PURDUE UNIVERSITY

PURDUE EXTENSION

The Indiana Flower Grower

In This Issue

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Roberto's Message

Message from Roberto

Dear flower growers, businesses, distributors, organizations and colleagues,

As many of you are aware, after a very long and brave battle, our friend Larry Houser passed away on Friday, May 29 from pancreatic cancer. Larry will be remembered for all that he did for his country and for the floriculture industry in Indiana and across the U.S. On June 18, a Benefit Golf Outing was held for Larry and his family. The weather was perfect and 10 teams had a great day of golf. There were 24 hole sponsors and the event generated just over $14,000.00 that will be presented to Peggy Houser to help with the medical bills and other expenses. A special thanks goes to Dean Bemis, Sonny Mosley, Bernie Ferringer and everyone else who contributed time and money to make this event a great success.

IFGA Update

By Steve Dewald and Roberto G. Lopez

President of the Indiana Flower Growers Association and IFGA Educational Chair

On June 12 the IFGA board met in West Lafayette to discuss the future of the organization. We are excited to continue our involvement with the Indiana Green Expo (IGE) to give our members access to the many greenhouse, nursery, garden center, turf and landscape workshops, seminars and trade show.

Don't worry, the IFGA annual meeting/golf outing and banquet will not disappear. We have made a few changes that we hope you will enjoy. This year, the 27th annual IFGA conference will be a one day event and will be held on Monday, October 5. Our reasoning for this is to keep costs down and encourage greenhouse owners to bring their growers and other employees to attend workshops, tours and seminars. The educational events will be held on the Purdue University campus (more details will be sent out shortly). For those that prefer to golf, we will have a golf tournament as always followed by our annual meeting and banquet at the University Inn.

Growers Column – NIFGA Garden Plant Tour

By Bernie Ferringer

Secretary and Treasurer of the NIFGA

You are invited to join the Northeast Indiana Flower Growers Association on our annual bus tour from Tuesday, August 4 to Wednesday, August 5. This year we will go to the Michigan Garden Plant Tour. This will be a good chance for you to see several greenhouse and the Michigan State University garden trials to evaluate what you want to grow next year. Leave the driving to the professionals while we talk shop. We need at least 25 people to sign up to make this trip a go, so please let Lynda Heavrin know your interest and get your reservation in by mid-July. This invitation is open to all greenhouse and landscape enthusiasts.

Tour the following greenhouses and trial gardens:

C. Raker and Sons, Duwayne's Greenhouse, Four Star Greenhouse, Michigan State University Trial Gardens, Mast Young Plants, Pell Greenhouse, and Zylstra Greenhouse

Price per person: Single - $199, Double - $162, Triple - $149

Price includes: Deluxe motor coach, accommodations, continental breakfast both days, lunch at a sponsoring greenhouse each day, and dinner and program on Tuesday evening. We will leave at 7:30 AM from Dewald Gardens, 12700 Lima Rd, Fort Wayne, IN.

For more information and reservations contact Lynda Heavrin at (260) 427-6424 or e-mail: lynda.heavrin@ci.ft-wayne.in.us.

Checks should be made out to NIFGA,
626 Big Valley Ct., Huntertown, IN 46748
Lynda Heavrin, Vice President of NIFGA
Fort Wayne Parks and Recreation
1900 N Clinton Street
Fort Wayne, IN. 46805
Phone 260 427-6415
E-mail: lynda.heavrin@ci.ft-wayne.in.us

Poinsettia Cold Finishing in Northern Latitudes

By Dr. Roberto G. Lopez and Dr. Brian A. Krug

Assist. Professor and Floriculture Extension Specialist and Floriculture/ Greenhouse Extension Specialist

Cultivar Selection

For greenhouse operations in northern latitudes, energy costs for heating alone account for 10 to 30% of their total operating cost. Poinsettia cold finishing is a viable option that growers can use to help reduce both energy and input costs. However, it is important to remember that not all cultivars can be cold finished successfully. Cultivars that are good candidates for cold finishing are those that are marketable early in the season (6 to 8 week response time), moderate-vigor, and have naturally large bracts. Why? Poinsettias finished at cooler temperatures can be shorter, have smaller bracts and be delayed (timing) compared to those finished at warmer temperatures. For our study, we worked with the five major poinsettia breeders: Ecke Ranch, Dümmen, Florema Young Plants, Selecta First Class and Syngenta Flowers to study two red poinsettia cultivars from each of their genetics.

Cold Finishing

Research was conducted at Purdue University in West Lafayette, IN (lat. 40°N) and the University of New Hampshire in Durham, NH (lat. 43°N) to study the effects of cold finishing under a range of temperatures on 'Advent Red', 'Prestige Early Red', 'EarlyGlory Red', 'Viking Red', 'Christmas Eve', 'Christmas Feelings', 'Early Orion', 'Orion', 'Alreddy Red', and 'Saturnus Red'. Rooted cuttings were received during the week of July 28 (week 31), August 4 (week 32), August 11 (week 33) and August 18 (week 34), transplanted into 6.5 inch pots and grown at day/ night temperatures (12 h/ 12 h) of 75/ 67 °F [Average daily temperature (ADT) of 71 °F] and a 16-hour photoperiod provided by high-pressure sodium lamps, until the start of short days (SD) on October 1.

One goal of this research was to quantify how constant and fluctuating [DIF (the difference between the day and night temperature)] cold finishing temperatures with the same ADT affect poinsettia growth and development. On October 15, plants were transferred to cold finishing temperatures that are described in Table 1. We choose to begin cold finishing two weeks after the start of SD when average outdoor night temperatures are below 45 °F across much of the northern U.S. leading to significant energy savings.

Height

Figure 1 displays the average weekly height of each of the 10 cultivars planted on August 13 (week 33) and cold finished beginning on October 15 (week 42) at 68/ 56 °F (ADT of 62 °F). Up until the start of cold finishing, the height of all the cultivars was above the graphical tracking curve because we did not

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To subscribe, send your name, company name and email address to:

Roberto Lopez at: rglopez@purdue.edu

Subject line: Indiana Flower Growers

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use growth regulators. Allowing the plants to grow above the curve prior to cold finishing compensated for the reduced stem elongation that occurred during the cold finish period. From Figure 1 we can see that the final heights of all ten moderate vigor cultivars planted on week 33 in our study were within or near the 14 to 16-inch range. As would be expected, final height of all the poinsettia cultivars planted on weeks 31 or 32 was significantly greater than those planted on week 33.

Bract Expansion over Time

In order to determine if cold finishing temperatures influence the expansion of poinsettia leaves and ultimately bracts, on October 15 we began taking digital photographs of leaves of one cultivar in each of the six cold finish temperature treatments. Using computer software, we were then able to non-destructively determine the leaf area of the photographed leaf. Photographs of the same leaves were subsequently taken each week to track leaf expansion over time until November 26. The average leaf area at the different constant and fluctuating temperatures is presented in Figure 2. With the exception of the coldest treatment of 61/55 °F (ADT of 58 °F), leaf area after six weeks was between 14.4 to 15.5 square inches across the cold finishing temperatures. This indicates that individual leaf or bract expansion was not delayed by constant or fluctuating cold finish temperatures at or above 62 °F.

Visible Bract Area

At anthesis (first pollen shed), bract length and width of the top four bracts (widest diameter across and widest diameter 90 degrees across) on a stem was measured and visible bract area per stem was determined by using the formula for an ellipse. In Figure 3, we present the average visible bract area per stem of four poinsettia cultivars cold finished at an ADT of 58 to 71 °F.

Our results and those of Jim Faust and colleagues at Clemson University indicate that bract area per stem was commercially acceptable at ADT at or above 60 °F across several cultivars tested. However, bract area was reduced and unacceptable when poinsettias were cold finished at ADT below 60 °F. In Figure 4, we can clearly see the effects of 61/ 55 °F on visible bract area and overall plant architecture.

Timing

One of the most important factors that can limit cold finishing is the delay in timing that can occur from reduced temperatures. In our study, time to anthesis from the start of SD was delayed by 2 to 21 days for all cultivars that were cold finished at constant and fluctuating ADT of 62 and 66 °F, compared to the 75/ 67 °F (ADT of 71 °F) treatment. Therefore, early season cultivars with a 6 to 8 week response time should finish and be marketable between mid- to late-November. It is also important to note that plants can be marketable a few days to 2 weeks before anthesis depending on the cultivar.

Temperatures

The cold finishing temperatures in our trial represent a wide range of temperatures attainable by northern greenhouse growers. When an ADT of 62 or 66 °F was obtained by holding a constant temperature throughout the day and night, plants were not as visually appealing as plants grown at the same ADT but with fluctuating day/night temperatures. Generally plant height was relatively similar regardless of how the ADT was obtained (Figure 4). Average daily temperature did however affect timing, plant diameter, visible bract area per stem, and bract expansion. Plants finished at 61/ 55 °F (ADT of 58 °F) were significantly smaller in all of these parameters and not marketable. Plants finished at 75/67 °F (ADT of 71 °F) were larger but to the extent that they may be relatively more difficult to ship, a PGR application may be needed.

Additional Benefits

Although reducing heating costs is the primary draw to cold finishing your poinsettia crop there are other added benefits to this production scheme. Other reported benefits include reduced or no PGR use, an increased post-harvest life of plants and intense and brighter bract colors such as those observed in Figure 4. This can translate into higher consumer satisfaction.

All the red cultivars that we tested in our trial were successfully cold finished at 68/ 56 ºF and 70/ 62 ºF without excessive delays in timing or negative effects on height or bract area. Keep in mind that the base temperature or the temperature at which the developmental rate is zero, is 50 °F for poinsettia; therefore night temperatures should never drop below 55 °F to obtain a desired ADT. Likewise, excessively high temperatures during the day can also cause problems. The practice of cold finishing poinsettias has shown promise as a cost savings technique in this and other studies. Research is ongoing at Purdue University and The University of New Hampshire to further quantify this production method in the northern tier of the U.S. We strongly encourage growers who are interested in cold finishing their poinsettia crop to conduct onsite trials of their own with different cultivars to determine how their specific growing conditions influence timing and other plant quality parameters. These studies were conducted under low light northern U.S. conditions; therefore growers in the south may need to apply growth regulators conservatively.

Table 1. Day and night cold finishing temperatures (12 h/12 h) were initiated on October 15. The average daily temperature and the DIF.

Cold Finish Temperature (°F) (day/night)	Average Daily Temperature (ADT)(°F)	Positive DIF
61/55	58	6
68/56	62	12
62/62	62	0
70/62	66	8
66/66	66	0
75/67	71	8

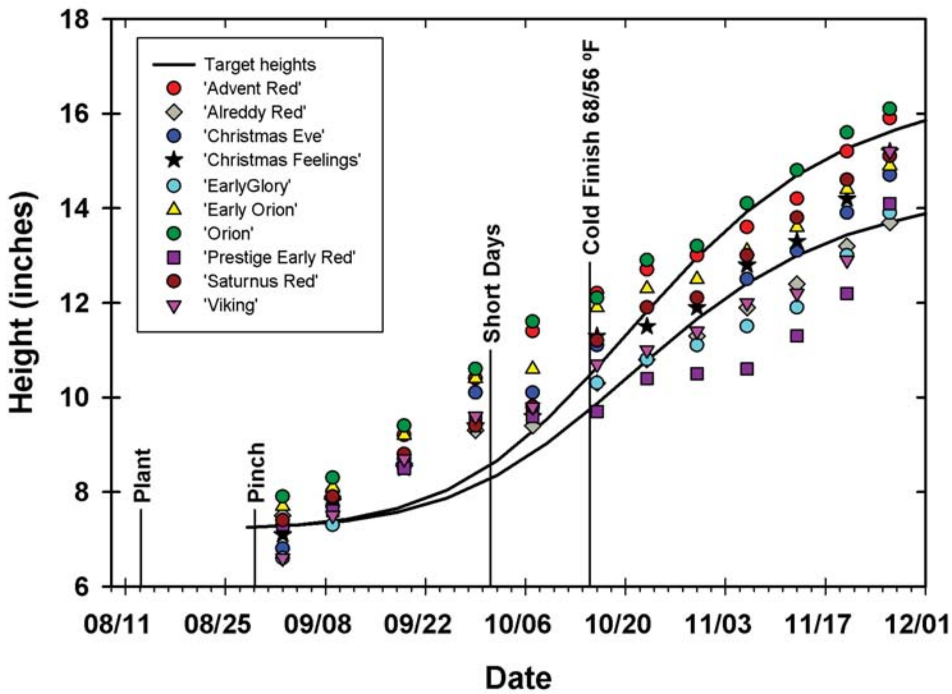


Figure 1. Graphical tracking of ten poinsettia cultivars that were planted on August 13 (week 33) and cold finished at 68/56 °F day/night (average daily temperature of 62 °F).

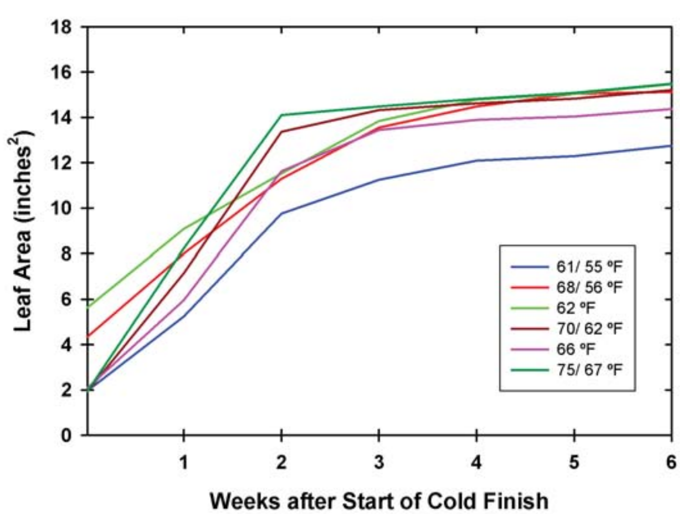


Figure 2. The effect of constant and fluctuating cold finishing temperatures on poinsettia leaf area.

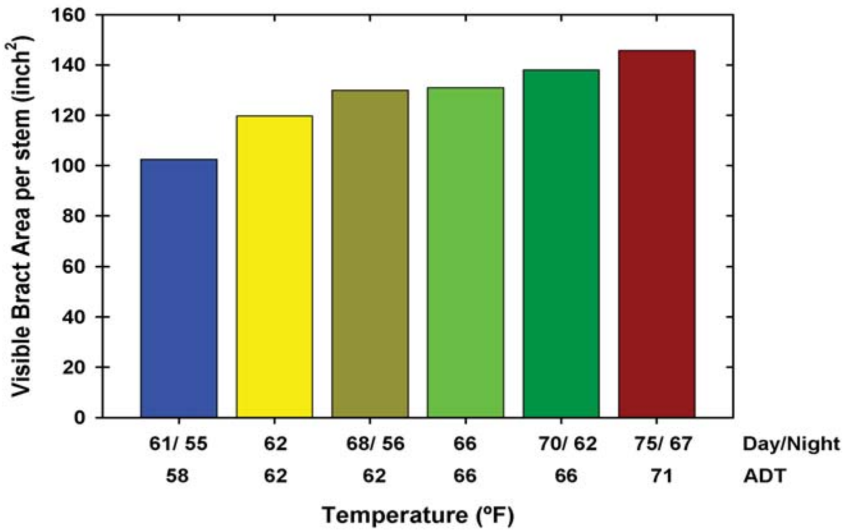


Figure 3. The effect of cold finishing temperatures on the average visible bract area of four poinsettia cultivars.

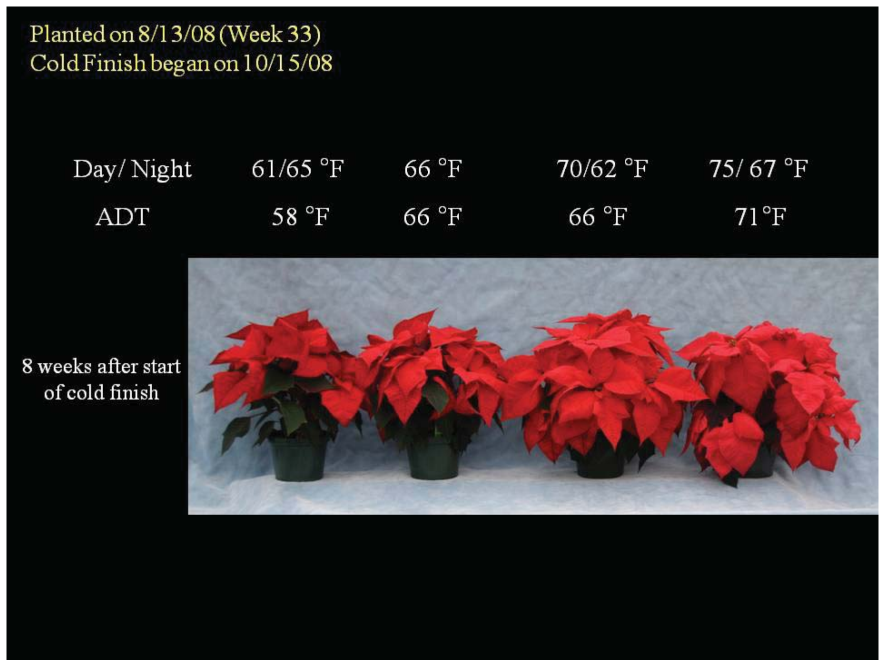


Figure 4. The effect of constant and fluctuating cold finishing temperatures on poinsettia height, bract area and timing.

USDA Census of Agriculture Provides Information about Indiana's Floriculture Industry

By Joyia T. Smith, Dr. Roberto G. Lopez, and Dr. Jennifer H. Dennis

Graduate student, Assist. Professor and Floriculture Extension Specialist and Assoc. Professor and Marketing Extension Specialist

The 2007 Census of Agriculture from the USDA -Nat'l Ag. Stat. Serv. was recently published: (http://www.agcensus.usda.gov/). The information reported therein will be used by state and federal policy makers, researchers, extension personnel, growers, and others to follow industry trends and help guide future plans. What picture does this census paint for the Indiana greenhouse industry? We will provide an overview of the national greenhouse industry as well as that of Indiana and the surrounding states (Illinois, Kentucky, Michigan and Ohio).

As of 2007, there were 18,670 commercial floriculture greenhouse operations across the United States. Approximately 460 or 2.5% of those operations were in Indiana. Michigan continued to be the regional leader with approximately 5.5% or 1039 operations. Ohio, Illinois, and Kentucky had 950 (5.1%), 510 (2.8%) and 486 (2.6%) greenhouse operations, respectively. When examining the Census of Agriculture data over the past ten years (1997 to 2007), there are several interesting trends that we will highlight. From 1997 to 2002, the number of greenhouse operations that produce floriculture crops in Indiana increased by 24% then decreased by 19% (loss of 109 operations) from 2002 to 2007 (Table 1, Figure 1). However, if we closely look at the ten year period of 1997 to

Table 1. Data from the 1997, 2002, and 2007 Census of Agriculture for the total number of operations that produce floriculture crops nationally and in Midwestern states. The number of operations that produce bedding/garden plants, cut flowers and florist greens, potted flowering plants and greenhouse vegetables and fresh cut herbs.

State	Year	Floriculture Crops	Bedding and Garden Plants	Cut Flowers and Florist Greens	Potted Flowering Plants	Total Greenhouse Vegetables and Fresh Cut Herbs
Indiana	1997	458	401	36	137	62
	2002	569	506	38	197	49
	2007	460	404	20	115	91
Illinois	1997	485	430	33	163	44
	2002	421	396	7	118	45
	2007	510	479	13	108	82
Kentucky	1997	412	368	9	115	67
	2002	550	496	15	190	69
	2007	486	432	31	121	118
Michigan	1997	1069	966	51	298	71
	2002	936	841	59	269	111
	2007	1039	955	42	241	170
Ohio	1997	1071	984	92	331	105
	2002	1127	1008	60	339	139
	2007	950	850	45	248	183
United States	1997	22,958	17,421	1,873	6,812	2,871
	2002	21,728	16,849	1,754	6,806	3,416
	2007	18,670	14,747	1,316	5,006	4,075

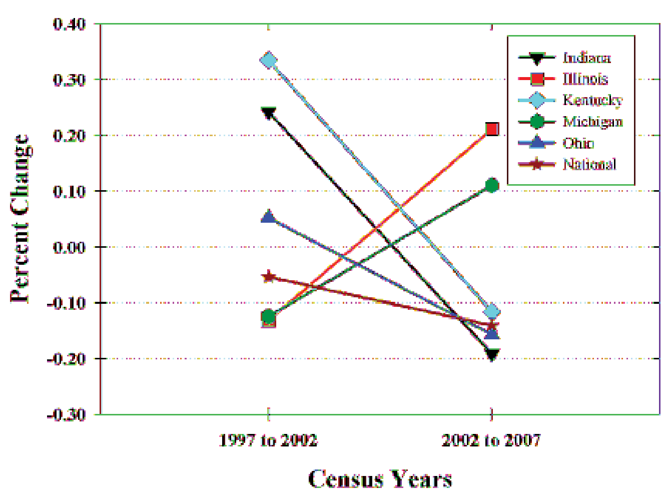


Figure 1. The percent change from 1997 to 2002 and from 2002 to 2007 of greenhouse operations that produce floriculture crops in the United States and in the Midwest region.

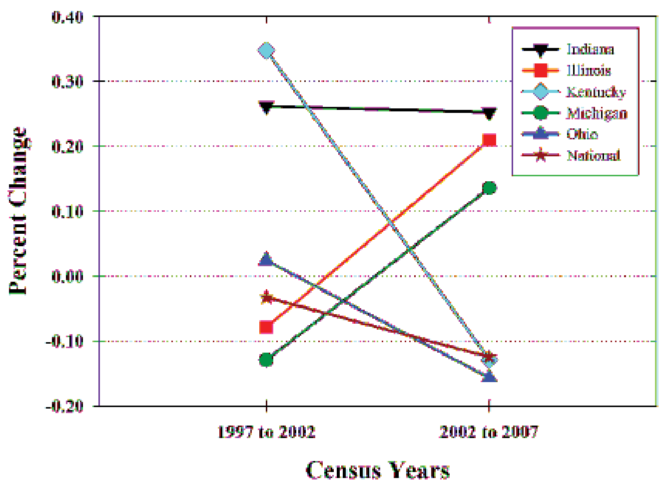
2007, the number of greenhouse operations in Indiana remained steady, at or near 460 (Table 1). The number of floriculture greenhouses also decreased in all of the surrounding states with the exception of Illinois and Michigan.

Similar to the national trend, from 2002 to 2007 there was a decline in the number of floriculture greenhouses in Indiana. However, nationally we began to see a decrease from 1997 to 2002 when the number of greenhouses that produced floricultural crops decreased by 5%. This number fell by an additional 14% between the 2002 and 2007 Census years (Figure 1).

At the end of 2007, there were 14,747 bedding/garden plant operations nationally. Approximately 2.7% or 404 greenhouses were in Indiana. Michigan was once again the largest producer regionally with approximately 6.5% or 955 bedding/ garden plant operations, followed by Ohio, Illinois, and Kentucky, which each had 850 (5.8%), 479 (3.2%) and 432 operations (2.9%) respectively.

From Figure 2, we can see that the number of bedding/ garden plant operations in Indiana, Kentucky, and Ohio increased from 1997 to 2002 and decreased from 2002 to 2007. For example, in Indiana, between the census years of 1997 and 2002 the number of bedding/ garden plant operations increased by 26% (from 401 to 506) and decreased by 25% (506 to 404) (Table 1, Figure 3) from 2002 to 2007. Nationally, bedding/garden plant operations decreased by 3% from 1997 to 2002, and further decreased by 12% from years 2002 to 2007.

In 2007, there were approximately 1,316 cut flowers/cut florist greens operations in the United States. Indiana had approximately 1.5% or 20 of those operations. Ohio was the regional leader with 3.4% or 45 operations. Michigan, Kentucky, and Illinois accounted for 3.2, 2.4 and 1.0 % of all U.S. cut flowers/ cut greens operations.



Figrue 2. The percent change from 1997 to 2002 and from 2002 to 2007 of greenhouse operations that produce bedding/ gerden plants in the United States and in the Midwest region.

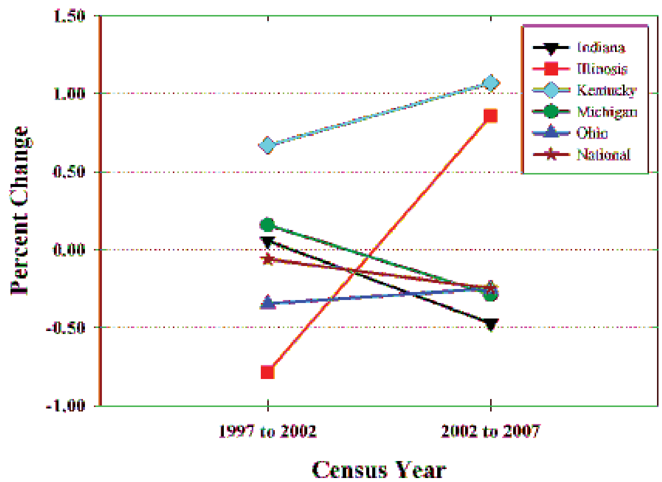


Figure 3. The percent change from 1997 to 2002 and from 2002 to 2007 in the number of greenhouse operations that produce cut flowers and cut florist greens in the United States and in the Midwest region.

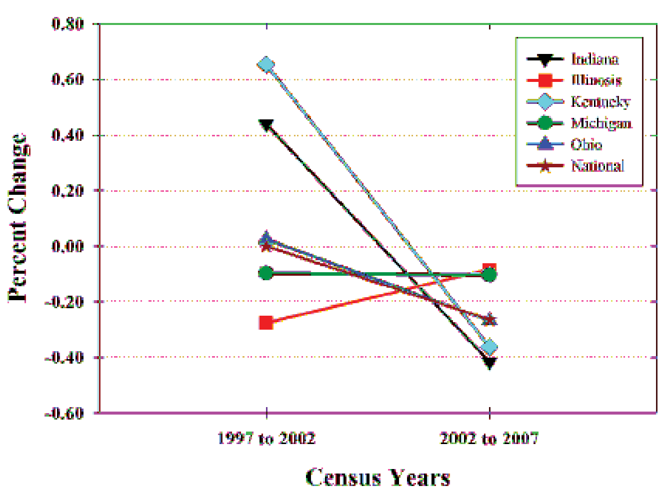


Figure 4. The percent change from 1997 to 2002 and from 2002 to 2007 in greenhouse operations that produce potted flowering plants in the United States and in the Midwest region.

The Census of Agriculture data over the past ten years for cut flowers/cut florist greens indicates a national decline in production, as well as one in Indiana and Michigan. From 1997 to 2002, Indiana had a 6% increase in the number of operations, and then a 47% decrease between the 2002 to 2007 census years (Figure 3, Table 1). Nationally, cut flowers/cut florist greens operations decreased by 6% from 1997 to 2002 and fell by an additional 25% from the 2002 to 2007.

As of 2007, there were 5,006 potted flowering plant operations nationally. Indiana was home to approximately 2.3% of those potted flowering plant greenhouses or 115 operations. Ohio was the regional leader with approximately 5.0% or 248 operations. Michigan, Kentucky, and Illinois each had 241 (4.8%), 121 (2.4%), and 108 potted flowering plant greenhouses (2.2%), respectively.

For potted flowering plants, we see that over the ten year period, there is a slight national decline in grower operations (Figure 4). From census years 1997 to 2002, the number of potted flowering plant growers in the U.S. remained constant, however from 2002 to 2007, it decreased by 26% . All of the states surrounding Indiana have also suffered a decline in the number of potted flowering plant growers, with the exception of Illinois. From 1997 to 2002, the number of potted flowering plant producers in Indiana increased by 44%, then decreased by 42% from 2002 to 2007.

According to the 2007 census, there were 4,075 greenhouse vegetables and fresh cut herb operations nationally. Approximately 91 or 2.2% of those operations are in Indiana. Ohio was the regional leader with approximately 4.5% or 183 operations. Michigan, Kentucky, and Illinois each had 170, 118 and 82 operations, respectively.

From 1997 to 2007, the number of vegetables and fresh cut herb greenhouses in the U.S. increased by 42% (Table 1). Indiana, Illinois, and Kentucky all exhibited an increase in

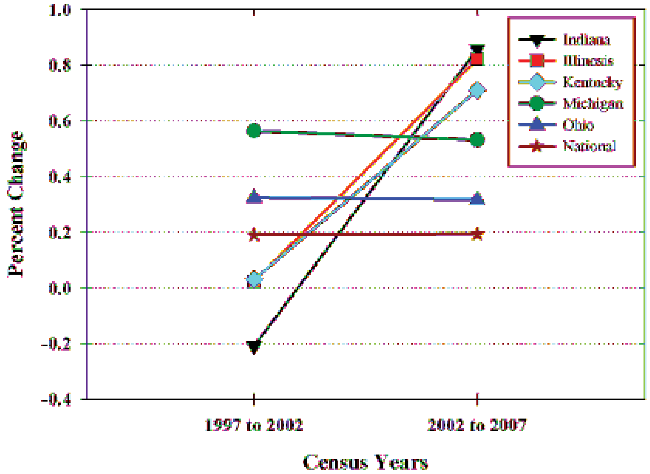


Figure 5. The percent change from 1997 to 2002 and from 2002 to 2007 in greenhouse operations that produce greenhouse vegetables and fresh cut herbs in the United States and in the Midwest region.

operations. For example, from 2002 to 2007 there was an 86% increase in the number of vegetable greenhouses in Indiana (Figure 5).

What Is Alkalinity? Why Does it Matter?

By Dr. Claudio C. Pasian and Dr. Roberto G. Lopez

Professor of Floriculture and Assist. Professor and Floriculture Extension Specialist

The telephone rings. The floriculture / greenhouse Extension specialist answers the call. On the other side a grower relates that their plants have a nutritional problem: most of the leaves are turning a pale yellow, especially the new ones. The grower indicates that they are applying sulfuric acid because the pH of the water is 7.8. When the Extension specialist asks what the alkalinity of the water is, the grower replies that they have no idea. Many Extension Educators all over the country have similar experiences: usually, growers do not have a clear understanding of what can cause increases in substrate pH, and that water alkalinity, rather than water pH, is the source of the problem. Where is the source of the confusion?

The purpose of this article is to help growers differentiate between "high pH" and "high alkalinity".

What is pH?

pH stands for hydrogen (H) potential and it represents a measure of the concentration of H+ ions in a solution. (Tap water and the water in the substrate inside a container are examples of solutions.) As a mathematical consequence of the formula that defines pH, the units on the pH scale range from 0 to 14. A value of 7.0 indicates neutrality, values less than 7.0 are called acidic, and values greater than 7.0 are called basic or alkaline. Values close to 0 or 14 represent extreme acidity and basicity, respectively. In general, the pH of water for irrigating greenhouse crops should be between 5.0 and 7.0.

What is Water Alkalinity?

Water alkalinity is a measure of the concentration of bases in a solution or the ability to neutralize acids in water. It can also be referred to as the buffering capacity of water. Examples of bases are carbonates, bicarbonates, magnesium bicarbonate, ammonia, borates, phosphates, silicates, and organic bases. For all practical purposes, carbonates and bicarbonates are the main contributors to the alkalinity of water. Irrigating your crops with water high in alkalinity is similar to adding lime to the substrate.

So, we have water that is called alkaline if its pH is greater than 7 and it is said to have high alkalinity if its base concentration is high. No wonder many growers are confused like the grower in our example above!

Now that one source of the confusion has been identified, let's look at alkalinity and irrigation water. **Water alkalinity can have a large and significant effect on substrate pH while the pH of irrigation water has a minimal effect on the pH of the substrate** (technically we should say: the pH of the solution in the substrate). The bottom line is that growers need to know the alkalinity of their irrigation water and based on its level, decide whether treatment is need.

The units of measure used to describe alkalinity are another possible source of confusion for growers. Alkalinity can be expressed in parts per million (ppm), milligrams per liter (mg/L) or equivalents. These units can be used to express alkalinity as calcium carbonate equivalents or calcium bi-carbonate equivalents. Different laboratories use different units and it is important for growers to know which units their labs are using, especially if such a number will be used to calculate how much acid needs to be added to the irrigation water.

Why is Water Alkalinity Important?

Water alkalinity increases the pH of substrates. At high substrate pH some nutrients become unavailable to some plants even if the nutrients are present in the substrate. The most common deficiency caused by high substrate pH is iron deficiency which manifests itself with chlorosis of the leaves, especially new ones (Figures 1 and 2).

Figure 1. Typical symptoms of iron deficiency in petunia.

Figure 2. Severe iron deficiency results in chlorotic (almost white) young leaves.

Figure 3. When grown at lower than normal substrate pH, marigolds can exhibit symptoms of spider mite injury.

On the other hand, if the pH of the substrate is too low, some crops like geraniums and marigolds may suffer from an excess of nutrients (toxicity) like iron and manganese because these nutrients are easily available and easily up-taken (Figure 3). Growers in areas with very low water alkalinity should also be concerned because of the possibility of the substrate pH becoming too low.

Water Alkalinity is not a Constant!

It is important to remember that water alkalinity is not a constant value. It can change seasonally, or over time. We advise growers to test their water at least once a year if not more often. In general, surface water from rivers and lakes, are less likely to have high alkalinity levels than water from wells. For example, if your water source is an aquifer or well, during extended periods of drought or heavy rain you may see you water alkalinity increase or decrease, respectively.

What is a High Alkalinity Level?

This question is difficult to answer because substrate pH is affected by several factors in addition to water alkalinity. Among these factors, we can include fertilizer acidity or basicity, the amount and type of lime added to the substrate mix prior to use, substrate components, and the crop itself. Container size can also be a factor, because it takes less volume of high alkalinity irrigation water to affect a small volume of substrate.

Growers should be concerned when the alkalinity of their irrigation water is approaching 120 ppm, expressed as ppm calcium carbonate. With values less than 120 ppm, the likelihood of substrate pH problems is reduced. Most often, growers encounter high substrate pH problems when their alkalinity values are greater than 120 ppm.

However, this is not absolute. For example, if you grow *callibrachoa* or any other pH-sensitive crops and your water alkalinity is 120 ppm calcium carbonate, you may never encounter iron deficiency symptoms if you use an acidic fertilizer. In other instances, growers with water alkalinity values well above 120 ppm may never experience problems even if they do not inject acid into their irrigation water because they use other cultural practices to compensate such as the use of acidic fertilizers and/or less pre-plant lime in their substrates.

So how do you overcome high alkalinity? By correctly acidifying your irrigation water, you reduce the amount of bicarbonates (HCO_3^-) and decrease alkalinity. More precisely, acid injection neutralizes alkalinity and results in the formation of carbon dioxide (CO_2) and water (H_2O):

$H+$ (from acid) + HCO_3^- (in the irrigation water) --------> $CO_2 + H_2O$

Sulfuric (H_2SO_4), phosphoric (H_3PO_4), nitric (HNO_3), or citric ($H_3C_6H_5O_7$) acid are commonly injected into irrigation water to neutralize water alkalinity. Consider several factors when selecting an acid: ease of use, safety, cost, and nutrients (nitrogen, phosphorous and sulfur) provided by the acid.

How much Acid do I Apply?

Researchers from North Carolina State University and Purdue University developed an Alkalinity Calculator using an Excel® (http://www.ces.ncsu.edu/depts/hort/floriculture/software/alk.html. Growers can enter their water pH and alkalinity into the spreadsheet and then select their acidifying agent of choice (sulfuric, phosphoric, or nitric acid) to reach a target pH or alkalinity. The spreadsheet also has the ability to calculate the nutrient additions from each acid and will report the acidification costs, based on the price per gallon of acid. In order to use this tool, you need to enter the alkalinity of the water, its pH, and the desired alkalinity level. Then, with a click, you will have an answer. It is that simple!

Can I use Iron Chelates?

The answer is "yes" if you need to quickly

Table 1. Corrective measures for pH substrate

Lower Substrate pH	Raise Substrate pH
Proper water acidification	Discontinue water acidification
Use acid-residue (ammoniacal nitrogen) fertilizers if plants are tolerant	Use basic-residue fertilizers
Drench with aluminum sulfate to rapidly reduce pH*	Inject potassium bicarbonate*

** Should only be performed in severe cases.*

"green up" your crop (e.g. before shipping). However, this practice does not solve the root of the problem: high substrate pH. If substrate pH is not lowered to a crop specific level, the iron deficiency will reappear over time leading to a poor quality crop for your customers.
Furthermore, iron chelates only supply iron and not other micronutrients that may be deficient due to high pH levels of nutrients such as manganese, zinc, or copper.

How do I Manage Substrate pH?

As a grower, you can plot the weekly substrate pH of your crops. On the plot, you can have upper and lower decision points. It is important to remember that all nutrients are readily available at a pH of 5.4 to 6.2 in soilless substrates, but each plant species has an optimal pH range. In table 1, we include corrective measures to either lower or increase substrate pH.

Important Points to Remember and Do:

- Understand the difference between water pH and water alkalinity.
- Know the pH and the alkalinity of your irrigation water.
- Remember that water alkalinity has a greater effect on substrate pH.
- Base the amount of acid to be added to your irrigation water on its alkalinity and not on its pH

Using Supplemental CO_2 in Tightly Sealed Greenhouses to Offset Growth and Development Decreases in Cool Production Environments

By Dr. Jonathan M. Frantz and Don Schmidlin

USDA-ARS Researcher and Greenhouse Grower

We made it through another frigid winter, and are near the end of the busy sales season. We quickly undo and possibly try to forget all the effort it took to seal up gaps in structures, tears in plastic, and vents that were tough to close.

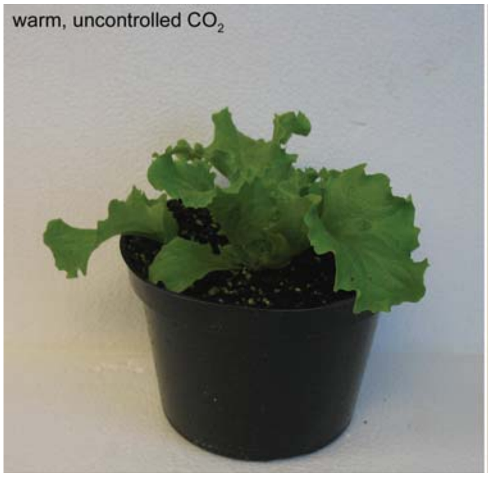
A couple of years ago, I carried a CO_2 sensor while I visited a handful of greenhouses during the winter, when everything was sealed up tightly (by the way, this CO_2 sensor is part of the OSU Extension Instrument package, available for use for free by contacting ABE Center Director Floriculture Greenhouse/ Hydroponic Program Beth Fausey at: (fausey.11@cfaes.osu.edu). I had always been told that CO_2 was sufficiently high inside greenhouses. After all, in spite of all the effort to seal up gaps, greenhouses still leak, right (Figure 1)?

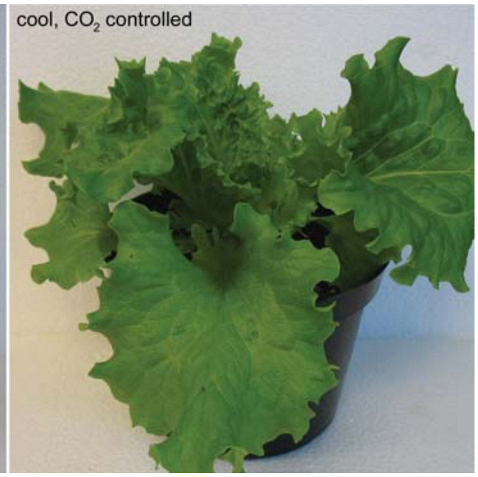
I was surprised to find CO_2 inside greenhouses in the 300 to 330 ppm range. In one case, I even found CO_2 as low as 175 ppm. Outside air is about 400 ppm, so even in the "best case", CO_2 was lower than outside air by about 20%. In this CO_2 range, that is effectively cutting growth by about 20% too! Having low CO_2 is a mixed blessing. If you have low CO_2, you have probably done an excellent job in sealing up the gaps in your facility and are saving on energy costs, while high CO_2 may suggest some leaks are being ignored.

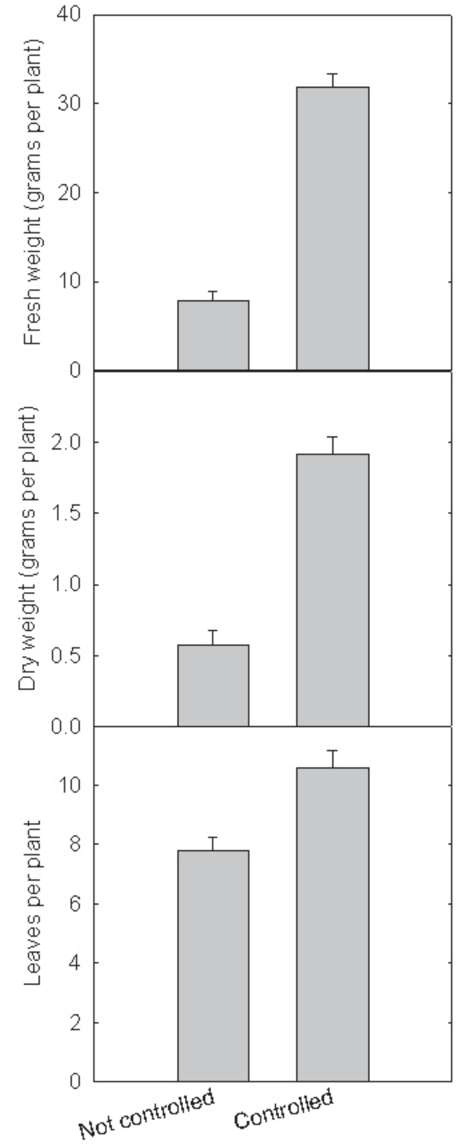
So what should we do about this? Is it a problem? One approach is to ventilate, but that certainly impacts your heating bill. Adding CO_2 with a "burner" system is also an approach, provided the water that is generated in the combustion process is dealt with, not to mention the issues of incomplete combustion can produce ethylene. Adding CO_2 by a liquid CO_2 source is yet another solution, but can have higher set-up costs. Is it worth adding CO_2? If CO_2 is low, the growth of plants will be affected, so adding CO_2 may accelerate growth. Dropping temperatures can save money and energy – about 3% for every 1 °F lower set point – but also slows growth and development. Can additional CO_2 compensate for growth at lower temperatures, and what is the cost of such a system and strategy?

Partnering with Don Schmidlin of Schmidlin Greenhouses in Delta, OH, we were able to test the first step to this strategy in a commercial setting. There are two essentially identical single-span, double poly houses at Schmidlin's, each 29 ft x 184 ft (5,336 sq. ft)In one, we set up a CO_2 controller ($599, model iGS-061 from www.specialtylights.com), a solenoid ($113, model SV122 from Omega: www.omega.com), purchased a tank of liquid

Figure 1. Sealing up gaps during the winter







CO_2 ($68 per tank, plus a one-time delivery fee of $15 from Airgas: www.airgas.com), set the CO_2 controller to maintain day-time CO_2 at a concentration of 500 ppm, and a temperature of 62 °F. The other greenhouse was left uncontrolled for CO_2, and a temperature set point of 65 °F.

Stock geranium plants were grown in both greenhouses, and five lettuce seedlings (for destructive harvest and comparison purposes) were put into each house. Then we waited. During this time, we measured CO_2 and temperature periodically in both houses. CO_2 in the uncontrolled house was between 200 and 300 ppm on sunny or partly-sunny days, and always at least 100 ppm lower and at least 3 degrees warmer than the controlled house.

A round of cuttings was the first data collected. Attempts were made to quantify total cuttings per pot and assess cutting quality. The cooler, CO_2 controlled house produced about 0.5 more cuttings per pot than the warmer, uncontrolled house, and the stem diameter of the cuttings in the cooler, CO_2-controlled house was noticeable larger. The lettuce plants were harvested later. Fresh and dry weight was substantially greater in plants from the cooler, CO_2-controlled house. There were also about 2 more leaves per plant in those plants, suggesting that development, even though they were grown in a cooler environment, was compensated by higher CO_2.

What was the cost, and since we were adding a "greenhouse gas" of CO_2, what was the environmental impact of this strategy? Using the online software Virtual Grower: (www.virtualgrower.net), we can estimate how much fuel was used in heating the two different greenhouses, and we know how much CO_2 was used for the heating season. Reducing the temperature by 3 °F saved $959 in propane over three months, assuming $2 per gallon cost, while adding CO_2 cost (including all parts, delivery, and three months of liquid CO_2) $931, or essentially a break-even for a single, 3-month season. The solenoid and CO_2 controller should last several years and could be scalable to different sized greenhouses. The additional fuel used in the warmer greenhouse contributed nearly 5,000 pounds more of CO_2 over this three month period than the cooler greenhouse, while the CO_2 addition added 1,200 pounds of CO_2 in the same time

period. So supplementing this cooler greenhouse with CO_2 actually contributed 3,800 pounds less CO_2 to the environment than the traditional production method.

These results are an encouraging step forward to design heating/control systems in a production environment in a more economical and environmentally friendly manner. The results in the case of CO_2 and environmental impacts may be counter-intuitive. The plants used in this test were vegetative (cuttings for propagation and lettuce production). We must do similar tests to determine if adding CO_2 can offset developmental delays for flower induction caused by cooler temperatures. In fact, a multi-disciplinary research effort has begun at Ohio State with Drs. Claudio Pasian, Peter Ling, Luis Canas, and Michelle Jones that is investigating this topic. As results continue to be collected, we will share strategies on managing the often ignored "problem" of tight greenhouses leading to CO_2 starvation.

Sustainable Solutions - Tag and Plastic Recycling Programs

By Roberto G. Lopez and Nora J. Catlin

Assist. Professor and Floriculture Extension Specialist and Floriculture Specialist

John Henry, a Multi Packaging Solutions Company, has partnered with Blackmore Corporation to promote recycling of styrene plant tags. In response to customer interest in sustainable print and packaging John Henry and Blackmore will offer customers a solution to their recycling concerns. The two companies have teamed up on a program that collects clean styrene tags and recycles them to produce plant trays. The program leverages John Henry's extensive customer base and Blackmore's state-of-the-art plastic molding capabilities to divert materials back into production that would otherwise end-up in a landfill.

To enroll in the program, customers are invited to contact Denise Herndon at (800) 874-8660 or trayinfo@blackmoreco.com.

The following companies recycle agricultural plastics. To arrange a pick-up, or for more information, contact them directly. If there is a minimum pick-up required, you may want to arrange with another grower to have their plastic picked up the same day.

Antek Madison Plastics Corporation
(www.antekmadison.com) is a plastics recycling company which will pick up pots, trays, bins, pallets, seed sacks, drip tube and nursery & greenhouse film. Contact the closest Antek Madison Plastics Corporation location to have a pick up arranged. Preparation guidelines apply – see below.

Jorge Farr Marshall
Antek Madison Plastics
8822 S. Dobson Avenue
Chicago, IL 60618
(773) 933-0900 Ext. 223
jorge@antekmadison.com

Universal Commodity Services Inc.
(www.ucsincny.com) will pick up pots, plug trays, flats, cell packs, nursery and greenhouse film, and nylon string. They deliver the plastic to domestic and foreign recycling wholesalers. Preparation guidelines apply – see below.

Arthur Akopyan
1421 Sheepshead Bay Road #264
Brooklyn, NY 11235
(347) 587-6158
aakopyan@ucsincny.com

Ag. Container Recycling Council
(www.acrecycle.org) facilitates the collection and recycling of one-way rigid HDPE plastic agricultural crop protection, specialty pest control, micronutrient/fertilizer, and/or adjuvant product containers

The Green Thumb Initiative
(www.newchristieventures.com) is a supplier of horticultural containers and has taken on the challenge of establishing an economical recovery and reprocessing system that can ensure that this set of resources can be reused. Industry members can sign up to participate as collection sites, back haulers, scrap generators and other supporting functions.

Stephen DePaolo, GTI
(203) 720-9478 x306
recoveryplastics@sbcglobal.net

East Jordan Plastics
http://www.eastjordanplastics.com/recycle.html is collecting used or obsolete growing containers to be recycled into new products. They are currently collecting PS, PP, and HDPE. Excess growing media and debris should be removed.

Material must be separated by type:

- Polystyrene: labeled with #6
- Polypropylene: labeled with #5
- High Density Polyethylene: labeled with #2
- No agricultural or greenhouse films
- Material must be palletized or baled
- Pallets should be stacked 90-100" tall

Pickup

- ½ truck load or more for EJP pickup
- Pickup can be coordinated with delivery of finished product
- Used containers can also be delivered to EJP
- Each pallet or bale must be marked with shipper's identification.

For further questions and advice on how you can participate please call: 800-353-1190 or send us an e-mail at nathan@ejplastics.com.

Preparation Guidelines:

Trays/pots should be shaken out, nested when dry and stacked on pallets 7 feet tall. To stabilize, shrink wrap or tie rope around each pallet. Approximately 26 pallets are needed to fill a trailer. If you do not have the minimum pick-up, arrange with another grower to have their plastic picked up the same day. All transportation is handled by Universal or Antek Madison. Nursery/greenhouse film should be taken off during a period of dry weather and should be kept from making contact with dirt. Film should be rolled and tied, or baled, producing easy to handle bundles, placed on pallets and kept clean and dry. (Film can be cut into pieces to facilitate handling.)

Kontos™: The First Systemic Miticide

By Dr. Raymond A. Cloyd

Associate Professor of Entomology

Twospotted spider mite, *Tetranychus urticae* is one of the most destructive mite pests of greenhouse-grown crops, and can become resistant to commercially-available miticides within a short period of time if miticides are not rotated properly based on mode of action. The miticides used by greenhouse producers to deal with twospotted spider mite populations have either contact or translaminar activity. Contact miticides include acequinocyl (Shuttle), fenbutatin-oxide (ProMite), clofentezine (Ovation), hexythiazox (Hexgon), pyridaben (Sanmite), bifenazate (Floramite), and fenpyroximate (Akari).

Those miticides with translaminar activity are abamectin (Avid), chlorfenapyr (Pylon), spiromesifen (Judo), and etoxazole (TetraSan). However, there has never been available a truly systemic miticide. Well, this has changed with the introduction of Kontos™, which is registered for use in greenhouses, nurseries, and interiorscapes. The product is labeled for "control" of spider mites, aphids, leafhoppers, mealybugs, and whiteflies. The active ingredient is spirotetramat (22.4% AI) and the mode of action is a lipid biosynthesis inhibitor (Mode of Action Group No. 23). The restricted entry interval (REI) is 24 hours.

Kontos™ is formulated as a soluble concentrate (SC) and is labeled for use on vegetable transplants. Kontos™ is a fully-systemic miticide and according to the label, the active ingredient moves through the xylem (water-conducting) and phloem (food-conducting) tissues with the active ingredient residing in new shoots and leaves. It is primarily active via ingestion and may potentially reduce the fecundity (the rate at which a female produces ovaries) of certain insect and mite females.

Kontos™ may be applied as a foliar spray or drench to the growing medium. In our studies, Kontos™ provided between 81% to 98% mortality of twospotted spider mite 7 to 14 days after application when applied as a drench to the growing medium. Based on the results, the active ingredient appeared to be more active on nymphs than adults. This may be due to the differential feeding behavior of nymphs and adults. For example, young adult females tend to spend more time moving than feeding whereas nymphs or larvae remain stationary, which may affect the amount of active ingredient ingested from plant tissues.

It is important to avoid using Kontos™ on a number of greenhouse-grown crops including geraniums, orchids, and ferns. Be sure to consult the product label for a complete listing of additional crops that Kontos™ should not be used on. For management of twospotted spider mite it is important to apply the product preventatively or when populations are first detected since Kontos™ will not "control" or reduce heavy populations of twospotted spider mite. Furthermore, for "control" of mealybugs, it is recommended to make two foliar applications at 14 to 21 day intervals so as to kill nymphs that emerge from eggs.

Thielaviopsis Management Becoming More Critical

By Margery L. Daughtrey

Senior Extension Associate

Similarly to last year, we saw far too many cases of black root rot caused by the fungus *Thielaviopsis basicola* in *calibrachoa*, petunia, pansy and diascia this spring (Figure 1). What has changed to bring about the escalation in the incidence and severity of this disease?

In many cases, it appears that the plug trays have been the source of the inoculum. When plugs are brought in from another operation, this may mean that another grower's *Thielaviopsis* problem is being transferred to your greenhouse. If you seeded your own plugs, the appearance of *Thielaviopsis* root rot may be due to the recycling of fungus inoculums from your disease problem of last year. Once you have this pathogen in your greenhouse it is hard to get rid of it. The fungus forms darkly pigmented survival spores that last for a long time in

soil or in debris on pots or trays. These spores are not easily eradicated except by steam pasteurization: they can shrug off a quick dip in disinfestant if they are hiding within root fragments at the bottom of plug compartments.

In order to reduce plastic debris and save dollars, many plug producers have switched to recyclable plug trays. The organic matter clinging to the trays needs to be physically removed with strong jets of water prior to treatment in disinfectant (quaternary ammonium or hydrogen peroxide type materials, for example, are registered for this use).

Ideally, plug trays known to be contaminated with *Thielaviopsis* should be discarded, or set aside for special scrubbing. Cleaned trays known to have been once contaminated with *Thielaviopsis* should be re-used on a crop not known to be highly susceptible to black root rot (which would exclude pansy, viola, *Catharanthus*, diascia, petunia or *Calibrachoa*). This extra precaution is rarely practical.

Cultural and chemical protection is the only recourse once a crop is known to be under assault by *Thielaviopsis*. Culturally, keep the mix pH at pH 5.6 or below in order to inhibit black root rot. High pH will encourage the disease, as will poor drainage. Fungus gnats are known to move the fungus from place to place, so throw out the diseased plants as they are detected. Leaving them in place provides a breeding ground for fungus-bearing fungus gnats.

Fungicide drenches are the other insurance against the black root rot disease. We have conducted several experiments at the Long Island Horticultural Research & Extension Center to study the benefits of different fungicide drenches, and will have a new study underway shortly. In a 2005, *Calibrachoa* study, Heritage gave no benefit and the 2.0 oz/100 gal rate of Medallion did not give statistically significant control, although it gave control on pansy in another 2005 trial. The 16.0 oz/100 gal rate of Cleary 3336 (one of the thiophanate-methyl containing materials along with OHP 6672 and Banrot) gave excellent control of stunting and wilting, and also apparently reduced the formation of the resistant spore structures in the calibrachoas' roots. Alude at 12.5 oz/100 gal, PlantShield at 5.0 oz/100 gal and Terraguard at 4.0 oz/100 gal all reduced stunting significantly; of these, Terraguard at 4.0 oz/100 gal did the best job of preventing wilting. A preventive program should include thiophanate-methyl, alternating it with triflumizole (Terraguard) and fludioxonil (Medallion) or other materials with demonstrated effectiveness. (Alude is not labeled for *Thielaviopsis* control). Protective fungicide treatments should be made to plugs of highly vulnerable species in greenhouses where the disease has historically been a problem.

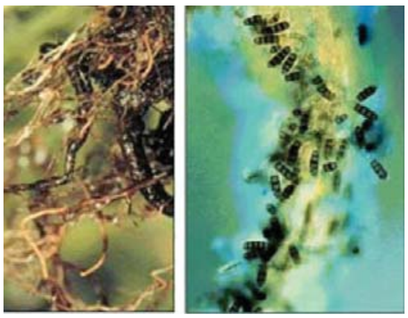


Figure 1. Characteristic black lesions and microscopic close up (source unknown).

Upcoming 2009 Industry and University Events

Date	Event	Location	Speaker/ Topic	Web site/ Email
July 11 - 14	OFA Short Course	Columbus, OH	Education and Trade Show	http://www.ofa.org/shortcourseinfo.aspx
July 15 – Aug. 28	Raker Trial Gardens	Litchfield, MI	Trial garden	http://trialgardens.raker.com/
Aug. 3-14	Michigan Garden Plant Tour	Throughout MI	Display gardens	http://www.hrt.msu.edu/planttour/default.htm
Aug. 4	MSU Garden Plant Showcase	East Lansing, MI	Educational and garden tour	http://www.hrt.msu.edu/planttour/MSU_showcase.htm
Aug. 20 - 22	Farwest Show	Portland, OR	Education and Trade Show	http://www.farwestshow.com/
Aug. 25	Proven Winners' Outdoor Living Extravaganza	Foxboro, MA	Retreat and Seminars	http://www.provenwinners.com/ce_index.cfm?OutdoorLiving
Sept. 20 - 22	Perennial Production Conference	Buffalo, NY	Educational	http://www.ofaconferences.org/
Oct 5	IFGA Meeting	West Lafayette, IN	Golf, banquet, tour & educational sessions	https://sharepoint.agriculture.purdue.edu/agriculture/flowers/events.aspx
Oct 7 – 8	Canadian Greenhouse Conference	Toronto, Canada	Education and Trade Show	http://www.canadiangreenhouseconference.com/
Nov. 12	NWIFA Meeting	Maday's Greenhouse, Crete, Il	Roberto Lopez	http://faculty.pnc.edu/emaynard/nwifa/nwifa.html

National Poinsettia Trials

http://www.poinsettiatrial.org

North Carolia State U.	Purdue University	U. of Florida
Industry Open House	Grower Open House	Grower Day
December 2, 2009	December 4, 2009	December 8, 2009
9:00 am to 2:00 pm	9:00 am to 3:00 pm	9:00 am to 3:00 pm

Contributors

Nora J. Catlin
Floriculture Specialist
Cornell Cooperative Extension
423 Griffing Ave.
Riverhead, NY 11901
(631) 727-7850 ext 214
njc23@cornell.edu

Ray A. Cloyd
Assoc. Professor of Entomology
Kansas State University
Department of Entomology
239 W. Waters Hall
Manhattan, KS 66506
(785) 532-4750
rcloyd@ksu.edu

Margery L. Daugherty
Cornell University
Department of Plant Pathology
Cornell Cooperative Extension
423 Griffing Ave.
Riverhead, NY 11901
mld9@cornell.edu

Jennifer H. Dennis
Assoc. Professor and Specialty Crop
Marketing Extension Specialist
Purdue University
Department of Horticulture & Landscape
Architecture
625 Agriculture Mall Dr.
West Lafayette, IN 47907
(765) 494-1352
jhdennis@purdue.edu

Bernie Ferringer
North Manchester Greenhouse
507 State Road 13 West
North Manchester, IN 46962
bernie.greenhouse@gmail.com

Brian A. Krug
Floricture/Greenhouse Extension
Specialist
University of New Hampshire
UNH Cooperative Extension
Spaulding Hall, G54
(603) 862-0155
brian.krug@unh.edu

Roberto G. Lopez
Assist. Professor and Floriculture
Extension Specialist
Purdue University
Department of Horticulture & Landscape
Architecture
625 Agriculture Mall Dr.
West Lafayette, IN 47907
(765) 496-3425
rglopez@purdue.edu

Claudio C. Pasian
Associate Professor
The Ohio State University
Department of Horticulture and Crop
Science
249B Howlett Hall, 2001 Fyffe Court
Columbus, OH 43210
(614) 292-9941
pasian.1@osu.edu

Joyia T. Smith
Masters Degree Candidate
Purdue University
Department of Agricultural Economics
403 W. State Street
West Lafayette, IN 47907
765-494-4191
smith_joyia@yahoo.com

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