A Publication of the UMass Extension Greenhouse Crops & Floriculture Program

Floral Notes NEWSLETTER

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In This Issue

Great Ideas Summer Conference & Trade Show

A summer educational program that you will not want to miss! Great Opportunities! Great Education! Great Food! Great Ideas! Join us on Thursday, July 14, 2011 at Mahoney's Garden Centers, East Falmouth, MA. Sponsored by: Massachusetts Nursery & Landscape Association and the Massachusetts Flower Growers' Association. Education coordinated by: UMass Extension, Amherst. Thanks to our Educational Sponsor: Farm Family Insurance Companies.

UMass Plant Diagnostic Lab Sample Submittal Form

The spring growing season is here and, unfortunately, so to are plant problems. The last page of this newsletter is the submittal form which should accompany all plant samples sent to the UMass lab for diagnosis. The information to submit samples is on the form. The lab's website address is www.umass.edu/agland/diagnostics

Free Late Blight Posters Available

Garden retailers can help prevent the spread of late blight in gardens and on farms this growing season and provide customers with the facts about this disease (see article, next page). Grow your own transplants from seed or purchase locally grown plants. Late blight is not seedborne in tomatoes (however, it is tuber-borne in potato), so tomato plants started from seed locally would be free of the disease. To help with this educational effort free colored posters are available.

"Disease-Free Vegetable transplants - Buy Locally Grown" small, colored posters with photos of late blight on tomatoes are available to garden retailers. To receive your FREE poster, contact Rob Wick, UMass Extension, email: rwick@pltpath.umass.edu or call (413)545-1045.

Plant Disease Control

Tomato Transplant Production and Late Blight

Bess Dicklow
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Late Blight caused by the fungus-like organism, *Phytophthora infestans*, occurs sporadically in most of New England in most growing seasons. Late Blight outbreaks from 2005 to 2008 developed during late summer/early fall and were the result of inoculum (sporangia) carried on storm systems that originated in southern areas where the disease was active. In 2009, the disease was widespread and developed early. Typically, potato is the main crop affected; in 2009, a strain aggressive on tomato was present on tomato transplants. This new genotype of late blight, US22, caused a disease epidemic throughout the Northeast. First reports of the pathogen were recorded in late June, the earliest incidence of widespread disease ever observed in our region. US22 was detected in tomato plants for sale in garden centers in numerous states by extension specialists.

Background

Late Blight has occurred in New England in recent years and different strains of the pathogen have been responsible: US11 (1994-1998), US8 (1992-2010), US17 (1996-1997), and US 22 (2009-2010). These genotypes differ in mating type, host aggressiveness, and fungicide resistance. Sources of *Phytophthora infestans* in New England include potatoes saved year to year for seed, tubers that survive the winter unfrozen in the soil, and volunteer potato and tomato plants in compost, cull piles, or fields. Other more recent sources of the pathogen have been infected tomato transplants, infected petunia bedding plants, and infected crops in frost-free areas producing wind dispersed spores.

Pathogen Biology

Phytophthora infestans needs cool (below 77 F) wet weather. Hot, dry summers, like 2010 are not conducive to late blight development. An exception would be where plantings are located where fog occurs periodically. The late blight pathogen has recently undergone changes in Florida that affect disease occurrence there and in other eastern states. Diseased tomato plants in south Florida have survived cold periods in winter allowing the pathogen to persist. Late blight has also been active into the spring as late as May indicating an increased tolerance for warmer temperatures. This means a potential source of inoculum persists until crops are being produced north of Florida and a ‘green bridge’ exists for the pathogen to progress on until it reaches the northeast.

Currently, the late blight pathogen is only known to survive on living plant tissue unlike *Alternaria solani*, the cause of early blight. If both mating types of the organism occur in the same field, sexual reproduction and therefore persistence outside a living host as oospores (long lived spores in the soil) is possible. Both mating types have been observed in the US and mating is known to occur in the Pacific Northwest.

Oospore production is common in central and South America as well as Europe and the disease is a perennial problem in these regions.

Steps to prevent Late Blight in your greenhouse garden center

1. Grow tomato plants from seed or purchase starter plants produced locally. *Phytophthora infestans* does not survive in or on tomato seed.

2. Tomato plugs imported from the south may be a potential source of the disease organism. If you must bring transplants from the south, carefully inspect all tomato plugs before accepting shipment and reject any with symptoms of disease (or insect infestations). If possible, isolate new plants and inspect them regularly until their disease-free status is confirmed.

3. Start transplant production in a clean greenhouse free from previous crops, pet plants, and weeds. Grow vegetable transplants separately from bedding plants. This prevents cross-infection from ornamental plants which can harbor Late blight, TSWV (tomato spotted wilt virus), INSV (impatiens necrotic spot virus) and other potential vegetable pathogens. This also makes pesticide treatment easier as many materials registered on ornamentals are not registered for vegetable transplants.

4. Select resistant tomato varieties where available. 'Mountain Magic', 'Legend', and 'Plum Regal' have excellent resistance to Late Blight. 'Red Pearl' and 'Matt's Wild Cherry' are small fruited tomatoes with good resistance. Some heirloom tomato varieties have good tolerance to late blight. A few cultivars also have resistance to Early Blight (*Alternaria solani, A. tomatophila*) and should be considered. The development of triple (LB, EB, *Septoria* leaf spot) resistant varieties is underway at Cornell and other Universities.

5. Remove solanaceous weeds in and around the greenhouse. Examples include hairy nightshade, bittersweet nightshade, jimson weed, golden henbane, and others. The ornamental plants petunia and calibrachoa are also hosts for late blight.

6. Check the Late Blight forecast model at http://newa.cornell.edu or http://uspest.org/risk/tom_pot_map weekly. These websites provide forecasts of where late blight is active and when environmental conditions are favorable for epidemic development.

7. Scout greenhouse regularly for disease and insect infestations or hire an IPM scout.

8. Confirm possible late blight occurrences with the UMass Plant Diagnostic Lab. Fee waivers are available in 2011 for late blight diagnoses.

9. If Late Blight is confirmed by a diagnostic lab in your operation, immediately remove and destroy affected plant tissue and promptly inform neighbors that grow susceptible crops. Late Blight is a community disease due to its potential to spread rapidly.

10. Protect remaining healthy plants with preventive fungicide applications. See www.nevegetable.org/ for a list of registered products. Continue scouting on a regular basis as late blight is difficult to manage once it has been established.

Aphid Banker Plants[z]

Aphid banker plants are containers with winter barley or common rye or oats on which colonies of grass-feeding aphid species such as the com-leaf aphid *(Rhopalosiphum maidis),* greenbug *(Schizaphis graminum),* and/or bird-cherry aphid *(Rhopalosiphum padi)* are established. Banker plants are primarily used to rear prey or hosts, in order to attempt to have a sufficient population of continually reproducing natural enemies.

Banker plants need to be placed along walkways and at the end of benches. It is essential to evenly distribute them throughout a greenhouse. General recommendations suggest that banker plants should be placed about 131 feet apart, using 4-5 banker plants per 10,000 ft^2, in order to increase parasitization. Some growers will place the banker plants both at the hanging basket and bench or floor level. The drip irrigation also insures that the banker plants will remain irrigated without inadvertently washing the aphid natural enemies off of the plant.

It has also been recommended to distribute containers of rye or barley, with the grass-feeding aphid, among the main crop at a rate of one banker plant per 1,000 ft^2 even before aphids are detected. It should be noted that existing recommended rates may vary since limited research has been conducted; start with these rates and adjust in succeeding years based on your experience.

Banker plants may have to be placed closer together or placed in greater frequency within a given area in order to allow parasitoids such as *Aphidius colemani* to find prey on plants, since research has found that this parasitoid migrates just 3.2-6.5 feet from the point of release.

Starter aphid banker plants are available from several biological control suppliers.

1. Place orders for banker plants up to 6 weeks before aphids are expected in your greenhouse.

2. Transplant the plugs into larger sized pots (10”) so that the grass plants have plenty of room to grow.

3. Wait one or two weeks for grass feeding aphid populations to grow.

4. Lightly release the "aphid mummies" or *Aphidius colemani* adults onto the starter banker plants. For example, 100 hundred *Aphidius* per banker plant before it is divided and repotted. *Aphidius colemani* attacks the grass-feeding aphid, which is not an aphid pest of most greenhouse-grown crops

5. Check banker plants weekly and look for newly parasitized aphids ("aphid mummies"), which indicate that the parasitoids are establishing on the banker plants.

6. Start new banker plants on a regular basis because they will decline and die within a few weeks.

7. Inoculate new banker plants by physically transferring aphids from old banker plants onto new ones every 2-3 weeks.

8. It may be necessary to "protect" or isolate your replacement banker plants from natural enemies (either established in your greenhouse or naturally occurring natural enemies that may enter the greenhouse from outdoors during warmer weather). If so, place banker plants in "starter cages" so you can build up your population of grass feeding aphids before releasing *A. colemanii.*

Keep in mind that the bird-cherry aphid is too small for the parasitoid, *A. ervi,* to develop. *A. ervi* parasitizes larger aphids such as the foxglove or potato aphid. Although some suppliers sell banker plants with *A. ervi,* these banker plants are not compatible with *A. colemanii* banker plants.

If this aphid is your predominant species, one option is to use the predatory midge, *Aphidoletes aphidimyza* for release onto your banker plants. If using predatory midges, placing the pots in trays with moist sand will help provide pupation sites for the predatory midges. (The predatory midges pupates in the soil).

Adapted from: Cloyd, R. Pest Management in Greenhouses. Biological control. *New England Greenhouse Floriculture Guide.*

[z]*Leanne Pundt, University of Connecticut, January 2009,* www.negreenhouseupdate.info/greenhouse update

Geothermal Heating and Cooling for Greenhouses

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Energy costs for heating and cooling can be significant for greenhouse operators. For the second time in three years, we are seeing fossil fuel prices creep toward record highs, and continued inflation of oil prices can be expected, given dwindling reserves, increasing global demand, and the long supply chain that often originates in politically unstable parts of the world. Geothermal systems for heating and cooling afford us a measure of independence from fossil fuels and offer significantly reduced operating costs, reduced emissions, and help keep our energy dollars circulating within our local and national economies.

Overview of Geothermal Systems

Geothermal systems are typically comprised of three main elements: (1) the interior heat distribution system, typically ductwork or hydronic piping for radiant floor heating; (2) the Earth couple, or ground heat exchanger (GHX), where heat is extracted from or added to the Earth; and (3) a water source heat pump, which uses a refrigerant cycle to move heat between the Earth couple and the conditioned interior space. In heating mode, geothermal heat pump systems deliver hot water at a lower temperature (~120°F max) than is normally delivered from a boiler (160-180°F). Therefore, a geothermal system is best suited to applications that call for a low supply temperature, such as bench heating in greenhouses. Geothermal heat pump systems are most efficient in heating mode, because the internal heat generated by the refrigerant cycle of the heat pump is added to the heat delivered to the interior space, whereas in cooling mode this heat must be expelled to the GHX in addition to the heat expelled from the conditioned space.

Geothermal systems can be further subdivided into open-loop and closed-loop systems. In open loop systems, the Earth coupling method is water is pumped from an aquifer or from a surface water body through a heat pump where heat is extracted from the water in heating mode or added to the water in cooling mode. Open loop systems typically have a lower installed cost for a given thermal capacity than closed-loop systems, however, precipitation of minerals from groundwater may foul or clog the heat exchanger within the heat pump, resulting in higher maintenance costs compared to closed-loop systems. Furthermore, it may be difficult to responsibly discharge the water that leaves the heat pump, as regulatory agencies are reluctant to permit discharges to wetlands, ponds or streams. Closed-loop systems circulate water or antifreeze fluid between the heat pump and the GHX. The GHX for closed loop systems can be either vertical, piped through a series of boreholes at depths up to about 400 feet, or horizontal, piped in a shallow (~8 ft) trench. While typically more expensive to install, because the fluid within a closed-loop geothermal system is conditioned and recirculated, there is no need to obtain a discharge permit or concern about fouling of the heat pump's heat exchanger. A horizontal GHX will usually be less expensive to install (than a vertical GHX), but requires significantly more on-site area. If a surface-water body is nearby, then a lake-loop GHX may be used, although obtaining the necessary permits from state and local environmental and conservation authorities may be complicated.

Seasonal Thermal Energy Storage

Most geothermal systems in the US are designed to dissipate excess heat or cold into the Earth, essentially using the Earth and the GHX as a thermal radiator. Beginning in the mid 1980s, an intriguing geothermal process has been developed and commercialized in Europe that involves storing thermal energy underground on a *seasonal* basis if the thermal capacity of a project is sufficiently large. Rather than use the Earth couple as a thermal radiator, it can be used as a thermal battery, capable of capturing and storing summer heat for use in winter. Underground Thermal Energy Storage (UTES) becomes economically attractive in larger applications with thermal loads greater than 100 tons, or about 1.2 MBtu/hr, which is within the realm of some of the larger growing operations in New England. UTES can offer significant efficiency improvements over conventional geothermal systems, and UTES can be combined with solar thermal or biomass to further increase energy efficiency and reduce CO_2 emissions. The energy efficiency of geothermal systems is typically expressed as the Coefficient of Performance (COP), which is the ratio of thermal energy output to electrical energy input. Most conventional geothermal systems operate at a COP of about 3-4, while the most efficient UTES projects can operate at COP values over 20. This is a remarkable level of efficiency, delivering 20 kWh of thermal energy from only 1 kWh of electrical energy.

Geothermal for Greenhouses

Because greenhouses in New England are usually used for heating only without cooling, these systems are said to be strongly heating dominant; that is, the geothermal system extracts more heat from the Earth during a year than it returns. If the GHX design is undersized, there will be a long-term decrease in ground temperatures near the GHX and the performance of the system will deteriorate over time. As the ground gets colder, the GHX loop temperatures decrease, and the heat pump has to make up the difference with increased electricity consumption to deliver heat to the greenhouse. An undersized GHX installed by a low-bid contractor is often the root cause of performance problems with geothermal systems.

An advantage that geothermal offers greenhouse applications, beyond its inherently more efficient operation in heating mode, is the potential to use summertime solar gain inside the greenhouse to raise the Earth temperature at the GHX merely by circulating fluid from the hot greenhouse to the GHX, without the operating expense of the heat pump. Thus, a measure of seasonal thermal energy storage can be obtained by rejecting summer heat from the greenhouse to the GHX, even for smaller sized system. The efficiency of this operation will require appropriate heat distribution systems in the greenhouse; these can be adapted to geothermal systems without significant cost. Seasonal thermal energy storage has been successfully used at numerous large growing operations in The Netherlands, where Aquifer Thermal Energy Storage (ATES – Figure 1) was developed and commercialized. ATES can be thought of as the Seasonal Storage analog to an open-loop

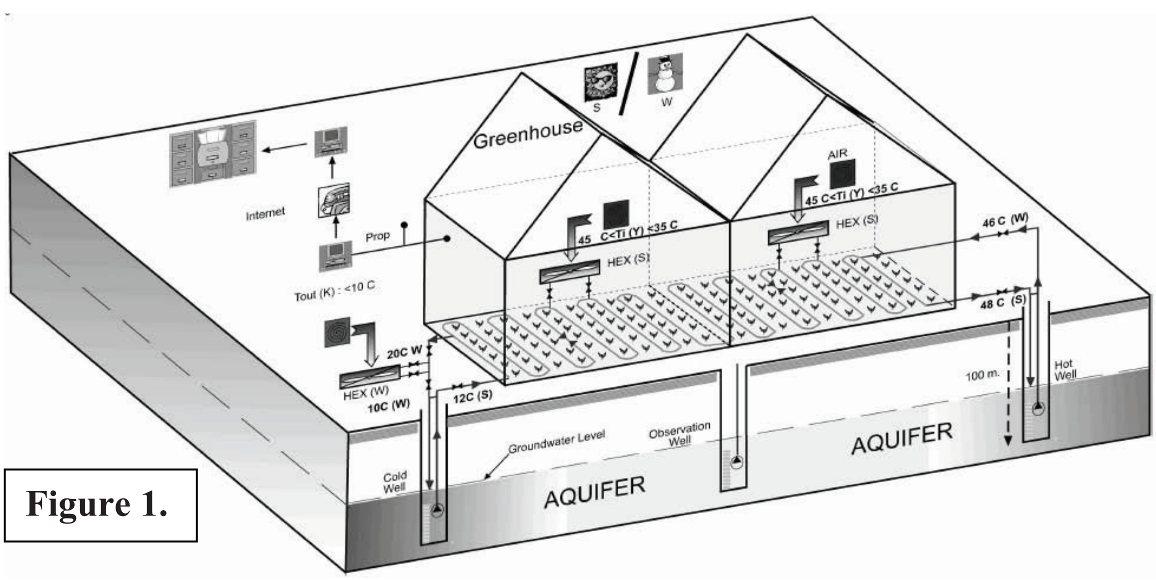

Figure 1.

geothermal system. These large, closed greenhouses are cooled during summer with stored groundwater that was chilled in winter. Sophisticated climate control systems enable growers to leverage energy efficiency improvements into increased crop yields by increasing CO_2 concentrations within the greenhouse. The International Energy Agency is currently preparing Annex 22 to their Energy Conservation through Energy Storage (ECES) program, which is specifically evaluating seasonal thermal energy storage applications for closed greenhouses. Information related to this and other ongoing and completed Annexes can be found at http://www.iea-eces.org/.

Economics of geothermal heating and cooling projects

Geothermal HVAC systems have higher initial costs than fossil-fuel-fired systems, but offer lower operating costs. Capital costs are highly dependent on site conditions, and range from about \$900/ton to \$5,500/ton (a ton is a measure of thermal capacity and is equivalent to 12,000 Btu/hr). If your greenhouse is currently heated by fuel oil or propane, the primary financial incentive will be a significant (50%-80%) operating cost reduction offered by a geothermal system. Table 1, based on February 2011 price data, compares operating costs for various fossil fuels (boiler efficiency of 84%) to geothermal systems operating at a COP of 3.5 and at a COP of 7, representative of GHX designs that enable seasonal thermal energy storage.

Table 1. Heating operating costs in $ per million BTU

Heating/fuel type	**Fuel cost/efficiency (Feb 2011 MA costs)**	**Operating cost ($ per million Btu)**
#2 Fuel Oil	$3.60 / gal	$25.96
Propane	$3.40 / gal	$37.23
Natural Gas	$1.26 /therm	$12.60
Wood Pellets	$208 /ton	$12.61
Geothermal closed loop	3.5 COP	$12.56
Geothermal w/ seasonal storage	7.0 COP	$6.28

Tax incentives and other subsidies are available that can significantly decrease (offset?) the installation cost of a geothermal system. In addition to USDA incentive program such as the Environmental Quality Incentives Program (EQIP) and the Rural Energy for America Program (REAP), geothermal systems that are put into service by January 1, 2012 are eligible for 100% first-year depreciation of capital costs. More information on financial incentives can be found at the Database of State Incentives for Renewables and Electricity (DSIRE) website at http://www.dsireusa.org/.

Mark Worthington is a hydrogeologist with 24 years of experience in New England. He formed Underground Energy, LLC in 2009 with a goal of commercializing seasonal thermal energy storage in the US. Mark plans to attend the next IEA ECES Annex 22 meeting in The Netherlands in May 2011. He can be contacted at mark.worthington@underground-energy.com.

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