Relationship of Water to the Development of Root Rot Diseases

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The relationship of water to the development of root rot diseases is often uncertain. "Avoid over-watering," is often the first response when a sample with a root rot disease is submitted to the Plant Disease Clinic at The University of Georgia.

But how does water affect the normal functions of a plant root system and the development of root rot diseases? These are some of the questions I will address. Anything that interferes with the normal functioning of a plant's root system will affect its growth and potential for developing root diseases. Symptoms of root stress often resemble nutrient deficiencies, as well as stunting and overall poor plant growth. Symptoms of root rot diseases can mimic root stress but also include root lesions, decay of feeder roots, damping-off, and eventual death of the plant.

Watering is one of the most important activities in any plant production operation. Its effects can be both beneficial and detrimental. Water exists in soil in three forms: bound water, water vapor, and free water. Bound water is a thin film of water molecules that is tightly adsorbed to the mineral particles in the soil, and it is unavailable to plants. Water vapor exists in the air spaces or pores of a soil. It also is unavailable to plants. Free water is the most important form, and it is what the plant utilizes. This form of soil water is not pure water but contains many dissolved materials such as minerals, gases, and organic compounds.

Soil Characteristics

The most important soil characteristics that determine the amount of water retained within a soil mix is the total amount of air space, pore size, and how these pores are distributed. A heavy clay soil can retain more water due to its smaller particle size, giving it more total air space than a sandy soil.

Water adheres or sticks to each soil particle. It also adheres to itself. In soils with larger pores (sandy soils), water is not trapped or held as easily as in a soil mix with smaller pores (clay soils). In soil mixes high in organic material, such as peat-based mixes, water-holding capacity is usually higher than in low organic mixes. This is because the organic material acts like a sponge and absorbs water.

The ability of plants to absorb water from soil depends upon the amount of tension holding the water to the soil particles and to itself and the amount of dissolved materials in the soil water. Water tension increases as soil dries, which results in it being held very tightly to soil particles. At this point, water is held so tightly that the plant's roots are unable to absorb any more water into the plant's system, and the plant responds by wilting.

Minerals and Salts

The other factor influencing the availability of water to plants is the amount of dissolved minerals and salts in the soil water. If concentration of a particular nutrient, such as nitrate, is higher in the soil solution (water) than it is in the root, water from the root will move out into the soil. If this movement is rapid, the cells collapse and die. This is referred to as "burning." Plants also may respond to this effect by wilting. Often plants show the same symptoms (wilting in this case) under extremely dry or wet conditions.

Aeration

Soil aeration or the exchange of oxygen and carbon dioxide between the soil and atmosphere is mandatory for normal root development. Aeration is dependent upon the physical structure of the medium (pore size), irrigation frequencies, atmospheric factors (temperature, humidity), and soil biological activity. Watering a container-grown plant forces air out of the medium. As the medium dries, air moves in. If the medium is kept constantly wet or there is poor drainage, oxygen is unable to move into the medium which results in increased levels of carbon dioxide. Root growth and activity is greatly reduced under these "anaerobic" conditions. Soil microorganisms, on the other hand, are favored by high carbon dioxide conditions and multiply. Their activity produces toxic compounds that further reduce root growth.

Pathogens

Root rot pathogens, especially the "water molds" such as *Pythium* and *Phytophthora*, are favored by the

same conditions that reduce root growth (especially high soil moisture, high soluble salts, and poor aeration). These pathogens produce motile spores, zoospores, that move freely in water. Zoospores infect the root behind the root tip. If root growth is reduced and slowed, these pathogens have plenty of time to germinate and penetrate into the root. If root growth is optimal, the growing root may outgrow the germinating zoospore and escape infection.

Stressed and injured roots are more susceptible to root infection than healthy roots. Roots are leaky. They are constantly exchanging water, sugars, and gases with the surrounding soil. Injured or burned roots are especially leaky. These roots tend to attract root pathogens because some, like the water molds, can follow a chemical gradient in soil water. Wounds also provide a direct entry point for many pathogens.

Some root pathogens, such as *Fusarium* and *Rhizoctonia*, are favored by excessive drying and rewetting of the soil medium. Roots subject to these conditions may crack and die. These roots are especially attractive to pathogens because of their leaky nature and direct opening for pathogen entry.

Root rot disease prevention begins with proper water management. Often it is a fine line between proper and improper water management, but in general the longer soil media stays wet, the greater the likelihood of a plant developing root problems. Scheduling watering operations earlier in the day, rather than in late afternoon and evening, may aid in reducing root diseases because the soil will dry faster. A well-aerated medium with good drainage will also reduce root diseases.

Sanitation programs also are essential in reducing the risk of root diseases. Anything that can move soil can potentially move a root pathogen. This may include water, tools, hands, hoses, even shoes. Infected plant material should be removed as soon as it is detected because this is a source of inoculum for further infection. Rooting media should never be reused. A good sanitation program is especially important for young plants and in propagation houses since these plants are most susceptible to root rots.

Fungicides

Fungicides are an important component in disease management. Fungicides are applied when conditions are favorable for disease development; preferably before infection occurs. The most effective fungicides to control root rots are systemic, meaning they are translocated through plant tissue. However, they are "locally" systemic. They may travel through a leaf, but they will not travel through the whole plant. Furthermore, their translocation is typically upward in the plant, not downward. Therefore, for root problems, fungicides need to be applied at the root. Systemic fungicides can be sprayed onto the foliage for root problems, but they will not be effective unless additional water is used to wash the product to the soil and roots. Soil drenching is the most effective fungicide application method for root diseases.

The fungicide used depends upon the pathogen present. Consult your county Extension agent for fungicide recommendations and submission of samples to the Plant Disease Clinic for pathogen identification. Follow fungicide label directions carefully.