A Publication of the UMass Extension Greenhouse Crops & Floriculture Program

Floral Notes Newsletter

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In This Issue

Employee Training for Garden Retailers

April 5, 2016 9:00-3:00

Publick House, Sturbridge, MA

Topics will include:

- Helping Customers Choose Fertilizers and What's Up with Phosphorus
- Dealing with the Most Commonly Asked Questions About Weeds
- Diagnosing Customer's Disease Problems in Landscapes
- Sorting Through Bagged Potting Mixes and Soils
- Helping Customers Choose Plants for Difficult Areas in Landscapes

Online Registration is available at http://extension.umass.edu/floriculture/

Plant Nutrition for Greenhouse Crops: On-site Media Testing

Tuesday, February 16, 2016 - 12:30pm to 4:00pm

Publick House

Sturbridge, MA

12:00 – 12:30 PM Registration

12:30 – 1:20 PM Taking Soil Samples & Media Testing Demonstration
Dr. Douglas Cox, UMass Extension
A soil test result is only as accurate as the sample being tested. Doug will review proper procedures for taking growing media samples. He will then demonstrate 1:2 and pour through methods for preparing samples for on-site media testing.

1:20 – 2:00 AM Learning to Identify Nutrient Disorders
Geoffrey Njue, UMass Extension
Geoffrey will provide information to help growers to correctly identify specific nutrient problems with key points that can help sort out problem symptoms of different nutrient elements.

2:00 – 2:10 Break

2:10 – 2:50 PM Sorting Through Different Types of Meters
Mike Tremel and Kathleen McDermott, Hanna Instruments
Meters with probes, pen style meters, EC, pH….which portable meter to choose? Mike and Kathleen will show different types of soil test meters for electrical conductivity (EC) and pH and talk about the pros and cons of the different styles. They will also talk about care of meters.

2:50 – 3:20 PM Interpreting Soil Test Result
Dr. Douglas Cox, UMass Extension
Interpreting a soil test involves comparing the results of a test with the normal ranges of pH, soluble salts, and nutrient levels. Doug will walk us through "what the numbers mean" when using 1:2 or pour through methods of on-site soil testing.

3:20 – 4:00 PM Checking and Calibrating Meters – Bring your meter to be calibrated
Dr. Douglas Cox, UMass, Mike Tremel and Kathleen McDermott, Hanna Instruments
Bring your soil test meter to be calibrated for EC and/or pH. Doug, Mike and Kathleen will check your meter and provide individual advice. Let us know the type of meter you plan to bring on the registration form.

Cost: $30 (Includes refreshments and handouts)

Event Website: http://extension.umass.edu/floriculture/

For more information contact:

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Reducing Humidity in the Greenhouse

Tina Smith
University of Massachusetts Extension Greenhouse Crops and Floriculture Program

John W. Bartok, Jr.
Natural Resources Management. & Engineering Dept., University of Connecticut

Introduction
The fall and spring are times when humidity related diseases usually peak in greenhouses. Sunny days increase the transpiration of moisture from leaf surfaces and evaporation from soil. The warm air holds the moisture in the vapor form. At night as the air cools to the dew point, condensation occurs and water droplets are formed on cooler surfaces such as the leaves and glazing. This moisture promotes the germination of fungal pathogen spores such as Botrytis and powdery mildew. Dripping water from condensation on the greenhouse covering also wets plant surfaces and spreads plant pathogens from plant to plant by splashing soil and plant debris. The key to successfully suppressing diseases is to keep the plant canopy dry, especially from dusk to dawn. This is accomplished through cultural practices and environmental control strategies.

Relationship Between Temperature and Humidity
The amount of moisture in the air is generally expressed as relative humidity (RH), which is the ratio between the weight of moisture actually present in the air and the total moisture-holding capacity of a unit volume of air at a specific temperature and pressure. This term can sometimes be misleading, because it is temperature-dependent. Warm air has a higher moisture-holding capacity than cooler air; therefore as the temperature of air increases, the relative humidity decreases even though the amount of water remains constant. Air at 70° F will hold twice as much moisture as air at 50°F. In the range of temperatures encountered in a greenhouse, for every 20° F rise in dry bulb temperature, the water-holding capacity of the air doubles, and the relative humidity is reduced by one-half. This relationship is important in managing humidity in the greenhouse.

Dewpoint temperature indicates the temperature at which water will begin to condense out of moist air. Condensation on plants occurs when leaf surface temperature is below dew point. This is when there is too much moisture in the air to remain in the vapor state. The moisture will fall out and condense as free-moisture on surfaces that are at or below the dewpoint temperature. In other words, condensation will occur on the coldest surfaces first. The coldest surfaces will be the piping, door knobs, roof and eventually the plants. For example, when the greenhouse is 85% RH and 60°F, condensation occurs when leaf temperature is lower than 55°F. At 95 % RH and 60°F, condensation occurs when leaf temperature is only one degree lower than air temperature.

How to Reduce Humidity
Proper watering and adequate plant spacing, having well-drained floors, warming plants, moving air and venting moisture are ways to reduce humidity in greenhouses.

The least expensive method is to keep the greenhouse dry, especially going into the night, when the temperature drops. Puddling water on the greenhouse floor and water on leaf and growing media surfaces evaporate, which adds moisture to the greenhouse environment. Evaporation makes the environment humid and it takes away energy that is intended to keep a house warm.

Cultural Practices to Reduce Humidity

Cultural practices include watering just enough to prevent excess water on the floor, and watering early enough in the day to allow plant surfaces to dry before evening. The highest relative humidity in a greenhouse is generally found inside plant canopies, where moisture is generated from transpiration and trapped due to insufficient air movement. Adequate plant spacing and mesh benches will help to improve air circulation at the plant level.

Weeds also contribute to high humidity by holding moisture in the leaf canopy and generating moisture through transpiration. Maintain well-drained greenhouse floors that are free from weeds.

Bottom Heat

Bottom heat will improve air circulation inside plant canopies and will help to prevent condensation on leaf surfaces. The warm air that rises creates air movement around the plants. Bottom heat also keeps the plant surfaces warm, preventing condensation on the plants.

Anti-drip Plastic

The use of a wetting agent, either sprayed on the interior surface or as part of the formulation of the glazing on poly covered greenhouses can also help to reduce the humidity level. The moisture that condenses on the glazing will drain to the eave or foundation rather than forming droplets and dripping onto the plants.

Glass greenhouse with a steep roof pitch (6:12) will allow moisture to run off without a wetting agent. More condensation will occur on single glazing than with double glazing since the dew point is reached sooner.

Ventilation and Heating

A combination of ventilation and heating is also very important for reducing humidity. Ventilation allows the exchange of moist greenhouse air with drier air from outdoors. Heating is necessary to bring outdoor air up to optimum growing temperature, and also increases the capacity of the air to carry moisture, thus avoiding condensation. Neither practice alone is as efficient as both combined. Ventilation without heating would chill the greenhouse and the crop, and heating without venting the moist air would raise the temperature beyond optimum levels and result in excessive heating costs.

The method and time it takes for heating and venting will vary according to the heating and ventilation system in the greenhouse. To vent the humid air in greenhouses with vents, the heat should be turned on and the vents crack open an inch or so. When doing this the warmed air will hold more moisture (RH), escape from the greenhouse through the vents and be replaced with outside air of lower RH. This natural rising of the air will result in a greenhouse of lower relative humidity.

In houses with fans, the fans should be activated and operated for a few minutes and then the heater turned on to bring the air temperature up. The fans should then be shut off. A clock could be set to activate the fans. A relay may be needed to lock out the furnace or boiler until the fans shut off so that both the fans and heating system do not operate at the same time and flue gases are not drawn into the greenhouse.

The venting and heating cycle should be done two or three times per hour during the evening after the sun goes down and early in the morning at sunrise. The time it takes to exchange one volume of air depends on several factors including whether or not fans are used and, the size of the fans and vents. For some greenhouses it may take as little as 2-3 minutes air exchange. For greenhouses using natural ventilation, it may take 30 minutes or longer. Heating and venting can be effective even if it is cool and raining outside. Air at 50°F and 100% RH (raining) contains only half as much moisture as the greenhouse air at 70°F and 95% RH.

What is a Desirable Humidity Level?

To vent and heat the greenhouse most energy efficiently, growers might consider purchasing a device to measure humidity, and then heat and vent accordingly. The desirable humidity varies with temperature. Plants in warmer environments can tolerate higher relative humidity. The chart below provides corresponding temperature and relative humidity set points for disease prevention.

°F	Humidity
50°	83%
61°	89%
68°	91%
86°	95%

What Does it Cost?

Based on 1,000 sq.ft. of greenhouse floor area (approximately 10,000 cubic feet of air) it would take 4,000 Btu of heat to raise the temperature of the air 20°F (for example from 50° to 70°). At $1.00 per gallon of fuel oil or $0.70 per therm of natural gas, this amounts to about $0.04 per cycle. Usually this is done two or three times per hour during the evening after the sun goes down and early in the morning at sunrise.

Air Movement

Air movement is another important consideration when managing diseases in the greenhouse. Air that is moving is continually mixed resulting in very small temperature differences. Adequate air movement around the plant occurs when the leaves move slightly. The moisture does not get a chance to condense on the leaf surfaces because the mixing action caused by the movement prevents the air along the surface from cooling to below the dew point. This results in less Botrytis.

When the greenhouse is heated with hot air furnaces, continuous air movement can be obtained by running the fans continuously. Some furnaces are equipped with a manual switch on the fan motor, others can be rewired by an electrician. If two furnaces are used, they should be located at opposite corners and set to direct the air in a circular pattern.

The fan-jet system can also be used to move air within a greenhouse. This involves a fan that is connected to a perforated plastic tube located below the ridge. The fan is set to run continuously and either draws in outside air through a louver or recirculates air within the greenhouse. The air in the tube is forced out through the small holes and mixes with the air in the greenhouse. Air circulation with this system is not as efficient as moving the entire air mass. Also, any hanging plants in the direct path of the air coming from the tube will dry out quickly.

Another system that gives good air circulation and mixing is horizontal air flow (HAF). Small fans (1/15 horsepower, 16" to 20" diameter) placed along the sides of the house push the air in one direction on one side and in the opposite direction on the other side. Fans should operate continuously except when the exhaust fans are operating.

Measuring humidity

The sling psychrometer is still one of the most accurate methods for determining relative humidity. This device uses two thermometers, one with a wick, contained in a holder that can be swung like a fan. Wetting the wick with water and rotating the thermometers for about a minute will give the wet-bulb and dry-bulb temperatures. After subtracting the wet-bulb temperature from the dry-bulb temperature to get the depression, the relative humidity can be determined (see chart below).

Sling psychrometers are available from greenhouse suppliers and scientific equipment stores for about $95. Humidity pocket meters or humidity pens are also available beginning at about $40. A recording hydrothermograph ($350-$700) provides a continuous chart of dry-bulb temperature and relative humidity. Although most older instruments used the human hair as the sensing element, new instruments use other materials such as polystyrene, nylon or cellulose acetate butyrate. Accuracy of humidity readings depends on good maintenance of the sensor.

Relative Humidity Chart										
Dry Bulb Temp. °F	(*) Indicates Difference (°F) Between Dry-Bulb & Wet-Bulb Temperatures Relative Humidity (percent)									
	*2	*4	*6	*8	*10	*12	*14	*16	*18	*20
50	87	75	62	51	39	29	18	9		
52	87	75	64	52	42	32	21	12	6	
54	88	76	65	53	43	33	23	14	8	
56	88	77	66	55	45	35	26	16	10	
58	88	78	67	56	47	37	28	18	12	4
60	89	78	68	58	48	39	30	21	14	5
62	89	79	69	59	50	41	32	24	17	8
64	90	79	70	60	51	43	34	26	19	11
66	80	80	71	61	53	44	36	29	22	14
68	90	80	71	62	54	46	38	31	24	16
70	90	81	72	64	55	48	40	33	27	19
72	91	82	73	65	57	49	42	34	28	21
74	91	82	74	65	58	50	43	36	30	23
76	91	82	74	66	59	51	44	38	32	25
78	91	83	75	67	60	53	46	39	33	27
80	91	83	75	68	61	54	47	41	34	29

Summary

Humidity management is a valuable tool to prevent diseases in greenhouses as part of overall Integrated Pest Management. Effective environmental control not only reduces disease pressure and reduces pesticide use, the reentry intervals from pesticide applications are no longer an issue.

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Resources

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Photoperiod Lighting to Create Long Days

Tina Smith, UMass Extension
Douglas Cox, Stockbridge School of Agriculture
Amherst

Photoperiodic lighting is used to create long days for flower induction of long-day (LD) plants or to delay the flowering of short-day plants. Generally, long-day plants will flower when the daylength is longer than 14-16 hours (night length of less than 10 hours). Therefore, long-day lighting should be used from around Sept. 1 to April 15. Note that the critical daylength is likely to be different for each species.

Photoperiodic lighting differs from supplemental lighting, the latter is used to increase the quantity of photosynthetic light during a day or to extend the day. Supplemental light is used during short winter days or very overcast days, and requires high intensity light (typically 300 – 600 footcandles (f.c.) for 6-12 hours).

Creating LD for photoperiodic lighting can be achieved using several possible lighting regimes:

- Day continuation lighting (also called day-extension lighting) - lighting from sunset until later in the night. (10 pm).
- Pre- dawn lighting - lighting from 2 am until sunrise.
- Night interruption lighting (also called "night break" lighting or “mum lighting”) - lighting in the middle of the night, usually 10 pm until 2 am. Fewer hours of lighting are needed for night-interruption compared to day continuation or pre-dawn lighting, so this is more economical and is used most often for lengthening the daylength.
- Cyclic or intermittent light –periodic lighting in the middle of the night, such as light on for five minutes every 20 minutes during a 4 hour period. Generally, plants need to receive at least 10 f.c. for a minimum of five minutes every half hour. This technique has been used to save energy using INC.

Incandescent (INC) light bulbs with reflectors have traditionally been used to create long days using night interruption lighting to regulate flowering of greenhouse crops. Unlike supplemental lighting, photoperiodic lighting requires only low-intensity light (typically 10 f.c.). Typically, a string of lights (60-watt INC bulbs spaced 5' apart) is hung 3’ above the tops of plants per bench or bed that measures 42-48" wide. A 24-hour timer is used to control the lighting period, turning lights on at 10 pm and off at 2 am.

As **compact fluorescent (CFL) bulbs** became available, growers replaced their INC lamps with CFL to save energy. CFLs are more energy-efficient than incandescent bulbs, however, their spectrum is not as effective at controlling flowering of some long day (LD) plants. CFLs are low in far-red (FR) light, which is required for rapid flowering of some LD crops, for example pansy and petunia. One solution has been to alternate CFL with incandescent bulbs in fixtures within the greenhouse to provide the necessary light spectrum for effective photoperiodic lighting and still achieved some energy savings.

Light-emitting diodes (LEDs) are emerging as a source of greenhouse lighting. LEDs have a long lifespan, are energy efficient and the spectrum of light emitted can be adjusted. The LED replacements for INC bulbs are more expensive than INC or CFL bulbs, but they last longer and are more energy efficient. Currently, LED bulbs are being successfully used in photoperiodic lighting for some crops. Research at Michigan State University tested LEDs developed by Philips Lighting (Philips DR+W+FR) as a replacement for 100 or 150 watt INC used for photoperiodic lighting. The lamps were installed 3-7 ft above the plant canopy and 3 to 10 ft. apart and used night interruption lighting (10 pm to 2 am). Flowering of bedding plant plants tested was similar as conventional INC lamps.

Resources

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UMass Greenhouse Crops and Floriculture Extension Program

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