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What Works for Organic Disease Control in Winter Tunnels

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Diseases can affect leaves and roots of winter crops. Step 1 in managing diseases of any crop is knowing what diseases can occur and have occurred in the past. Understanding how the pathogens causing these diseases can be dispersed and survive between crops plus conditions favoring their development is critical for developing an integrated management program; pathogens differ in their abilities. Do not rely on using organic fungicides to manage diseases; their use should be last resort as part of an integrated management program. Thorough coverage is particularly important with organic fungicides as most have contact activity and cannot move through leaves as conventional fungicides can. Important to realize that fungicides do not have the capability to cure diseased tissue. Adequately managing diseases affecting leaves of leafy crops is especially difficult because consumers prefer leaves free of symptoms and residues. Situation is different with foliar diseases of fruiting vegetables. Select resistant varieties when available (note that resistance rarely means no disease). Note that some pathogens (notably those causing downy mildew in spinach and lettuce) evolve rapidly generating new races able to overcome resistance. Avoiding bringing pathogens on to a farm is a very important management step. Select seed that has been tested for pathogens that can be seed-borne. Treating seed with hot water or steam kills many seed-borne pathogens; notable exception is those causing downy mildews. Thoroughly clean and disinfect equipment used on another farm, and also in other production areas on your own farm to avoid spreading pathogens. Field plantings of a crop that is also grown in the winter tunnel should be located as far away as possible when susceptible to a pathogen that produces spores dispersed by wind (the mildews), and consider prevailing wind direction; fall planting should be downwind from tunnel. Destroy field planting promptly after final harvest. Avoid favorable conditions. Wet soil is favorable for *Pythium*, a common root rotting pathogen, and slows plant growth especially when also cool. Especially important to avoid wet, cool soils with seedlings because they are more susceptible to root rot. Many foliar pathogens need leaf tissue to be wet for several hours to be able to infect. Therefore it is best to use drip irrigation. When using overhead irrigation with crops under row cover, water in morning so there will be enough time for leaves to dry before putting row cover back on. Downy mildew pathogens can infect when humidity is high for several hours. Powdery mildew pathogens are unique in that they prefer dry conditions. Promote rapid drying in tunnels with fans. Vent high tunnels as often as temperature permits; but realize when open while field-grown crops are present, spores can move inside from an infected crop outside and vice versa. Routinely check plants for disease symptoms. Look in leaf symptoms for signs of fungal pathogens (spores). Hand lens may be necessary. Early morning is the best time to look because foliar fungal pathogens produce spores during nighttime. Seeing spores confirms identification. Remove diseased crop debris when the causal pathogen can survive in it. Promptly clean up after the crop is finished. Physically remove this tissue from tunnels to minimize potential for the pathogen to remain. With white mold (aka lettuce drop) it is well worthwhile to remove diseased plants when first seen because the pathogen produces survival structures (sclerotia) that can survive in soil many years and the pathogen has a very wide host range; as diseased plant tissue breaks down the sclerotia can drop into the soil. Manage weeds inside and around tunnels as some can be alternate hosts for pathogens and also insect pests, and inside they contribute to humidity. Anaerobic soil disinfestation is a method to manage soilborne pathogens in high tunnels. Critical aspect of an integrated management program is that practices are implemented targeting all potential sources of the pathogen. Sowing pathogen-free seed (tested or hot-water

treated) will be irrelevant if planted where crop debris or weeds could be harboring the pathogen from previous disease occurrence, and vice versa. Successful program also has practices focused on the other requirements for disease to develop: susceptible host and favorable environment.

Powdery mildew and downy mildew diseases have been seen developing on leafy vegetables in winter tunnels in the region. These include downy mildew in spinach, lettuce, and kale and powdery mildew in lettuce and kale. Similarities among all of these diseases include that the pathogens produce spores that are dispersed by wind, have very narrow host ranges that could include weeds, and cannot survive in dead crop debris unless they produced their sexual spore type which are thought to be uncommon for most of these. Narrow host range means these diseases are all caused by different pathogens. Downy mildew pathogens infect when leaves are wet or humidity is high for several hours while powdery mildews develop under dry conditions. The downy mildew pathogens can be seed-borne. Role of this source of the pathogen for outbreaks in the region is not known.

An on-line survey conducted with growers in the region about occurrence of the mildew diseases generated valuable information. It was done to determine how important (widespread) they are and to gain knowledge about occurrence that could contribute to understanding pathogen epidemiology in the region, in particular likely sources. Widespread occurrence could suggest pathogen is being dispersed by wind among farms which is less likely with crops in tunnels than open field, especially during winter. Random occurrence could suggest contaminated seed was an important source. Based on the responses received, these mildew diseases are not occurring widely and tend to occur repeatedly on a farm. For example: 8 responded downy mildew occurs on winter lettuce every year (6) or most years (2) while only 2 saw less frequently and 12 reported never having seen. Several people responded saw in more than 1 cropping season (fall, winter, spring). But 2 responded only saw in winter crop. With spinach downy mildew, 2 responded saw it in fall, winter, and spring crops at least 3 times. 14 reported never having; 12 of those grow spinach all 3 seasons. This suggests these pathogens might be surviving on some farms. It is also possible occurrence reflects varieties being grown with those growers who have a disease selecting varieties without effective resistance or purchasing seed harboring a downy mildew pathogen. Occurrence may partly reflect farm-to-farm variation in favorability of conditions. 4 responded they had downy mildew on both lettuce and spinach. The pathogens are different; they do not infect both plants. But high humidity is favorable for both. 9 respondents had only one downy mildew occur on their farm, which could reflect presence of only one pathogen. Similar with powdery mildew: several respondents had powdery mildew on both lettuce and kale. Similar to the downy mildews - different pathogen but similar favorable conditions, which are drier than downy mildews.

Additional information about the mildew diseases plus photographs and results from the survey are at http://vegetablemdonline.ppath.cornell.edu/NewsArticles/winter-greens.html.

Please share information about diseases occurring in your winter crops! Production in winter tunnels is sufficiently new that there are gaps in knowledge, which is needed to identify research and extension needs. Samples of spinach with downy mildew are wanted for race identification to guide variety recommendations.

Labeled organic products for downy mildews include copper, Actinovate, Cease, Double Nickel, LifeGard, Oxidate, Regalia, Serenade, Sonata, Timorex Gold, Trilogy, and Zonix. These are also labeled for powdery mildews with the exception of Zonix. Other fungicides include sulfur, JMS Stylet-oil and other mineral oils, and MilStop and other potassium bicarbonates. Products labeled for root rotting pathogens include Actinovate, Bio-Tam, Double Nickel, Promax, RootShield, Serenade, Taegro and SoilGard.

Please Note: The specific directions on pesticide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Note that some products mentioned are not yet registered for use on cucurbits. Check labels for use restrictions. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.