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This issue of Vegetable Notes gives information on soil-borne diseases. Club root of crucifers is only mentioned briefly in the main article because it is covered separately in more detail. The club root article is primarily the effort of Gideon Porth, a graduate student in Plant and Soil Science. We are very pleased with the progress of this research.

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In this Issue:

Soil-borne Diseases of Vegetable Crops
Crop Insurance for Diversified Agriculture

SOIL-BORNE DISEASES OF VEGETABLE CROPS

Robert L. Wick

Soil-borne diseases are caused by plant pathogens (mostly fungi and nematodes) that can survive in the soil indefinitely. Indeed, soil is their natural habitat. Typically, soil-borne pathogens cause root and crown rot but several cause fruit rot and foliage blight. Most plant pathogens that cause disease of the foliage, such as *Alternaria*, and *Septoria*, cannot survive in soil. Despite a few exceptions to these generalizations, it is useful to categorize pathogens as either soil-borne, or not soil-borne, because it helps us understand how to manage them more effectively.

Soil-borne pathogens are difficult to control because they have the ability to survive for many years in the soil. Plowing crops into the ground after the growing season does not help reduce soil-borne pathogens; it's like throwing br'er rabbit into the briar patch. The most important practice is to avoid planting susceptible crops into contaminated soil. Crop rotation, along with other cultural practices, and fungicide applications, are important tools for managing plant diseases. An integration of management practices is the most effective approach. This article addresses practices that can be targeted to specific soil-borne diseases. Knowing exactly what diseases you are dealing with is the most important first step in developing an integrated pest management program. Make sure your diseases are accurately diagnosed.

Clubroot of Crucifers Club root is caused by *Plasmodiophora brassicae*, a primitive protozoan-like organism. See article on page in this issue for more information on this soil-borne disease.

OOMYCETES

Pythium, Phytophthora, and the downy mildews are often referred to as "water-molds" or "primitive fungi". They are not "true fungi" but we refer to them as fungi because they look like and behave like fungi. They are more properly known as oomycetes. Oomycetes

survive for many years in the soil by producing specialized resistant spores called oospores (Fig 1, next page). These thick-walled structures germinate only when root secretions from a susceptible host are present, and soil moisture is abundant.

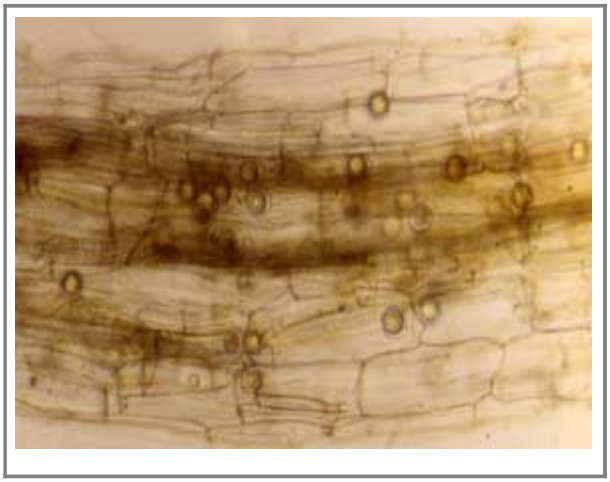

Figure 1. The circular structures in this root are oospores of Pythium. Oospores of Phytophthora would look similar

Pythium is a common inhabitant of all field soils and has a very wide host range. Though it is a weak pathogen in the field, and rarely a cause for concern, it often causes damping-off in the greenhouse
(Figure 2). This is because *Pythium* does not compete well with other soil-inhabiting fungi and bacteria, which are generally absent in soilless growing media used in greenhouses. When starting transplants in the greenhouse choose a soilless growing medium that drains well. Avoid contaminating the medium with soiled hands, hose-ends and tools. Avoid overwatering and overfertilizing. Pythium occasionally causes disease to seedlings in the field when soil is excessively wet and cool. Also, transplants are more susceptible during the first week or two after setting out.

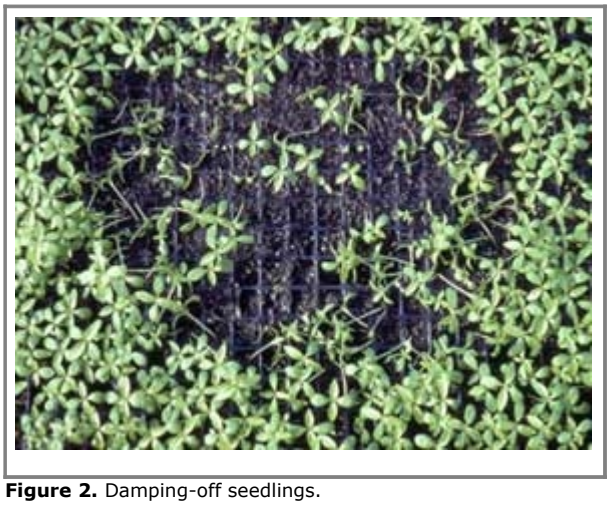

Figure 2. Damping-off seedlings.

Phytophthora is closely related to *Pythium* but is different in several ways. *Phytophthora* is much more pathogenic but unlike *Pythium* it is not widely distributed. Also, *Phytophthora* species that attack vegetable crops generally have relatively narrow host ranges.

Phytophthora infestans attacks only tomato and potato. It behaves like a downy mildew in that it causes blights of the foliage **(Figure 3)**, and spores are easily blown throughout the field. It generally does not take up residence in the soil because it needs two different mating types (similar to male and female) to produce the oospores that allow long-term survival. For this reason, we don't see this disease repeating itself in the same field year after year. Typically, it is brought in on seed potatoes, and its spores can be blown for a mile or so in a good storm. *Phytophthora* infestans can survive in potato cull piles. Diseased plants should be plowed into the ground to prevent further spread. It is especially important to bury cull piles of potatoes and tomatoes. There are several fungicides registered for use on potatoes and tomatoes but they may not perform well when disease pressure is significant.

Figure 3. Late blight on tomato.

Phytophthora capsici causes blight of cucurbits, tomatoes, peppers and eggplant. Crown rot and fruit rot are the most common symptoms **(Figure 4)**. Often, a powdery or mealy bloom of whitish growth appears on the surface of infected fruit. This *Phytophthora* species can survive for very long periods of time in the soil. Plowing infected plant debris into the ground will not help, and may increase the level of soil contamination. However, chisel plowing may improve drainage, and that can help reduce *Phytophthora* blight. There may be some benefit gained from removing the diseased fruit from the field. However, do not dispose it on agricultural land. Diseased fruit should be landfilled or placed where cucurbits, peppers and tomatoes will never be grown. *Phytophthora capsici* can contaminate farm ponds if fields with diseased plants drain into the pond. Avoid planting susceptible crops on land known to be contaminated with *Phytophthora capsici.* Avoid bringing contaminated soil to clean fields with plows, etc. Plow and disc contaminated lands last and spray the soil off equipment before moving to new fields.

Figure 4. Fruit rot of summer squash caused by Phytophthora capsisci.

Downy mildews are caused by a number of different species. Most have a narrow host range, attacking a single genus or family of plants. They cause blights of the foliage rather than root and crown rot. *Peronospora tabacina* is one of the most destructive species and causes blue mold of tobacco. This pathogen does not survive in the northern states and must travel up the eastern seaboard, hopscotching from field to field. It can also overwinter on ornamental tobacco and volunteer tobacco in greenhouses.
Downy mildews of crucifers are caused by *Peronospora parasitica*. Most crucifers, including weeds are susceptible. Disease occurs when temperatures are between 50 and 60 F and plants are wet for 12 to 24 hours. The pathogen can survive in the soil by forming oospores. Rotate away from crucifers for at least two years. Some broccoli cultivars are resistant, see your seed catalogues. Registered fungicides include: Bravo Ultrex, Aliette, Maneb and Ridomil Gold EC/Bravo.

TRUE FUNGI
Rhizoctonia causes damping-off **(Figure 2),** crown rot and root rot of a variety of vegetable crops. As is the case with *Pythium, Rhizoctonia* is mostly a problem in the greenhouse. Several fungicides are available to protect seedlings. Occasionally, head rot of cabbage, "soil rot" of squash, or stem rot of crucifers will occur in the field. Rhizoctonia is generally not a problem in field soil and fungicide applications are usually not warranted.

Sclerotinia blight affects a wide range of vegetable crops but not corn or grasses. *Sclerotinia sclerotiorum* survives in the soil by producing sclerotia, hard black structures that are 1/8 to ½ inch in length **(Figure 5)**. They are usually embedded in the fruit and stems of the plants. *Sclerotia* that are within 1 to 2 inches of the soil surface germinate when the soil has been saturated for about a week and temperatures are between 50 and 70 F. They may directly infect stems, or produce tiny mushrooms, which disperse millions of spores. The spores do not have enough energy to germinate and infect healthy tissue. However, spores that land on dying flowers germinate and develop enough growth to cause infection once the flower drops to a stem or fruit. If conditions for disease are present, fungicides should be used when the plants come into flower. Once the disease has become established there is no point in using fungicides because there are no

secondary disease cycles. Sclerotia that develop after infection cannot germinate until the following year.

Figure 5. Sclerotinia Sclerotia.

If practical, remove diseased plants and fruit from the field. A single head of cabbage can have thousands of sclerotia. If removal is not practical, it is better to plow the infected plants into the soil than disking them in. Plowing under the diseased plants will bury the sclerotia to a depth that will inhibit germination, while disking will tend to place the sclerotia in a more favorable place to germinate. Like many seeds, sclerotia will only germinate when they are within an inch or two of the soil surface. Improving drainage by chisel plowing would also be of value. When a soil is infested with Sclerotinia, it is recommended to rotate away from susceptible crops for 7 years.

Fusarium crown rot of squash and pumpkin *Fusarium* solani causes a crown rot of squash, gourds and pumpkins. The disease appears to be more prevalent now than in previous years. Plants develop a soft, water-soaked rot at the crown of the plant. Wilting and collapse soon follow (Fig 6). Fungicides are of no value, rotate away from cucurbits for at least 4 years.

Fusarium wilt is caused by *Fusarium oxysporum*. Unlike *Fusarium solani, F. oxysporum,* does not cause rotting. This fungus enters through the roots and grows up through the water-conducting cells of the plant into the stem. Symptoms of Fusarium wilt include yellowing and wilting, often on one side of the plant. A cut through the stem often shows discoloration of the vascular system. This fungus is highly host specific. For example, Fusarium wilt of basil occurs by a specific strain that can only cause wilt in basil. Fusarium wilt of tomato only affects tomato. Fungicides are of no value, rotate with another crop for at least 4 years. Some cultivars have been bred to be resistant to *Fusarium oxysporum.*

Verticillium wilt is caused by *Verticillium dahliae. Verticillium* infects plants in the same way that *F. oxysporum* does. Yellowing, scorching and wilting follow infection. Discoloration of the vascular system may be evident. This fungus has a very wide host range but some specificity exists. For example, strains that infect maple trees may be weak pathogens of vegetable crops. A variety of vegetable crops can be infected by the

same strain. Eggplant is particularly susceptible. A combination of lesion nematodes and *Verticillium* causes “early dying” in potato. Fungicides are of no value. Avoid planting susceptible crops in contaminated fields. Some resistant cultivars are available.

NEMATODES

There are many species of plant parasitic nematodes, and most of them have wide host ranges. Every handful of soil has a few plant parasitic nematodes but they are not a problem unless they build up to high numbers. Root-knot, lesion and stubby root nematodes occasionally build up enough to cause problems. Dagger and stubby-root nematodes can transmit viruses such as tobacco ringspot virus and tomato ringspot virus. The Plant Disease Diagnostic Lab can assay soil for nematodes.

Figure 6. Fusarium crown rot on gourd

Root-knot nematode *(Meloidogyne hapla)* is the most serious nematode pest in the New England region. It is not widely distributed, but there are fields where it is a perennial problem. Root-knot nematodes can result in significant losses to tomato, lettuce, carrots, parsnips and a few other crops. Above ground symptoms, wilting and stunting, are not unique to nematodes. Below ground symptoms are fairly unique, small galls occur on the roots **(Figure 7).**

Figure 7. Root-Knot Nematode on parsnip

Galls are similar in size to the nitrogen fixing nodules on legumes. Some clubroot galls can be of similar size but crucifers are not good hosts of root-knot nematodes. Root-knot is very difficult to control short of fumigation or nematicides, both rather risky ventures. Resistant cultivars are available for some crops, and non-susceptible crops can be grown. Corn and grains are not hosts of root-knot. Sudangrass and rapeseed may reduce populations of some nematodes and reduce their damage. Soil incorporation of two month-old Sudangrass was found to be more effective against root-knot than three month old plants.

Lesion nematodes *(Pratylenchus)* are widespread in soils and are not a problem unless they build up to large populations. This can happen when a susceptible crop is grown year after year. With potatoes, lesion nematodes plus Verticillium results in a disease caused "early dying". Corn and potato plantings occasionally develop high populations. A soil and root assay is necessary to determine if populations are damaging. Resistant cultivars are not available but lesion nematodes are not frequently a problem.

Stubby-root nematodes *(Trichodorus),* along with the dagger nematode, can transmit viruses. When populations are high, they can also cause injury by themselves. The presence of tobacco ringspot and tomato ringspot virus indicates that one or both of the nematodes are present. Resistant cultivars are not available but stubby-root nematodes are not frequently a problem.

CROP INSURANCE FOR DIVERSIFIED AGRICULTURE - SIGN UP BY JANUARY 31!

The Adjusted Gross Revenue (AGR) program is a relatively inexpensive way to insure a wide variety of crops against natural disaster or loss of market. This program is provided through commercial insurance carriers, but the cost is low because the premiums are heavily subsidized by USDA Risk Management Agency. The program is unique among crop insurance in that it insures income rather than crop production levels.
Most Vermont vegetable and berry farmers will be eligible for the program. Some requirements include: five consecutive years of filing Schedule F tax forms; no more than 35% of income from animal agriculture; no more than 50% of income from purchase and re-sale of agricultural products.
Your coverage is based on your average gross income reported for the last 5 years. You can choose among 3 levels of coverage that protect against your income dropping below 65%, 75% or 80% of your average gross. Then you select either a 75% or 90% payment rate on the loss. Obviously, the more of your gross income you choose to insure, the higher the premium.
To help you understand the program here is an example, but remember, each farm will be different. Farmer Vern's main crops are summer and winter squash, strawberries, sweet corn, tomatoes, peppers, cabbage, green beans and gourds. He has an average Schedule F income over the past 5 years of $76,800. Since his operation has been growing at 3.5% annually, his indexed Adjusted Gross Income is determined to be $88,166. Vern can choose 6 difference levels of coverage (65, 75 or 80 percent of gross income and 75 or 90% payment level). The "loss inception point" is the gross income level below which losses are covered.

COVERAGE LEVEL	PAYMENT RATE	LOSS INCEPTION POINT	PREMIUM YOU PAY	MAX.INSURANCE PAYMENT
65%	75%	$57,308	$144	$43,981
65%	90%	$57,308	$137	$51,577
75%	75%	$66,124	$212	$49,593
75%	90%	$66,124	$254	$59,512
80%	75%	$70,533	$344	$52,900
80%	90%	$70,533	$412	$63,480

Another example is a diversified vegetable and strawberry farmer with an AGR of $214,400.
His 80% coverage level (or loss inception point) is $171,520. To get 90% payment on losses below that income (up to $154,368) his annual premium would be $668. At 75% payment (up to $144,720) the premium is $452, and at 65% payment (up to $125,424) the premium is $218.

You can see that the AGR program is a good way to protect your business against major disaster.
TO BE COVERED for 2003 you must sign up January 31, 2003. However, your premium will not be due until December 2003.

For more information or to sign up for the AGR program,
contact an insurance agency that handles this program,

including: Arthur Carroll Crop Insurance Agency
(800) 531-4700 or agcarro@adelphia.net;
O'Dell Insurance, Bradford VT (802) 222-4755;
Rain and Hail see website for local agencies:
http:www.rainhail.com/tools/agent_search.html

Excerpted from Vermont Vegetable & Berry News, 01/15/03.
Written by Vern Grubinger, UVM Ext

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PLEASE FILL OUT YOU AGRICULTURAL SURVEYS!

One really important thing that you should do this winter is fill out your Ag Census. We are aware of many new farms springing up all over New England, yet, for official purposes, these do not exist unless they are accounted for by the census. Many important publicly funded services are based on census information such as Extension employees and programs and State and Federal Departments of Agriculture.

When filling out your census, Hank Bissell, President of the Vermont Vegetable & Berry Growers' Association suggests that you do not get bogged down with highly accurate figures. It took Hank about 35 minutes to fill his census out using ball park estimates. The USDA's National Agricultural Statistics Service (NASS) began mailing the 2002 Census of Ag. to every farmer and rancher in the Nation the week of December 5, 2002. For anyone with a stake in agriculture, census data are the best sources of information on farmland use, acres harvested by type of crop, and much more.

Farmers are being asked to report on their operations for 2002 and return the forms by February 3, 2003. Because of its importance to our Nation, the law (Title 7, U.S. Code) requires every individual who receives a census to fill it out, whether they currently farm or not. This same law protects your privacy.

NASS has provided a toll-free number: 1-888-4AG-STAT, for producers who need help completing the form. Farmers and ranchers, who do not receive a census form by the end of January, can call the toll-free number to ensure they are counted.
The 2002 Census of Agriculture results will be released in February 2004,
at www.usda.gov/nass/.

Vegetable Notes is a publication of the University of Massachusetts Extension Vegetable Program, which provides research based information on integrated management of soils, crops, pests and marketing on Massachusetts farms. Subscriptions to Vegetable Notes include the IPM Newsletter, published weekly during the growing season. For subscription information call (413)577-0712 or visit our website at http://www.umass.edu/umext/programs/agro/. For more information about the Vegetable Team's research and UMass Extension programs call Ruth Hazzard at (413)545-3696.