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In This Issue

The "New" Stockbridge School of Agriculture

On May 3rd the UMass Faculty Senate voted to approve the formation of the "new "Stockbridge School of Agriculture. This is a major step in preserving and enhancing agricultural teaching, research, and extension at the University. For the first time since 1918, when it was created, the Stockbridge School will now have its own faculty. It will also gain 4-year B.S. degree majors: Sustainable Horticulture, Turfgrass Management, and Sustainable Food and Farming to go along with its five 2-year A.S. degree majors. At this time 13 faculty, mostly from Plant, Soil, and Insect Sciences, have committed to the new School and some more are expected to join soon. In time faculty from other ag-related departments may also join.

The Stockbridge School will not lose its important historical traditions. However, it will now function as an academic department doing teaching, research and outreach as part of the College of Natural Sciences. By gathering together faculty and other staff who are committed to agriculture and who believe in teaching and the Stockbridge School, agriculture will now have much greater stature in the University community and, for the School and what it does, greater visibility in Massachusetts and the region. We will recruit more students to the 2- and 4-year majors and will be able to replace faculty and staff with ag-interested people when they retire or otherwise leave. In the latter case this has already come true as searches will start soon for horticulturalists to fill Paul Lopes' former position and for a sorely needed extension faculty member specializing in woody and landscape plants.

As a personal note it's a great feeling to know that I am now a member of a department working with people who don't believe that "agriculture" is a dirty word. I know it's going to be a very exciting future! *Douglas Cox*

Crop Production

Garden Mums: Weather-related Tips for Production

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Each year weather-related production problems challenge mum growers. Here are some situations that have occurred over the past few seasons and how growers responded to correct those problems. These tips may help prevent a problem or two with your crop this season.

Cool Temperatures and Premature Budding

Chrysanthemum flower buds initiate easily and develop rapidly, especially if plants are stressed in any way. Lack of adequate water and fertilizer are two common causes for premature budding. Also, plants grown outdoors rely on natural daylength and temperature to control the timing of the crop. Chrysanthemums are short-day plants. Both flower initiation and development of the flower buds occur more rapidly under short days than under long days. However, temperature has a greater influence than daylength on flowering of garden mums. Several cool nights in a row can cause garden mums to initiate buds prematurely which results in early flowering of the plants.

Sometimes a period of cool temperatures causes plants to begin the flowering process however, when temperatures become warm again, flower development stops and the buds fail to develop properly. This results in "crown buds" which are distinguished by strapped shaped leaves.

If premature budding occurs early in production, buds should be pinched off, and adequate moisture and fertilizer supplied. The plants will almost always continue to grow and develop into a quality fall crop.

Early season production tips to prevent premature budding

> Water-in freshly planted cuttings with a fertilizer solution containing 200 to 300 ppm of nitrogen immediately after planting. The cuttings will establish faster and grow more rapidly.
>
> Do not stress the young plants during their first 4 to 5 weeks of growth. Keep plants moist, well fertilized and properly spaced - especially during the first 10 days of the crop.
>
> Always use "hard" pinches, rather than "soft" pinches if pinching mums. Remove at least ½" of new growth when pinching. This helps to minimize premature budding. Often, only 5 to 7 leaves are left on the plant after the first pinch.
>
> Choose varieties carefully. Many of today's cultivars have been bred so that they branch naturally and do not need to be pinched. This technique is successful if planting actively growing cuttings and fertilizing them heavily, especially during the first few weeks of production. It is important to avoid water stress during this time. Water stress will result in hardened growth, fewer breaks and/or premature flower budding. If you change growing practices, from 2 to 1 pinches or 1 to 0 pinches, experiment on a small scale first. You may also want to plant a week later, since less pinching can result in more growth/plant size.

During 2009, cool temperatures during the summer resulted in crown budding in July. Some growers responded by pinching buds off of plants and increasing the frequency of fertilizing using higher rates (350 ppm nitrogen) to encourage plants to grow larger and flower later. This did not always work for very early and early flowering varieties.

Some growers left buds on plants and fertilized with up to 400 ppm nitrogen of 20-10-20. Some growers also included ammonium forms of nitrogen such as 20-20-20 or urea in their fertilizer program. Their theory was that vegetative growth would by-pass the budded growth. This worked for some growers

while for others it resulted in uneven plants. Uneven plants were short, budded or flowering plants surrounded by some tall growth, but not enough to fill out the plant, creating two-tiered plants. The plant's response varied according to the variety.

During a normal year, mums should receive constant feed of 300 ppm nitrogen from fertilizers like 20-10-20 to promote vegetative growth. Reapply up to 400 ppm after each rain to keep sufficient nutrient levels.

Short plants

Short plants are also a result of plants setting bud too early. In chrysanthemums, flower bud initiation marks the end for vegetative growth. Garden mums initiate leaves rapidly. Cool weather early in the growing season will reduce the number of leaves formed on each shoot, thereby, resulting in plants with fewer nodes and shorter plants. Another reason for smaller, harder plants may be due to plants experiencing stress due to dryness. Plants must never be allowed to wilt during the early stages of growth. Wilting in the first few weeks of growth restricts branching action and overall growth.

High Temperatures and Fertility

While cool temperatures prevail some years, during other years, high temperatures over an extended period of time have created problems. This weather pattern has caused controlled-release fertilizer (CFR) to release early, burn roots and weaken plants. Growing media temperatures over a period of two weeks soared in plants grown on black landscape cloth in open growing areas. Soil temperature is a primary factor affecting release of fertilizer from the prills.

Plants can also go from being over-fertilized to being under-fertilized due to overwatering during hot periods. The controlled-release fertilizer releases during the heat and is leached out with excessive watering. If not detected early, plants will become nutrient deficient with short, hardened growth.

To prevent nutrient related problems, growing media of chrysanthemum crops should be regularly tested. Controlled release fertilizers should generally be used at the low rate in a combination feed program to supplement water-soluble fertilizer applications. This strategy will produce crops that maintain better color for your customers. A medium rate is best for a 100 percent CRF fertilizer program without any other supplemental fertilization under most conditions. The longevity of the CRF product should be matched with growing temperatures and desired delivery time. Choose longer-term release CRF products to extend nutrients for customers. Most mum growers in the United States achieve good results with five to six months or eight- to nine-month longevities.

Overwatering

Fall mums will often exhibit signs of wilting during extended periods of 90 plus degree temperatures. The solution may not be as easy as turning on the irrigation. Fall mums wilt when the soil is dry, but wilting will also occur in hot weather when plants are stressed, or if the roots are damage from a root disease such as *Pythium*, even if the soil is saturated with water. When the roots stop functioning normally the plants will show signs of stress by wilting.

Fall mums can survive excess amounts of fertilizer and resulting soluble salts when temperatures are normal and soil moisture is maintained. Problems occur when the growing medium is dry and the salts become more concentrated, resulting in root damage. The plants will react first by wilting and than collapsing.

Take precautions to avoid overwater garden mums especially during extended periods of hot weather. Lift the pots and check the roots periodically. If the pots feel heavy and the soil is saturated, do not irrigate, even if it is hot. However, do not allow plants to dry to wilt prior to watering.

If plants are wilting on a regular basis and excess amounts of fertilizer have been used, the roots maybe damaged and root disease will occur. Check the plant roots, especially with slower growing varieties. The roots tell a lot about a plants health, often before the top growth shows symptoms.

Signs of poor root health are blackened or rotted roots or lack of roots. Diseased roots will not take up fertilizer compounding the problem with high soluble salts.

Pythium aphanidermatum is the species of *Pythium* most commonly causing root rot losses to mums in recent years. The pathogen thrives in hot, summer weather. Avoid puddling around containers, deep planting or overwatering. Provide even moisture and avoid high EC values. Root stress is likely to open the plant up to *Pythium* attack. To manage *Pythium*, utilize etridiazole-containing fungicides (Truban, Terrazole, Banol) at a monthly intervals. An occasional treatment with mefenoxam (e.g. SubdueMAXX) is advisable in rotation with the etridiazole, but beware of using mefenoxam exclusively because of widespread fungicide resistance issues with that active ingredient.

Misshapened plants

Athough not weather related, misshapen finished plants are a problem that can be prevented during production. Garden mums grown too close together will be tall, but poorly shaped, and often flat on one side. Space so plants barely touch each other at the time of flowering. Ball's guidline recommends 8" pots have a final spacing of 9"-18" on center. Larger plants to be marketed in garden centers may require 24" spacing. Garden mums grown too close together may also develop a "stove pipe" appearance.

Chrysanthemum White Rust

Chrysanthemum White Rust (CWR) is a quarantine significant pest in the United States; therefore, occurrence of this disease leads to state and federal regulatory action. CWR has been an issue for growers for the last few years. The weather conditions in the Northeast and Western Regions of the United States in certain years has been ideal for the development of CWR on the hardy mum crop. The symptoms of chrysanthemum white rust are very distinct; light green to yellow spots up to 5mm in diameter appear on the upper surface of the leaf. These spots become brown and necrotic with age. Raised beige to pink pustules form on the underside of leaves beneath the spots. Pustules become white with age and are most common on young leaves and flower bracts but may form on any green tissue or the petals.

Infected plants may look normal until correct environmental conditions encourage symptom development. Hot and dry weather may delay onset of symptoms for up to eight weeks. Symptoms usually occur during cool, wet weather. Basidiospores are only produced and released during periods of high relative humidity (96 to 100%) and temperatures from 40-73°F (optimum 63°F). A film of free water is required for infection and penetration.

In the fall of 2009 the Massachusetts Flower Growers' Association and the Connecticut Greenhouse Growers' Association proposed changes in CWR regulations to top administrators in USDA/APHIS. The process moved slowly but progressed to where a meeting was held in winter 2012 to have growers discuss and review a proposal to change CWR regulations to a Regulated Non-Quarantine Pest or (RNQP). This change would allow growers to deal with CWR as a common disease pest. CWR regulations would continue to stay in place for propagators and imported plant material would still be subject to inspection at the US borders.

Paul Lopes from the University of Massachusetts and a grower attended the meeting representing the Massachusetts Flower Growers' Association and their members. As a result of the meeting USDA's Animal and Plant Health Inspection Service (APHIS) is expected to proceed with a notice in the Federal Register of the proposed changes in CWR regulations. The notice will invite public comment on the quarantine status of chrysanthemum white rust.

In addition to asking for public comment on all regulatory options, APHIS will continue communicating with its trading partners, including Mexico and Canada, as discussions proceed. Any actions taken will likely be lengthy and time-consuming. It will be important for interested growers to participate in the request for public comment and make their opinions known concerning CWR.

Reducing Moisture in High Tunnel Systems

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One of the most common complaints of growers using high tunnels is excessive moisture inside the tunnel, especially during the early part of the growing season. When there is high moisture inside the high tunnel, there are commonly increased disease problems. The lack of supplemental heat makes this problem much more difficult to handle in high tunnels than in heated greenhouses. Here are some of the strategies that may be used in a grower's effort to minimize excessive moisture in the high tunnel during the early growing season.

Proper site selection is most important. Set the high tunnel on a ridge crest where possible and avoid sites that are lower than the surrounding terrain.

Address drainage issues. The impermeable cover of the high tunnel results in a high volume of water shed which falls along the sides. The design of the structures makes guttering impractical. Therefore, it is critical that earth be sloped away from the baseboards. This will be part of the directives for those using the NRCS program. Additionally, when two houses are sited near each other, there must be extra effort to address drainage issues between the two tunnels. Some growers use French drains to address drainage requirements while others use drainage tile. Care must be taken to avoid creating erosion problems in efforts to improve drainage.

Keep water from running in from outside the tunnels. This may require the development of diversion ditches or channels and may involve additional needs for drain tile.

High tunnels must have adequate ventilation. This can be managed to help reduce humidity levels (moisture) within the house. By using several cycles of opening and closing, moisture levels can be reduced. This is similar to the technique used in greenhouses. In the greenhouse, growers reduce humidity levels by drawing in cold air (typically in the evening). As the air is heated by the furnace in the greenhouse it becomes lower in humidity. This allows the air to pick up additional water from the plants, media, etc, in the greenhouse. After the now heated air becomes higher in humidity, it is in turn exhausted from the greenhouse and new cold air is drawn in, and in turn heated and the cycle is repeated. A few cycles per night over a couple of nights nearly always dries down even the wettest greenhouse. Since there is no supplemental heat source in a high tunnel, we modify this technique by venting the house as soon as it gets warm in the morning which results in cooler air being drawn in. The tunnel is then reclosed and allowed to reheat. This can be done two or three times each morning and will help dry down the house.

Employ the use of circulation fans. The use of fans (typically 4 or 6 for a 96' structure) can help in keeping the plants drier and also helps make the air throughout the house more uniform. This makes the method above more effective.

Use a wetting agent. If a grower is having problems with water dripping down onto the crop from the polyethylene covering, there are wetting agents which can be purchased and sprayed onto the covering. These will result in the water running down the covering and being shed to the hip board rather than dripping down onto the crop.

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Diseases and Their Control in High Tunnels

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Editor's Note: This article was originally published in the issue of the May 2012 *Agricultural News*, a publication of Cornell Cooperative Extension - Suffolk County, NY. The original article had specific information on vegetable diseases and their control in high tunnels. This was edited out in favor of the excellent discussion of disease occurrence in high tunnels useful for all types of plants in high tunnels.

Conditions in high tunnels differ in important ways from conditions outside in fields. Consequently, disease occurrence can differ as well. Environment is one of the three 'disease triangle' components that dictate disease occurrence. The drier environment in high tunnels creates less favorable conditions for many diseases, but not all. Ability to manipulate the environment to create conditions that are more unfavorable and further improve disease management is an important benefit of growing crops in high tunnels. On the other hand, rotating land amongst crops is an important management practice that cannot be implemented as easily in high tunnels as in fields where a much greater diversity of crops typically are grown. Therefore, tolerance needs to be at or near zero for diseases caused by pathogens able to survive in soil between crops. Knowledge of the biology of pathogens is valuable for identifying diseases that could occur and for developing a management program. The objective of this article is to explain the factors that determine what diseases can occur in this protected environment and to describe general management practices, thereby providing the foundation for successful managing diseases in any crop.

Disease Occurrence in High Tunnels

Principles dictating disease occurrence are applicable to all cropping situations. Thus in addition to susceptible plants, a pathogen must be present in a high tunnel and conditions must be favorable for development of a disease in order for it to occur. To enable disease to develop, conditions must favor infection and also pathogen spread.

Ability of a pathogen to enter a high tunnel is an important factor to consider in determining what diseases could occur. Main ways in which a pathogen can get into a high tunnel include: 1. wind-dispersed spores blown in through open vents or sides, 2. insect vectors of pathogens that fly or are blown through these openings, 3. infested seed or transplants, 4. contaminated soil brought in on shoes or tools, and 5. Contaminated tools such as pruners. Once a pathogen has come into a high tunnel it can survive there between crops in alternative weed hosts, in infested soil or crop debris, and on contaminated planting and production supplies.

Fortunately all these means are not options for every pathogen. Most fungal and bacterial pathogens affecting foliage require a certain amount of time with free moisture (wetness) in order to infect. Those needing a period of time that plant tissue is wet are less likely to occur in a high tunnel than in field-produced crops, unless overhead irrigation is used or there is dripping water due to extensive condensation. These include tomato early blight. Pathogens primarily dispersed by splashing water, such as tomato bacterial spot and Septoria leaf spot, are also less likely to occur in a high tunnel unless overhead irrigation is used. Among the diseases most likely to occur in high tunnels are those caused by pathogens that can enter plants through wounds, such as tomato bacterial canker, and those caused by pathogens that only need high humidity to infect, which include tomato leaf mold, late blight, powdery mildew, and downy mildew.

Viruses do not have a moisture requirement. Diseases they cause are among the more common in greenhouse crops. The vector (typically an insect) needs to be present for viral diseases to develop.

Some diseases are more likely to occur because conditions are more favorable in high tunnels than outdoors. These include gray mold, leaf mold, powdery mildew, and pith necrosis in tomato.

Diseases caused by soil-borne pathogens infecting roots can also be important in tunnels.

Disease management in high tunnels

General practices:

1. Avoid introducing pathogen.
2. Create unfavorable conditions. Most importantly minimize humidity and leaf wetness.
3. Minimize opportunity for pathogen spread.
4. Implement no tolerance for pathogens that can survive between crops.
5. Understand biology of pathogens that could occur. Routinely inspect crops for symptoms. Obtain help with diagnosis when at all unsure. New diseases can appear, as illustrated by basil downy mildew, which first appeared in the USA in 2007, therefore crops should be examined thoroughly for more than expected diseases.

Specific practices:

1. Locate and orient high tunnels such that they will receive good sunlight and air movement. An east to west orientation, perpendicular to prevailing winds, and away from shade of trees or buildings is ideal.
2. Select roof design that minimizes condensation dripping on plants. Condensation occurs on tunnel plastic over night because as temperature decreases, air can hold less moisture. Also vent tunnel early in morning to dry condensation.
3. Select seed that is "pathogen-free": produced where seed-borne pathogens were controlled or didn't occur, tested for these pathogens, treated if necessary.
4. Select disease resistant varieties.
5. Add compost and other sources of organic matter to soil to promote beneficial microbes.
6. Cover the ground with plastic mulch. This raises soil temperature and prevents evaporation of soil moisture, plus serves as a barrier for pathogens in soil that infect above-ground plant parts.
7. Use raised beds to manage soil moisture.
8. Practice good sanitation. Thoroughly clean and disinfect tunnel structure and planting materials (e.g. trays). Wear gloves and also disinfect tools and planting materials routinely while working. Minimize worker movement between tunnels to avoid moving pathogens.
9. Avoid moving soil on shoes or tools from fields into high tunnels and between tunnels.
10. Separate plantings of a crop inside and nearby when feasible. An older planting can be a source of pathogens for a younger planting in the same high tunnel; however, this needs to be balanced with crop rotation needs.
11. Grow ornamental crops separately from vegetable crops. They can be sources of some viruses, notably TSWV.
12. Provide appropriate fertilization (especially N; avoid excess), soil pH and temperature for good growth, and provide consistent soil moisture. Some diseases are more likely to occur when there is excessive vegetative growth; others when plants are stressed and growing poorly.
13. Control weeds and volunteer crop plants inside and around high tunnels.
14. Minimize humidity by using wide row and plant spacing, fans, ridge venting,

open sides (early in day; also late unless this will result in unacceptable loss of temperature elevation gained from having the tunnel closed during daytime), orient rows to air movement, avoid overwatering, irrigate with drip, and prune old leaves and dead tissue. Cover the ground with plastic mulch. Many pathogens need a period of time when humidity is above 90% for infection.

15. Minimize humidity by pruning leaves and branches from tomato and other crops that tolerate pruning.

16. Rogue affected plants and plant tissue when appropriate and feasible; dispose far from high tunnel. This is especially important when causal pathogens can survive long time in soil (e.g. white mold, Verticillium wilt).

17. Use plants grafted onto resistant rootstock for soil-borne pathogens (e.g. with solanaceous and cucurbitaceous crops for Fusarium wilt).

18. Apply fungicides. Start at or before first symptoms. Ensure disease is correctly identified. Apply regularly (e.g. weekly) maximizing coverage. Check state regulations about pesticide use in high tunnels, which many consider to be a greenhouse; a few do not if the sides are rolled up at the time of the application. Choose product labeled for target disease, and preferably also documented tobe effective. Note that documented efficacy is not required for registration in the USA. Check label for restrictions on greenhouse use.

19. Remove crop debris including roots after harvest; dispose far from high tunnel.

20. Rotate where crops are produced. The goal of rotation is to manage soil-borne pathogens. It is critical to clean rototillers and other soil tools between production units. This can be challenging when these units are within one high tunnel, but in this situation it is absolutely essential as moving soil between units could defeat the purpose of rotation.

21. Consider growing a biofumigant cover crop to manage soilborne pathogens when there is sufficient time between crops.

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