occasionally contain Pythium. Source materials from a reputable supplier with quality control procedures in place.

Because of the prevalence of Pythium it will be difficult (or impossible!) to completely restrict Pythium from hydroponic operations. Therefore, it is important to periodically sanitize surfaces that come into contact with plants or the hydroponic nutrient solution, such as: pond or NFT channel surfaces, irrigation tubing, tools, and carts or other receptacles used to hold plants or move them around. Sanitize containers or seedling trays before reusing. When sanitizing surfaces be sure to remove debris/organic matter first. Be sure to include inspection of plant roots in your routine IPM scouting practices. Toss infected plants at the first sign of Pythium. Don't reuse growing media.

Environment

Environmental conditions that favor Pythium include excessively high fertility, waterlogged substrates (for example, in the seedling stage), low dissolved oxygen, and extreme temperatures. Injury to roots such as through mechanical damage, allowing roots to dry out, or extreme temperatures can provide an entry point to Pythium. Maintain a target root zone temperature of 68 to 75 °F (20 to 24 °C). Lower temperatures favor establishment of *Pythium dissotocum* and higher temperatures favor development of *Pythium aphanidermatum*. At Cornell University, we have found that use of a water chiller to reduce hydroponic pond temperatures to about 68 °F is an effective way to reduce, but not completely eliminate, *Pythium aphanidermatum* from ponds with baby leaf spinach. Low dissolved oxygen levels in hydroponics have also been reported to increase Pythium infection. Therefore it is important to ensure adequate aeration so as to achieve greater than 6 ppm dissolved oxygen and ideally saturated dissolved oxygen (about 8-9 ppm O_2) in nutrient hydroponic solutions.

Biofungicides

Biofungicides are microbial-based products that act to prevent disease development. Several commercially available products are labeled for control of root-disease of greenhouse vegetable crops, see the excellent e-Gro article on this topic here. Some of these materials are primarily suited for use in substrates (such as seedlings or larger plants growing in container media) while some are also meant for use in hydroponic nutrient solutions. Biofungicides should be used as a preventative control strategy before a problem arises (rather than as a curative). Always follow the product label, and be sure to check if a given material is registered for use in your state.

In summary, if you are growing hydroponic basil or spinach you will almost certainly come across Pythium. However, careful attention to your growing practices and sanitation procedures can limit this disease to an occasional annoyance rather than an annihilating nemesis.

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