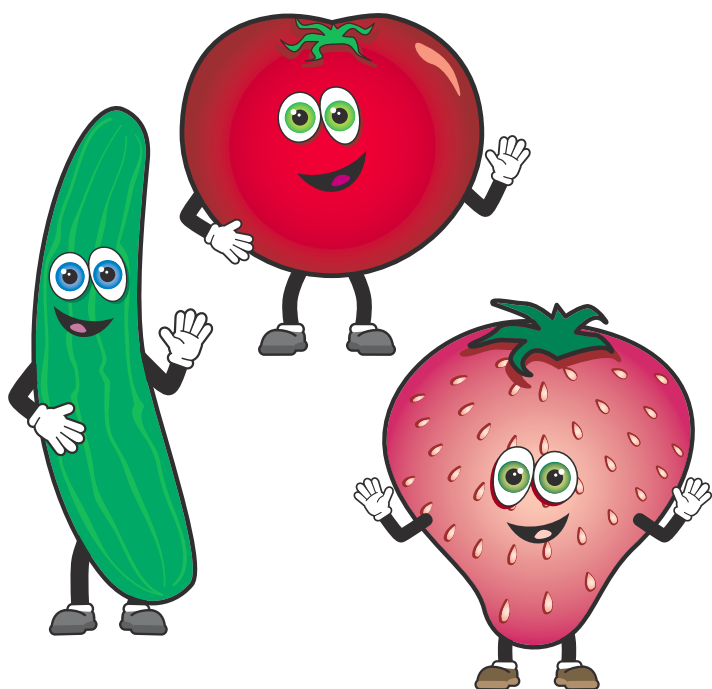


New hydroponic growers cringe at the thought of their green lovelies being mowed down by a plant disease. But growers can learn how to prevent most outbreaks and deal with them when they happen. The key is knowing what to look for and acting quickly when things don't look right

Below left: Healthy plants should show no signs of disease foliage spots, spore growth or discoloration. *Top right:* Gray mold, or botrytis, can occur on foliage, stems and fruit. This is a botrytis outbreak on a strawberry fruit after harvest. *Bottom right:* Leaf spots can be of fungal or bacterial origin. Spots most commonly occur when leaf surfaces become wet and humidity and is high.



HEALTHY PLANTS, HAPPY PLANTS

All growers should have several good reference books on plants and plant production to refer to when problems arise. And all hydroponic growers should pay regular visits to their local hydroponic retailer for news and information about the wide range of safe and effective disease-prevention and control options.

Identifying the Problem

Hydroponic growers fight the same plant diseases that soil gardeners fight. Infectious plant diseases are ones which can actively spread from plant to plant. The most common are those caused by fungi, although bacteria and virus diseases are also infectious. The first step when dealing with a suspected disease outbreak is to try and determine if the cause is indeed fungal, bacterial or a virus, then narrow the options down to a possible culprit.



Above, clockwise from top left: Healthy plants means not just choosing resistant varieties wherever possible but keeping a close watch for signs of trouble. Many diseases have descriptive names, such as these gray mold spores indicating that gray mold, or botrytis, disease is attacking this plant. Many diseases like to take hold at the end of the growing season, just as fruit is starting to ripen. Leaf spots can be of fungal or bacterial origin. Spots most commonly occur when leaf surfaces become wet and humidity and is high. Below: Even mature fruit can be prone to disease problems and should be checked regularly.

This makes working out a plan of action for control of the disease much simpler, and growers soon learn to recognize signs and symptoms of trouble before they have much chance to spread.

Fungal Diseases

Fungal diseases cause the most problems for all growers. Some of the most commonly encountered diseases in indoor hydroponic systems are fungal and include botrytis (gray mold), powdery mildew, damping off of seedlings (pythium and rhizoctonia), downy mildew, rusts, leaf spots, root rots and wilt fungi. However, of these the most commonly reported problems in hobby systems appear to be powdery mildew, botrytis and pythium which thrive in areas of high humidity such as those in indoor gardens.

Fungal diseases are spread via spores which are too tiny to be seen individually, but can often be identified when produced en masse on leaf surfaces where they look like a furry or powdery growth. When the plant is shaken, spores can erupt upwards and be carried on air currents or in water for considerable distances to find a new host to infect. Once the spore lands on the plant, and provided conditions are favorable, it will germinate and penetrate down into the plant tissue where it continues its infection inside the plant. Once inside the leaf or root tissue it becomes much more difficult to control the attacker, so preven-

tion or early control options are the best way of halting infection. The plant itself does have some defenses against fungal attack and it's likely that many of the spores that touch down on a healthy plant don't germinate or don't get inside the plant due to unfavorable conditions and the plant's own defense systems. Hobby growers can do a lot to prevent infection of fungal pathogens by making sure conditions don't favor spore growth and that plants are in the best health to resist such attacks. Failing that, protective fungicides and other products which provide a coating over the leaf surface can also prevent fungal spores from germinating and growing into the plant.

Fungal Identification

Identification of the most common fungal diseases is not too difficult. Many appear just as their common name indicates. Gray mold (botrytis) will develop brownish-grey furry spore growths almost like ash sitting on the tissue surface. Powdery mildew produces white fluffy spore covering mostly on the upper leaf surfaces. Downy mildew appears as grayish-white downy patches of spores on the undersides of leaves. Damping off (pythium or rhizoctonia) cause young seedlings to develop a water-soaked area around the lower stem, the seedling often toppling over as it dies back. Rust appears as rusty red or brown patches of spores which develop in clus-



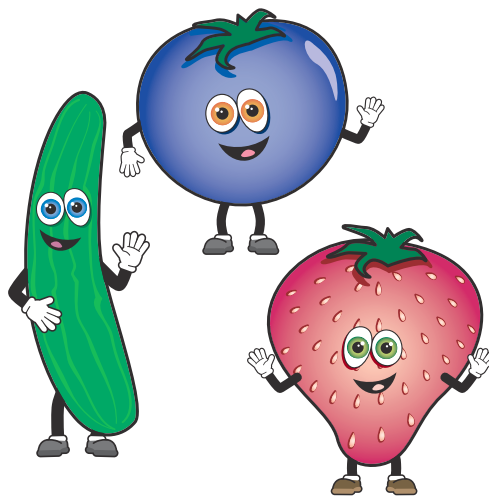
ters, although some rarer forms of rust can also be yellow, black or even white in color. Wilt fungi infect the root system and cause the plant to wilt in the early stages as the infected root system can't take up and transport sufficient water to keep the plant turgid. There are a number of wilt fungi which have been known to occur in hydroponics including fusarium, phytophthora and verticillium. These diseases are best prevented with use of resistant cultivars, sterile growing media and preventing soil contamination of the hydroponic system.

Fungal leaf spots are less common in indoor hydroponic gardens. Many of these pathogens are spread by water. By avoiding leaf wetness, condensation and irrigation systems that splash water, many leaf spot pathogens can be prevented. Leaf spots, if they do occur, are the most difficult of the fungal pathogens to nail down to just one cause as similar leaf-spotting symptoms can result from bacterial infection, nutritional disorders and deficiencies, environmental conditions and even insect feeding.

Botrytis (gray mold)—Tends to appear first as water soaked areas on leaves and stems that quickly produce the characteristic gray/grown furry spore growth. As the disease progresses, infected areas grow in size and encircle stems causing plant collapse. Common in humid conditions and in winter, spores need high humidity to germinate and infect plants.

Mildew—Powdery and downy mildew are often confused. Powdery mildew is more common than downy mildew. Powdery mildew develops under warmer, drier conditions and produces white clumps of spores on the leaf surfaces. Downy mildew prefers cool, moist conditions and appears as grayish white patches on the undersides of leaves. First symptoms of downy mildew are often light green or yellow spots on the upper surface of older leaves. Plants can become completely covered in mildew, followed by plant death.

Rusts—Rust is common on mint, chives, cilantro, parsley, and many ornamentals such as geraniums. Rust infection causes clusters of rusty colored spores on the



undersides of leaves and also causes yellow and purple spots where the leaf tissue has been infected. Rusts are common in warm conditions with plants growing at a high density. Rust spores require high humidity to develop.

Pythium and Rhizoctonia (damping off and root rot)—*Pythium* is a common fungal pathogen which is present in water, air, dust and plant material. *Pythium* does not usually attack healthy plants or root systems unless the spore load is high. This disease prefers to attack damaged or weakened plants/root systems and young seedlings. Seedlings may develop water-soaked brown areas in the lower stem and die back (“damping of”), or mature roots can become infected and disintegrate. Browning of the root tips is an early sign of *pythium* infection. *Rhizoctonia* causes similar symptoms, and is favored by water-logging and high salinity.

Fungal leaf spots—Leaf spots are also caused by large number of different fungal pathogens. The most commonly recognized is black spot of roses and fruit trees. The plants most frequently affected by leaf spots are lettuce, passion fruit, parsley, pansy, zinnia, cymbidium orchid, celery, carrot, carnation, brassicas (cabbage family), bean, peas, lilies, rose and chard. Fungal leaf spots can range in size, shape, distribution pattern and color depending on the pathogen and the plant infected. Under very damp conditions, leaf spots may grow and merge causing whole shoots or leaves to wither and die back (“blight”). The leaf spot fungi become dormant in

drier conditions and can easily re-activate when moisture or high humidity returns.

Bacterial Diseases

Bacterial diseases of plants are much less common than those caused by fungi. Since indoor hydroponic gardens are protected from rain, leaf surfaces don't get as wet, limiting the spread of bacterial pathogens. Bacteria don't produce spores on plant surfaces in the way fungal diseases do. They are microscopic organisms that can be spread by seed, insects, on plant residue, windblown soil particles, rain or water splash or in water supplies.

Bacterial diseases are characterized by a few distinct symptoms usually including bacterial leaf spots which have a slightly greasy or water soaked appearance or bacterial dieback which often ooze with a gummy fluid or become black and slimy under humid conditions. The main difference between a fungal and bacterial disease outbreak is that fungal diseases often produce powdery spores which can be seen on leaves and stems, where as bacterial disease don't have any spore growth. The most common bacterial diseases of hydroponics plants are leaf spots, blights, and soft rots and these tend to be most common in unprotected outdoor hydroponic systems or those with very high humidity/condensation or some other form of regular leaf wetness.

Leaf spots—Leaf spots are perhaps the most common of the bacterial diseases which smaller growers may encounter and these are usually caused by either *pseudomonas* or *xanthomonas*. Bacterial leaf spots may look quite similar to many of the fungal leaf spots. However, bacterial spots are typically more angular in shape because the bacterial cells tend to be constricted or prevented from spreading past the larger leaf veins. They may also have a yellow halo around the leaf spot where the bacteria is actively growing and multiplying. In contrast, leaf spots caused by fungal infection tend to have smoother edges and don't have the outer halo. Distinction between fungal and bacterial leaf spots is important as the control options for the

each are very different. Applying a fungicide to control a bacterial leaf spot pathogen just won't work.

Soft rot (*erwinia*)—Soft rot initially appears as a rapid wilting of leaves of plants such as lettuce. Carrots, potatoes and other tubers, corms and rhizomes can also become infected and develop into a rotten and smelling mess. Soft rot bacteria enter plants through wounds, particularly under wet and saturated conditions.

Bacterial Canker/Wilt—Disease symptoms may be seen on tomatoes and causes wilting of the leaflets and light-colored streaks on leaf stems. These may break open to form cankers in the case of bacterial canker. Inside the stems tissue becomes discolored and turns brown. As the disease progresses the stem may become hollow.

Viral Diseases

Viruses are relatively uncommon in hobby hydroponic systems with most of the plant types grown. Viruses are often misdiagnosed as the cause of a number of strange plant symptoms, usually those caused by environmental factors, nutrient imbalances, herbicide or other chemical/spray damage, or even naturally occurring plant variegations.

There is no cure or spray product that can contain and kill off a viral infection, so prevention and plant removal is the best control technique. Viruses are tiny particles of genetic material that infect plant tissues and disrupt growth in many different ways. There are hundreds of named plant viruses and many unidentified ones. However, hydroponic growers likely will to come into contact with only some of the more common and highly infectious types. The effects of virus on the plant may be quite mild—so mild, in fact, the grower never recognizes there is a problem, just a slightly stunted or unproductive plant in the midst of a healthy system—to severe.

The main problem with a virus outbreak is that a single infected plant coming into the hydroponic system has the potential to infect many others through sap contact, handling, harvesting and trimming operations. Sucking insects can also spread virus from an infected plant to many others or even bring virus into healthy plants in the

system from outside the cropping area. Most hobby growers tend to produce a wide range of plants in the one system, so this does limit spread of most virus diseases as many are species-specific or have a very limited host range. Of the plants most commonly grown in hobby systems, tomatoes, cucumbers, peppers, lettuce and some ornamental plants such as dahlia, lily, rose and tulips are the most susceptible to viruses of various types, although many are specific to the plant itself.

What probably concerns small growers more than anything else with a virus is where the disease came from and how to prevent it spreading. Most virus outbreaks in a hobby system can be traced to the introduction of infected plant material, either as a new seedling or plant brought into the cropping area, cuttings taken from another plant carrying a virus or spread through sap contact or insect feeding. Occasionally, viruses are seed-borne but this is very uncommon in hobby systems.

Common viruses such as tobacco mosaic can be spread easily from infected dried tobacco, so smokers should wash hands after smoking and before handling plants such as tomatoes. One virus infected tomato plant can rapidly infect surrounding plants when the grower removes laterals or trims old leaves. The infected sap gets transmitted from plant to plant on hands or pruning tools, and this is the most common cause of virus spread in small systems.

The main treatment for viruses-infected plants is to completely remove the offender from the hydroponic system and out of the cropping area to prevent spread.

Common Viral Diseases and Symptoms

Typical symptoms of virus disease are distortion of leaves, particularly at the growing points and flowers, leaf mottling or strange coloration of foliage, leaf bunching, plant stunting, reducing flowering and fruiting, deformed fruit on plants such as tomatoes, and chlorotic, or yellowing, patterns on foliage. Growers should take care to distinguish viral disease symptoms from those caused by aphid feeding and nutrient deficiency, which are similar in

appearance.

Tobacco mosaic virus—This virus often attacks tomatoes and peppers. Symptoms include leaf mottling with curling and malformation of leaflets, stunted plants. Fruit may be affected.

Cucumber mosaic virus—Tomatoes, peppers and cucumbers. Plants stunted, short internodes, leaves often very distorted and malformed, become narrow (shoestring symptom). Often spread by aphid feeding.

Lettuce mosaic virus—Most common virus of lettuce causes leaves of young plants to appear irregular in shape and develop a light green mottled appearance. Older plants develop a stunted growth pattern with distorted leaves and this may result in a lack of head formation in heading types. Plants infected in later stages show a light green-yellow mottling on leaves and leaves may develop a downward curling.

In the next article in this series, I'll discuss details of how to prevent and control infectious diseases, with emphasis on the safe and effective products for hobby systems. 🍀

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References and Resources

Cornell University

vegetablemdonline.ppath.cornell.edu/cropindex.htm

Pennsylvania State University

vegdis.cas.psu.edu/Identification.html

University of Florida

edis.ifas.ufl.edu/CV273

"Tomato Diseases" edited by B. Gabor and W. Wiebe, 1997. Seminis Vegetable Seeds Inc., California, USA.

"Compendium of Lettuce Diseases" edited by R.M. Davis, K.V. Subbarao, R.N. Raid, E.A. Kurtz, 1997. APS Press, Minnesota, USA.

"Identifying Diseases of Vegetables" by A.A. MacNab, A.F. Shierf, J.K. Sprinker, 1983. Published by Pennsylvania State University, USA.