



Bulletin

The Information Source for the Floriculture Industry Since 1929

CIRCULATE

Insect and Mite Problems on Bedding Plants

Ray Cloyd
 University of Illinois
 Department of Natural Resources
 & Environmental Sciences
 384 National Soybean
 Research Lab
 1101 W Peabody Lab
 Urbana, IL 61801
 217-244-7218
 Fax: 217-333-4777
 rcloyd@uiuc.edu

Bedding plant season is always a busy time of year as greenhouse managers concentrate on growing and selling the crop. During these times, pest management is generally not a top priority. However, by incorporating pest management into the daily schedule,

greenhouse managers will have a better handle on the insect and mite pests attacking bedding plants – thus avoiding having to deal with high insect and mite populations later on. The key insect and mite pests of bedding plants are aphids, thrips, fungus gnats, shoreflies, whiteflies, and spider mites.

APHIDS

Aphids are small (approximately 1/25 to 1/10 inches long), soft-bodied insects that possess tubes (cornicles) on the ends of their abdomen. Because of their rapid reproductive ability they can create tremendous population

explosions within a short period of time – which results in aphids spreading quickly among bedding plants. This will occur more rapidly if plants are spaced close together. Aphids feed on new terminal growth and on leaf undersides. Aphid feeding results in young or new leaves curling downward. They may also stunt plants if populations are high enough. As they feed, aphids produce a clear sticky liquid material called honey-

dew, which serves as a growing medium for black sooty mold fungi. This can reduce a plant's aesthetic appearance.

THRIPS

Thrips are very tiny (less than 1/13 inch long) insects with piercing-sucking mouthparts. Thrips feed on flowers and leaves. However, they primarily feed in flower buds, which may prevent flowers from opening, cause premature bud abortion or flower deformation. They

Continued on page 10

THE NEW WORLD OF SHIPPING PLANT MATERIAL







Allen R. Pyle
 C. Raker & Sons Inc
 10371 W. Litchfield Road
 Litchfield, MI 49252
 517-542-2316
 Fax: 517-542-2565
 allenpyle@raker.com



Shipping is obviously an important consideration when producing ornamental plants, regardless of whether a grower is producing plugs/liners, pre-finished, or finished material. The most beautiful crop that leaves your facility is of little or no value to the purchaser if it doesn't arrive in good shape.

Continued on page 13

JANUARY 2002

	INSECT AND MITE PROBLEMS ON BEDDING PLANTSPAGE 1
	THE NEW WORLD OF SHIPPING PLANT MATERIAL.....PAGE 1
	CHANGING TIMES.....PAGE 2
	SAVING EVERY LAST PENNY ON YOUR ENERGY BILL.....PAGE 3
	THE PROS AND CONS OF GROWING PLANTS COOLERPAGE 5
	DISEASES OF BEDDING PLANTS.....PAGE 15

OFA

An Association of Floriculture Professionals

Our mission is to assist the floriculture industry in being competitive, profitable, and responsive to its needs.

(As adopted by the OFA Board of Directors 2/18/01)



OHIO FLORISTS' ASSOCIATION

SPONSORS OF THE SHORT COURSE®

U.S. Floriculture's Premier Educational and Trade Show Event

2130 Stella Court, Suite 200

Columbus, Ohio 43215-1033 USA

614-487-1117 Fax: 614-487-1216

e-mail: ofa@ofa.org home page: www.ofa.org

BULLETIN

VOLUME 865 • JANUARY 2002

EDITORIAL STAFF

MICHELLE GASTON
Editor

LAURA KUNKLE
Managing Editor

CHERYL CUTHBERT
Managing Editor

STEPHEN CARVER
Technical Editor

PETER KONJOIAN
Technical Advisor

DENNIS KIRVEN
Executive Director

CONTRIBUTORS

RAY CLOYD

JOHN E. ERWIN

PETER KONJOIAN

NEIL MATTSO

MICHAEL J. MCDONOUGH

STEVE G.P. NAMETH

ALLEN R. PYLE

RYAN M. WARNER

Copyright® Ohio Florists' Association 2002.

Permission is hereby given to reprint articles appearing in this Bulletin provided the following reference statement appears with the reprinted article: "Reprinted from the Ohio Florists' Association Bulletin, (phone: 614-487-1117) Number 865, January 2002."

No endorsement is intended for products mentioned in this Bulletin, nor is criticism meant for products not mentioned. The authors and Ohio Florists' Association assume no liability resulting from the use of practices printed in this Bulletin.

CHANGING TIMES

*Michelle Gaston
Ohio Florists' Association
2130 Stella Court, Suite 200
Columbus, OH 43215
614-487-1117
614-487-1216
mgaston@ofa.org*



It is that time of year again for me to write the forum. Have I ever told you before that writing is not my favorite thing in the world to do? I'm more into the graphic aspect of OFA's publications, like making sure the articles fit, the lines break cleanly, and the photos have something to do with their articles.

So, I'm sitting here today on deadline and trying to crank something out. Can I use the excuse that I did it and then a computer virus destroyed my article? Anyway, I'd better get on with this article so I can cross it off my to do list and then enjoy the holidays.

9-11 EVENTS

First of all, all of our hearts go out to those affected by the events of September 11. The recent events have contributed to the country's recession. I know this sounds bad for the United States, but from the industry magazine articles I've been reading (not from personal experience) our industry has prospered during past economic downturns. I think the theory is that people aren't traveling and aren't making big single-item purchases so they spend more money around their homes on lawn and garden products.

Gardening is already America's #1 leisure pastime. Just think if even more people turn to this hobby. I have great hope for this industry during this recession. So, don't cut short what you are growing or what you are ordering for your garden center. Yea, like you'll take the advice of the *OFA Bulletin* editor. I'm sure you wouldn't want to miss sales because you were a pessimist. Let's be optimistic and say that 2002 is going to be a great year for our industry.

OFA'S EXECUTIVE DIRECTOR

You have all probably heard by now that Dennis Kirven is retiring from the leadership of OFA on April 1. Dennis started at the Association January 1, 1993 (which happened to be my start day too). The Association has come a long way under Dennis' leadership. The *Bulletin* has gone from 8- or 12-page, two-color issues to 16-pages with half the issues being full color. We've also added two newsletters, the quarterly *FirstNews*, and the *Exhibitor Connection*.

During Dennis' tenure the Short Course has increased in attendance from 5,450 to 10,277. The Trade Show has grown from 355 companies in 585 booths to 521 companies in

1,218 booths. During the last few years we've been cooperating with other industry associations and doing more outreach programs for our members. These are just a few of the accomplishments OFA has achieved with Dennis' guidance.

Thank you Dennis for all that you have done for this Association and the floriculture industry ... you will be missed.

Our new executive director, John Holmes, will start at the Association in mid February. John comes to us with leadership experience in the association industry and should be able to take OFA to the next level. We will learn more about John in a future *OFA Bulletin*, and please watch for him out and about at industry meetings.

BPI

This month we want to welcome about 300 new readers to the *OFA Bulletin*. The "new readers" were formally BPI members. When BPI dissolved their organization in July 2001, OFA extended a hand and offered a home for their displaced members. OFA will provide a complimentary one-year membership for all BPI members who were not already active OFA members. Please enjoy this gift and take advantage of all the OFA benefits.

WWW.OFA.ORG

Did you know that you can now access this current *OFA Bulletin* as well as past ones on-line? Since you are an OFA member you can do just that through OFA's web site. Pull up www.ofa.org on your internet browser to see how it has changed during the last year. To enter the "Members Only" section in the lower left-hand corner of the screen, type in your membership identification number (located on your *Bulletin* label) and your password which is the first letter of your first name and then your last name (mine would be mgaston). In this section, among other things, you can view *OFA Bulletins*



and easily locate fellow OFA members by name, company, and city. Hopefully you will find this information a benefit to your OFA membership.

OFAS PUBLICATIONS

Just a quick note about our OFAS books. Last year we printed two new books that were released at the Short Course. Those books were: *Tips on Regulating Growth on Floriculture Crops* and *Tips on Managing Problems in the Interior Plantscape*. This year we are updating *Tips on Managing Floriculture Crop Problems* and each company that has an OFA membership will receive one complimentary copy in late winter. We have one more book that we are working on that is targeted to be released at Short Course – *Tips on Designing, Growing, and Marketing Mixed Baskets and Containers*. This should fill a void in the industry and support OFA's educational mission.

WE WORK FOR YOU

As you probably know, OFA is a member-driven association. We have about 25 committees that meet with us at least once a year to represent you and your needs. Our publications committee is made of 12 industry representatives who plan and critique OFA's publications. Those dedicated committee members are: Bridget Behe, Kathy Benken, Ali Cybulski, David Hale, Susan Hamilton, Debbie Hamrick, Matt Hopkins, Nona Koivula, Peter Konjoian, Claudio Pasion, Josh Schneider, and Kim Williams. These committee members represent all segments of the floriculture industry. If at anytime during the year you have suggestions for the *Bulletin* or other OFA publications please contact one of the above committee members or me (mgaston@ofa.org).

Keep your chin up, and with everyone working together, this industry can have a prosperous year. Have fun and enjoy 2002!

OFA

Editor's Note: This is a clarification of a statement made in Peter Konjoian's December 2001 *Bulletin* forum.

"Blooms of Bressingham (BOB) material is not provided from offshore locations. All of our propagators licensed to supply growers are located in the U.S.A.

"The only offshore connection is that BOB in the United Kingdom does send plants of potential new cultivars for us to trial and introduce if we feel they have market potential.

"One time, some tissue culture plantlets of a variety were purchased from a European lab when additional product was needed." – Bill Aulenbach, Blooms of Bressingham, North America Marketing

Saving Every Last Penny on Your Energy Bill

Peter Konjoian
Konjoian's Floriculture
Education Services
48 Brundrett Ave
Andover, MA 01810
978-683-0692
Fax: 978-683-6962
peterkfes@aol.com

During last winter's spike in natural gas and oil prices you could hear growers from all corners of the country make one, unified observation: "Here we go again". These were the growers who have been in business long enough to remember the energy crisis of the 1970s.

During that challenging period, we put our noses to the grindstone and developed double poly over glass, heat curtains, and cultivars that cropped faster.

The cover article in last September's *Bulletin* was titled "Winter's Coming." It

was written by Al Zylstra of Trueleaf Enterprises, better known to many of us as the company that brought Biotherm root zone heating to our greenhouses. We asked Al to provide a checklist of things growers could do during the fall season to ensure optimal energy

Continued on page 4

SAVING EVERY LAST PENNY ON YOUR ENERGY BILL

Continued from page 3

efficiency during the current heating season.

The point in the article that caught my attention was that gravity stack unit heaters allow 10 to 13 percent of the heater's output to escape through the chimney. Every grower should be considering induced draft technology. The point Al made was that most growers go for the least expensive heater available when building a greenhouse, and they fail to balance the fuel consumption differences and payback for the initial investment of induced draft units. I looked in the mirror after reading the article and somehow heard the mirror say "guilty as charged." My father and I had a good conversation and agreed to turn the corner and start upgrading, first in our year-round greenhouses.

THE SURVEY SAYS ...

Today's article will update readers on how growers have responded to that September article. After all, if January has arrived and nothing has been done, complaining about high gas and oil prices will fall on deaf ears, right? A quick e-mail survey was conducted in early December asking growers what steps they took between last year's price spikes and now in order to conserve dollars.

Ten growers were invited to participate. Seven were able to respond during their poinsettia-shipping season. Responding were: Joe Boarini of Grande Greenhouse in Indiana, Bruce Bordine from Bordine Nursery in Michigan, Doug Cole from DS Cole Growers in New Hampshire, Tim Donahue of Donahue's Greenhouse in Minnesota,

P.J. Ellison-Kalil from Ellison's Greenhouse in Texas, Bob Frye of The Plantation in Nebraska, and Bill Swanekamp of Kube-Pak in New Jersey.

As the responses criss-crossed the Internet and arrived in my office, a common theme became apparent immediately. Several mentioned that they have been involved in continuous, long-term efforts to conserve energy since the '70s. Several of the group reported that there was nothing earth shattering in their preparation for this season. In effect, they reported that they have been on top of this issue for years. Here are their comments.

One grower has replaced some old unit heaters with more efficient units since last spring. He also reported holding off on his final poinsettia spacing until early October to reduce the amount of space being heated.

Another grower reported the following list of things he's been concentrating on for many years, not just as a result of last year's energy price increases. He tries to install a double curtain system; one is for both shade and nighttime heat retention, and the second is transparent and strictly for heat retention. Boilers have been fitted with dual fuel capability to take advantage of the cheapest fuel available. A recently purchased gas boiler was equipped with fully modulating gas capability, which adjusts the fuel consumption continuously to maintain constant water temperature efficiently.

This grower also reported purchasing Priva's "Supervision" environment

control software to fine-tune this aspect of his greenhouse. Natural ventilation is being used in new construction to reduce cooling costs. Lastly, natural gas prices have recently been deregulated in his state, which has improved his buying position.

Three of the responding growers reported that their biggest effort has been to contract their natural gas prices well out in the future. One has locked in for the 2003 season already! He began his comments by stating that he maintains a very "tight" structure and has installed very efficient heaters.

1973 OIL EMBARGO MEMORIES

Another of our group reported that, since the 1973 oil embargo, he and his family have embarked on a long-term energy conservation plan, which hasn't changed in 28 years. Bottom heat has been installed in all 16 acres of the range, making it possible to maintain optimal root temperatures while allowing air temperatures to be run cooler. This was cited as the single most important step he's taken. Heat curtains were installed and mentioned as the next most important step that was taken during this period. This operation is run by Q-Com, and it was reported that the curtain material with the highest heat retention was installed even though it also provides close to 100 percent shade. Through progressively closing the shade during the summer, this grower has learned to cool the range without diminishing crop quality.

The third step taken was to install dual fuel capability in as many boilers as possible. Cited as an expensive undertaking, this task has been stretched out over the last 15 years and only a few units remain to be converted. Lastly, this grower pays strict

attention to current events to anticipate fuel price changes. As much as he can, he tries to stay abreast of OPEC's antics in an attempt to prevent getting blindsided.

Another grower reported going to every one of the company's major buyers to show how the fuel increase would impact growing costs and how prices would have to increase to cover the added fuel cost. Heating and venting systems were re-examined; the company's hazard fund was tapped to upgrade these systems. In anticipation of another tough year, budget cuts have been implemented – 10 percent on the expenses and 5 percent on labor. This grower has even taken a 10 percent personal salary cut. Salaried staff is being asked to perform hourly functions, and overtime has been put on hold.

This grower reported aggressively pursuing new markets in the independent garden center and interiorscape sectors. Production is shifting to more color such as perennials and mixed containers, while traditional potted and foliage production is being de-emphasized. True to this grower's personality, comments ended by noting that the current climate in floriculture may be the best thing that's happened to the family business in some time, because it's forcing everyone to focus more on consumer demand rather than producer supply.

The last grower stated that he learned from his father how to conserve on heat and has been energy conscious for quite some time. He has the usual checklist of chores to tighten the range before the heating season and also has dual fuel capability and uses it to his advantage. He drew an interesting analogy by

suggesting that while current fuel prices are low, a recessionary economy is having a greater impact on sales than last year's high fuel prices coupled with a healthier economic atmosphere. In his words, "I would gladly pay a little more for fuel right now to have my sales numbers back to normal."

MORE ON TEMPERATURE

Accompanying this article is one written by Ryan Warner at the University of Minnesota on cool growing temperatures. We included

this topic because word got out last spring that too many growers reacted to the energy cost increases by lowering thermostat settings. While a degree here and there is okay, turning the thermostat back also turns the clock in the same direction and crop development is affected. This would be acceptable if anticipated by earlier planting, but last year's scenario was that temperatures were lowered midstream and many crops failed to flower on time. For many, it wasn't that cool to grow cool.



MY COMPLIMENTS TO OUR PARTICIPANTS

So there you have it. This group of conscientious growers was able to survive the energy crisis of last season in part because they have been upgrading their ranges for years. What a refreshing, proactive approach to dealing

with a recurring challenge like energy efficiency. They couldn't do much of anything this fall, because they have been doing things all along. A tip of my hat to them. Now for the final question ... how are **you** doing on this front?

OFA

THE PROS AND CONS OF GROWING PLANTS COOLER

**Ryan M. Warner, John E. Erwin,
Michael J. McDonough, and Neil Mattson**

*Department of Horticultural Science
University of Minnesota
1970 Folwell Ave
Saint Paul, MN 55108
612-624-0736
Fax: 612-624-4941*

It is estimated that approximately 80 percent of the cost of heating a greenhouse is incurred at night. Given the long nights of winter, heating costs are clearly a major cost in plant production in the north. The dramatic increase in fuel prices last winter caught many people off-guard and reduced profits for many greenhouse growers. The forecast for fuel costs this winter and beyond is uncertain, but it is likely that the higher fuel prices will be with us for some time. The bottom line is that many growers are deciding whether to lower greenhouse temperatures. Lowering greenhouse temperatures will reduce heating costs, but will likely increase production times. This article will weigh the pros and cons of lowering greenhouse temperatures and provide an idea of what impact cooler temperatures will have on crop quality, timing, and pest control. Specifically, we will discuss how temperature impacts seed germination, plant development rate, plant quality characteristics such as flowering and branching, insect and disease incidences and control, and whether the increased production times under cooler temperatures will minimize the savings growers are hoping to realize by reducing greenhouse temperatures. We will also discuss ways to physically save on heating costs.

IMPACT ON PLANTS

Seed Germination – It is critical to provide appropriate temperatures during seed germination! Seed germination and early seedling establishment is one of the most temperature-sensitive stages of plant development. Temperatures too warm or cool during seed germination will delay germination, reduce the percent of germination and decrease the uniformity in germination time. Also, cool temperatures (<70°F) can promote damping off diseases, such as *Pythium* spp.

For most species, germination media temperature should be maintained between 72 and 76°F. When your crop is established and actively growing, most species are much more tolerant of cool temperatures than at the seed germination stage. It is important to remember that 1) the temperature on the floor can be 10 to 20°F cooler than at bench level, and 2) on clear nights, plant temperature is lower than air temperature. Never place seed trays on the floor! For these reasons, **do not try to save money by dropping temperatures during this stage!**

Plant Development Rate – Plant development rate (i.e. leaf unfolding rate) is dependent on the average daily temperature at which plants are grown. Leaf unfolding rate increases as average daily temperature increases (Figure 1). Above a given maximum temperature, leaf unfolding rate declines. Therefore, plants will come into flower earlier when grown under a warmer temperature regime compared to a cooler temperature regime to a point. However, growing plants "too hot" will increase production time!

We conducted research at the University of Minnesota on the effects of temperature on time to flower of a few major bedding plant crops (Table 1, page 6). The impact of reducing

Continued on page 6

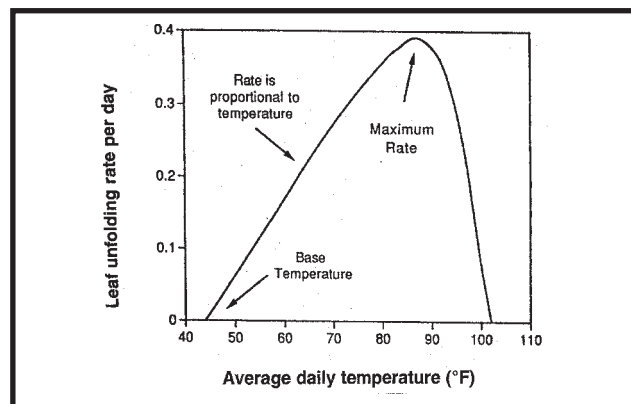


Figure 1. Leaf unfolding rate in response to temperature (Erwin, 1995).

THE PROS AND CONS OF GROWING PLANTS COOLER

Continued from page 5

temperature on days to flower differed across species (Figure 2). That is, growing plants cooler increased production time of some crops more than others. For instance, decreasing temperature from 68 to 61°F increased days to flower for *Impatiens* 'Super Elfin Lipstick' from 54 days to 72 days, an increase of 18 days. In contrast, decreasing temperature from 68 to 61°F increased days to flower for *Petunia* 'Purple Wave' from 57 to 88 days, an increase of 33 days! Most of you are probably considering lowering your greenhouse temperature less than the 7°F of this experiment. Still, each 1°F decrease in temperature will delay 'Purple Wave' flowering by approximately three days (Table 1). Would it be cheaper to keep your temperature higher and decrease your production time, or lower the temperature and increase production time? This, in part, depends on the operating cost of your facility.

Temperature also impacts rate of development from visible bud to flower opening. For example, as temperature increases from 55 to 75°F, days from visible bud to flower opening of Easter lily decreases from 42 to 27 days (Figure 3). A general "rule of thumb" is that there is little benefit in increasing average daily temperature above 72°F with any crop.

Disease Pressure – One very important consideration when producing plants under cool temperatures is the potential for increased disease pressure. This is the result of three things: 1) some pathogens are more active at cool temperatures; 2) plants, benches, and floors stay wet longer after each watering when temperatures are lower, providing a larger window for pathogen spores to germinate; and 3) plant health of some species is weakened.

Diseases caused by *Pythium*, *Rhizoctonia* and *Thielaviopsis* are promoted under cool temperatures. For instance, damping off caused by *Pythium* is most severe at 53 to 68°F (Nameth, 2001). Damping off diseases are not the only diseases promoted by cool temperatures. *Thielaviopsis* is the pathogen that causes black root rot and, unfortunately, is becoming a more common problem for pre-finished plants, particularly pansies, vinca and petunias. *Thielaviopsis* can be a problem under either cool or warm temperatures, but *Thielaviopsis* activity is reportedly optimal at 62°F (Nameth, 2001). Another widespread disease promoted by cool temperatures is gray mold, caused by *Botrytis*. *Botrytis* is a problem for pre-finished plants and is favored by cool temperatures. Previous research has identified that 71°F is optimal for *Botrytis* growth, and 59°F is optimal for *Botrytis* spore production (Nameth, 2001).

When plants are grown cool, they typically require less water than when they are grown warmer. Therefore, each time you water, the media will stay wet longer, and any standing

Table 1. Effect of temperature on the number of days to flower for *Impatiens wallerana* Hook f., *Petunia x hybrida* Hort., and *Viola x wittrockiana* Gams. (pansy) cultivars. Plants were grown in the reported temperatures from when the cotyledons expanded to when the first flower opened (Mattson and Erwin, unpublished data).

Cultivar	54°F	61°F	68°F	75°F	Delay in Flowering if 24-hour Temperature is Reduced 1°F (days)*
<i>I. wallerana</i> 'Super Elfin Lipstick'	–	72	54	47	1.8
<i>P. x hybrida</i> 'Avalanche Pink'	88	74	47	39	2.5
<i>P. x hybrida</i> 'Dreams Rose'	84	67	46	37	2.3
<i>P. x hybrida</i> 'Purple Wave'	112	88	57	45	3.3
<i>V. x wittrockiana</i> 'Colossus Yellow Blotch'	95	82	63	58	1.9
<i>V. x wittrockiana</i> 'Crystal Bowl Supreme Yellow'	72	63	51	46	1.3
<i>V. x wittrockiana</i> 'Delta Pure White'	88	71	61	53	1.6
<i>V. x wittrockiana</i> 'Sorbet Blackberry Cream'	68	60	50	45	1.1

* for temperatures between 54 and 75°F
 – plants died in this treatment

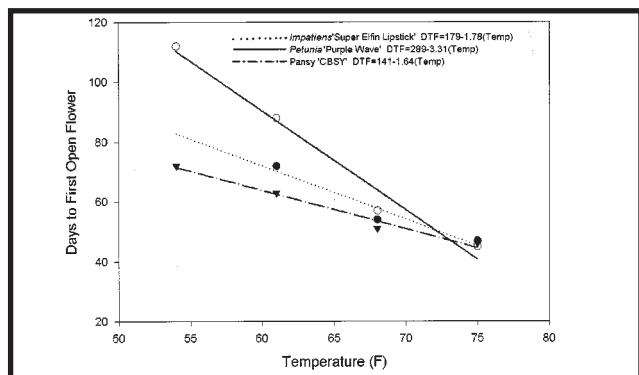


Figure 2. Impact of temperature on days to flower of three bedding plant species (Mattson and Erwin, unpublished data).

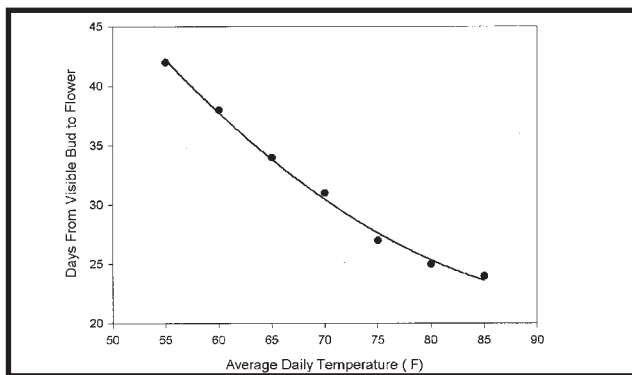


Figure 3. Easter lily 'Nellie White' reduction in time from visible bud to flower opening under increasing temperature (Erwin and Heins, 1995).

water will take longer to evaporate. Combined, these two factors can increase the root rot disease pressure on plants. Many diseases require standing water for spores to germinate. Keeping greenhouses cool will increase the opportunities for diseases to become established. It is very important to actively scout for diseases and have a plan for applying fungicides ready before the need arises.

Here are some suggestions for reducing disease severity when growing under cool temperatures (Nameth, 2001):

1) Don't place seed flats/seedlings on the floor. Floor temperature can be 10 to 20°F cooler than the air temperature a few feet off the ground. Also, having flats on the floor increases the amount of time that free-standing water is present, creating germination opportunities for fungal spores. Raising flats off of the floor even a few inches will raise temperature and reduce direct contact with standing water.

2) Keep floors and benches as dry as possible.

3) Keep air circulating. Keeping air moving at all levels of the greenhouse, not just at bench level, will reduce the length of time you have standing water after each watering.

4) Use active bottom heating if possible. Heating of seed trays to the appropriate temperature will reduce disease severity by promoting actively growing plants and by raising the temperature above the optimum for damping off disease growth. If you do not already have under-the-bench heating, you may want to consider heating pads. They are expensive to install, but they can serve as a long-term strategy to reduce heating costs.

Keep in mind that chemical activity is reduced at lower temperature. Therefore, it may take longer to see results of an insecticide/fungicide application. It is important that you don't increase the amount of chemical applied.

Insect Control – Temperature is the greatest factor determining



the development rate of insects. Cool temperatures slow the life cycle of insects (Table 2). For example, decreasing temperature from 80 to 55°F increases fungus gnat life cycle time (from egg to adult) from 12 to 27 days (Lindquist, 1998). Similarly, decreasing temperature from 86 to 68°F increases Western flower thrips life cycle time from 16 to 31 days (Robb, 1989). Therefore, you may need to increase the amount of time between pesticide applications to maintain the same number of applications during a single life cycle.

Flowering – One positive impact of reducing greenhouse temperature is that flower size and flower number often increase as greenhouse temperatures decrease. For example, decreasing temperature from 76 to 59°F increases flower diameter of chrysanthemum 'Bright Golden Anne' (Figure 4, page 8). Flower number per inflorescence of zonal geranium 'Veronica' increases from approximately 15 to 50 flowers as temperature decreases from 85 to 54°F (Figure 5, page 8). Similarly, decreasing temperature from 77 to 59°F increased Fuchsia 'Dollar Princess' flower number per inflorescence from three to six flowers and increased flower width from 46 to 77 mm.

Branching – Another potential positive aspect of reducing greenhouse temperature is increased plant quality due to increased branching. For example, in Fuchsia 'Dollar Princess' single stem pinched cuttings, decreasing greenhouse

Continued on page 8

Table 2. Impact of temperature on life-cycle duration of common greenhouse insect pests.

Insect	Impact of temperature on time from egg to adult	Reference
Aphid – Green Peach*	Increases from 6 to 20 days as temperature decreases from 68 to 50°F	El Din, 1976
Aphid – Cotton/Melon*	Increases from 7 to 10 days as temperature decreases from 77 to 68°F	van Steenis & El Khawass, 1975
Fungus Gnats	Increases from 12 to 27 days as temperature decreases from 80 to 55°F	Lindquist, 1998
Shore flies	Increases from 10 to 16 days as temperature decreases from 93 to 73°F	Lindquist, 1998
Spider Mite – Two Spotted	Variable, but generally increases from 8 to 28 days as temperature decreases from 86 to 59°F	Lindquist, 1998
Thrips – Western Flower	Increases from 7 to 13 days as temperature decreases from 98 to 62°F	Robb, 1989
Whitefly – Greenhouse	Approximately 21 to 26 days at 81°F and 32 to 39 days at 65 to 75°F	Lindquist, 1998 & Sanderson, 1998
Whitefly – Silverleaf	Increases from 16 to 31 days as temperature decreases from 86 to 68°F	Lindquist, 1998

* Aphids do not reproduce by eggs. Reported times are from birth to adult.

THE PROS AND CONS OF GROWING PLANTS COOLER

Continued from page 7

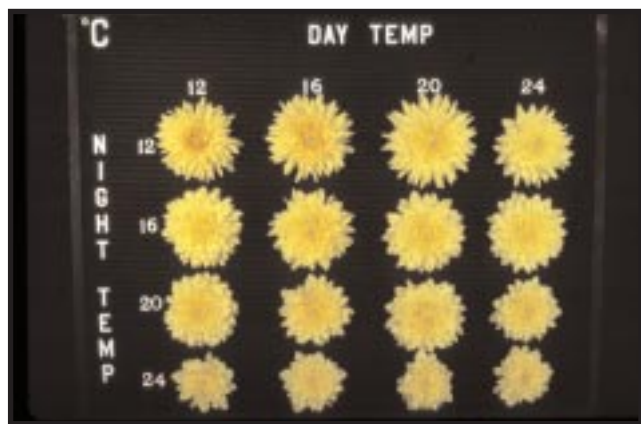


Figure 4. Effect of day and night temperature on flower diameter of *Dendranthema x grandiflora* 'Bright Golden Anne' (12°C=54°F, 16°C=61°F, 20°C=68°F, 24°C=75°F).

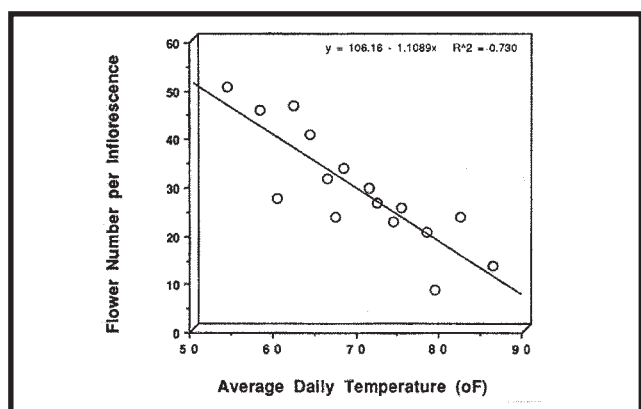


Figure 5. Impact of temperature on number of flowers per inflorescence of zonal geranium 'Veronica' (Erwin and Heins, 1992).

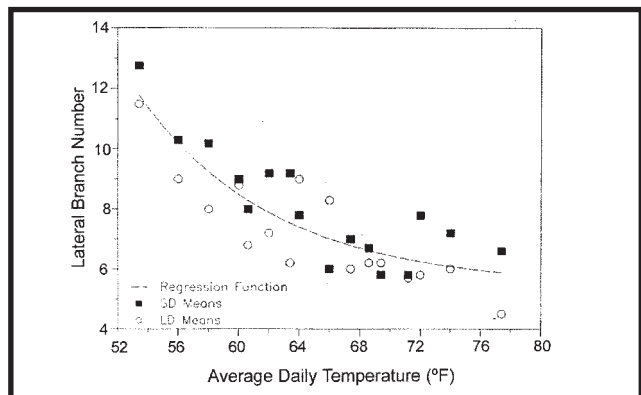


Figure 6. Impact of temperature on number of later branches at flowering for *Fuchsia* 'Dollar Princess' (Erwin et al, 1991).

Figure 7 (right). Internode length of Easter lily 'Nellie White' increases as the difference between day temperature (DT) and night temperature (NT) increases (Erwin and Warner, 1999).

temperature from 72 to 55°F increased lateral branch number at flowering from 6 to 12 branches (Figure 6).

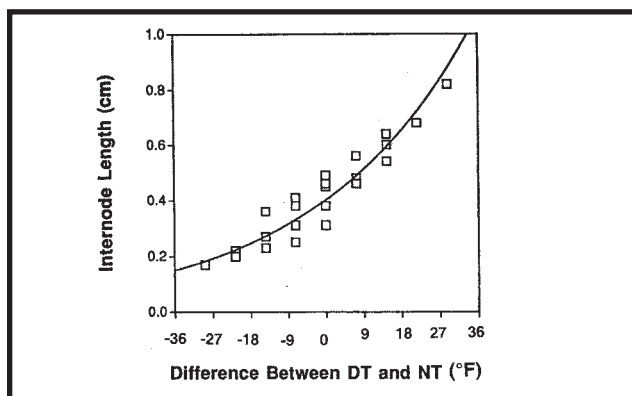
Dry Weight – Decreasing night temperature while maintaining the same day temperature increases plant dry weight, an attribute of plant quality. For example, for New Guinea impatiens 'Mimas' grown at a day temperature of 77°F, decreasing night temperature from 77 to 59°F increased total stem dry weight from 6.3 g to 7.1 g, a 13 percent increase (Table 3). However, changing temperatures may affect how a plant uses that dry weight. For instance, dropping temperature from 77 to 59°F almost eliminated flowering on New Guinea impatiens.

Plants often have an optimal temperature for flowering. Flower dry weight of New Guinea impatiens 'Mimas' was greatest when plants were grown at constant 68°F. If either day or night temperature deviated from 68°F, floral dry weight decreased (Table 3).

Plant Height– As mentioned previously, it is estimated that 80 percent of the cost of heating a greenhouse is incurred at night. Therefore, if you are planning on reducing temperature, it is likely that you will focus on reducing night temperature. The difference between day and night temperatures is known to impact stem elongation. The greater the difference ('DIF') between day and night temperatures, the more stem elongation or 'stretch' you will see on your crop (Figure 7). Therefore, if you are reducing your night temperature only, expect increases in stem elongation. As a result, your crops may require more growth regulator applications or application at higher concentrations. Alternatively, using a morning temperature dip can help reduce the necessity for growth regulators. Plants are stretching the most at the end of the night and early in the morning. Reducing temperature 30 to 60 minutes before dawn and maintaining a lower temperature for the first few hours of the day will reduce the amount of plant growth regulators needed on a crop. This practice is called a morning temperature 'DIP' or 'DROP'. For more information on 'DIF' and 'DIP', see the May 2001 issue of the *OFA Bulletin*.

WILL YOU REALLY SAVE ANY MONEY?

Keep in mind that, depending on how much you reduce greenhouse temperature, you may be decreasing the total number of crops you can turn through your greenhouse. If you are strictly a spring bedding plant grower, or you are dependent on producing a certain number of crops (or turns) each season, decreasing greenhouse temperature may not ultimately save you any money. As discussed previously, reducing greenhouse temperature will increase crop production time by slowing the rate of development. Therefore, it is important to compare the total fuel cost of producing a crop under the temperature you



would traditionally use with the lower per day costs, but increased production time, of a cooler temperature regime.

Let's use 'Purple Wave' petunia as an example to illustrate how reducing temperature will impact overall fuel usage during the entire production time of a crop. From the equation in Figure 2 (page 6) we can predict that 'Purple Wave' will flower in 64 days at 68°F. For this example, let's assume that you want to reduce your temperature from constant 68°F to a regime of 68°F day temperature and 58°F night temperature (because, as mentioned previously, 80 percent of heating costs are incurred at night). Therefore, your average daily temperature is 63°F. Again from the equation in Figure 2 (page 6) we can predict that 'Purple Wave' petunias will flower in 80 days at 63°F.

Using information from the Natural Resource, Agriculture, and Engineering Service (NRAES) bulletin Greenhouse Engineering (Aldrich and Bartok, 1994), we can compare the approximate total fuel usage for growing 'Purple Wave' under a day/night temperature regime of 68/68°F or 68/58°F. In Minneapolis, Minnesota we need to provide 19.2 heating degree days (HDD; in this case defined as a 24-hour period in which the inside temperature is 1°F higher than the outside temperature) during the night to maintain a 68°F night temperature and 16.3 HDD to maintain a night temperature of 58°F. Therefore, the approximate number of HDD provided at night to grow 'Purple Wave' at constant 68°F is:

$$19.2 \text{ HDD/day} * 64 \text{ days} = 1,229 \text{ total HDD}$$



In contrast, growing plants at 68°F/58°F would require approximately: 16.3 HDD/day * 80 days = 1,304 total HDD

Therefore, the total amount of fuel required to produce a 'Purple Wave' crop under the cooler temperature regime is approximately 6 percent higher than growing that crop under warmer temperatures and crop time is increased by 16 days. Keep in mind that this is an extreme example. The delay in flowering for growing plants under an average daily temperature of 68°F compared to 61°F for other crops presented in Table 1 (page 6) is as little as nine days for some pansy cultivars, and 22 to 27 days for other Petunia cultivars examined. **However, it is important to consider that increasing crop production time under a cool temperature regime may eliminate any fuel savings you gain by reducing the greenhouse temperature in the first place.**

WHICH CROPS SHOULD NOT BE GROWN COOL?

Not all bedding plant crops will adapt well to a cool temperature regime after germination and early seedling growth. The most obvious example is vinca. *Celosia*, *Cleome*, *Cosmos*,

Continued on page 10

Table 3. Effect of day and night temperature on stem, leaf, flower and total shoot dry weight of 'Mimas' New Guinea impatiens (Erwin, 1995). Data on the percent of total shoot dry weight are presented in parentheses. Plants were grown under a 9-hour photoperiod. Data were collected after 51 days in temperature treatments.

Night Temp.	Day Temperature (°F)			
	59°F	68°F	77°F	86°F
	Total shoot dry weight (g)			
59	2.8	6.3	7.1	6.7
68	4.6	6.3	6.7	6.8
77	4.7	5.9	6.3	6.8
86	2.3	4.8	4.7	4.2
	Stem dry weight (g)			
59	0.06 (2%)	1.02 (16%)	1.28 (18%)	1.43 (21%)
68	0.07 (1%)	0.86 (14%)	1.14 (17%)	1.42 (21%)
77	0.07 (1%)	0.83 (14%)	1.08 (17%)	1.30 (19%)
86	0.04 (2%)	0.72 (15%)	0.82 (17%)	0.83 (20%)
	Leaf dry weight (g)			
59	2.69 (95%)	3.87 (62%)	4.46 (63%)	4.41 (66%)
68	2.88 (63%)	3.28 (52%)	4.29 (64%)	4.49 (66%)
77	3.30 (71%)	3.71 (63%)	4.16 (66%)	4.95 (72%)
86	2.26 (97%)	3.67 (77%)	3.71 (79%)	3.37 (79%)
	Flower dry weight (g)			
59	0.08 (3%)	1.38 (22%)	1.34 (19%)	0.87 (13%)
68	1.60 (35%)	2.12 (34%)	1.29 (19%)	0.87 (15%)
77	1.30 (28%)	1.33 (23%)	1.05 (17%)	0.59 (9%)
86	0.03 (1%)	0.38 (8%)	0.18 (4%)	0.04 (1%)

THE PROS AND CONS OF GROWING PLANTS COOLER

Continued from page 9

Gomphrena, *Portulaca*, and sunflowers are other crops that are adversely affected by cool greenhouse conditions. To deal with this problem, there are two main options: 1) don't grow these crops; or 2) group these crops together and maintain a subsection of your greenhouse warmer than the rest of the greenhouse or use heat mats or skirted benches with under-bench heaters.

CROPS THAT GROW WELL UNDER COOL CONDITIONS

Several bedding plant crops will perform very well under cool temperatures, including snapdragons, alyssum, *Dianthus*, and pansy. For these crops, crop quality will not be compromised under cool conditions, but crop production time will still be longer than under warmer conditions.

HOW TO PHYSICALLY SAVE ON HEATING COSTS

Impact of greenhouse glazing material on heat loss.

Different greenhouse glazing materials lose heat at different rates. Single-layer glass and single-layer plastic film lose heat at the highest rates (approximately 1.1 Btu/hr. °F-ft²; Aldrich and Bartok, 1994). In comparison, double-layer polycarbonate or acrylic loses heat at less than half of the rate (0.5 Btu/hr. °F-ft²) of single-layer glass or plastic.

Installing a thermal energy blanket can greatly reduce fuel usage for two reasons. First, adding the energy blanket reduces the rate of heat loss from the greenhouse. For example, adding a thermal energy blanket to a greenhouse covered with single-layer glass reduces the heat loss rate from 1.1 Btu/hr. °F-ft² to 0.5 Btu/hr. °F-ft² (Aldrich and Bartok, 1994), the same rate as for double layer acrylic. Second, energy blankets reduce fuel costs by reducing the volume of air that you are heating. Why spend money to heat the roof of your greenhouse when your plants are 10 to 20 feet below? The short-term cost of installing energy blankets can quickly be recovered by reduced fuel costs.

Here are some tips for reducing your energy bill in both the short- and long-term (adapted from Both, 2001):

- Install energy curtains
- Reduce air leakage
- Provide heat only where it is needed, i.e. under benches
- Circulate air to reduce/eliminate cold spots
- Install an energy-efficient heating system
- Calibrate temperature sensors
- Insulate greenhouse perimeter

- Use a double-layer glazing material
- Install windbreaks
- Use the cheapest fuel available
- Explore alternative fuel sources

The current energy crisis is not likely to go away any time soon. Therefore, optimizing greenhouse heating efficiency should be a priority for any greenhouse expansion plans. You have less flexibility in altering your current structures to increase energy efficiency, but some of the tips listed above can be employed in any greenhouse situation. It is often said that growing plants is as much an art as it is a science. This will certainly be very true as growers search for creative ways to reduce energy costs without sacrificing plant quality and, ultimately, profitability.

REFERENCES

- Aldrich, R.A. and J.W. Bartok, Jr. 1994. Greenhouse engineering. NRAES-33. Natural Resources, Agriculture, and Engineering Service. Cooperative Extension, Ithaca, NY.
- Both, A.J. 2001. Ten ways to reduce your: energy bill. *Greenhouse Grower* 19(8):56-62.
- El Din, N.S. 1976. Effects of temperature on the aphid, *Myzus persicae* (Sulz.), with a special reference to critically low and high temperature. *Z. Angew. Entomol.* 80:7-14.
- Erwin, J. 1995. Light and temperature. pp.41-54. In: W. Banner and M. Klopmeier (eds.). *New Guinea impatiens – a Ball guide*. Ball Publishing, Batavia, Ill.
- Erwin, J.E., R.D. Heins and R. Moe. 1991. Temperature and photoperiod effects on *Fuchsia x hybrida* morphology. *J. Amer. Soc. Hortic. Sci.* 116:955-960.
- Erwin, J.E. and R.D. Heins. 1992. Environmental effects on geranium development. *Minn. Commercial Flow. Growers Bull.* 41(1):1-9.
- Erwin, J. and R. Heins. 1995. Easter lily production. *Minn. Commercial Flow. Growers Bull.* 44(5):1-11.
- Erwin, J.E. and R.M. Warner. 1999. Temperature p. 69-82. In: Buck, C.A. et al.(eds.). *Tips on growing bedding plants* 4th ed. O.F.A. Services, Inc., Columbus, Ohio.
- Lindquist, R.K. 1998. Identification of insects and related pests of horticultural plants. O.F.A. Services, Inc., Columbus, Ohio.
- Nameth, S.G.P. 2001. Cool runnings. *Greenhouse Grower* 19(12):56-64.
- Robb, K.L. 1989. Analysis of *Frankliniella occidentalis* (Pergrande) as a pest of floriculture crops in California greenhouses. Ph.D. Dissertation, Univ. of California, Riverside, Riverside, Calif., 135 pp.
- Sanderson, J.P. 1998. Weapons against whitefly. Volume 62. Ball Publishing, Batavia, Ill.
- van Steenis, M.J. and K.A.M.H. El Khawass. 1975. Life history of *Aphis gossypii* on cucumber: influence of temperature, host plant and parasitism. *Entomologia Exp. Et Applicata* 76:121-131.

OFA

INSECT AND MITE PROBLEMS ON BEDDING PLANTS

Continued from page 1

are most attracted to bedding plants that have yellow or blue flowers. Flowers or leaves of bedding plants fed upon by thrips have a "silvery" appearance. In addition, thrips, most notably the Western flower thrips (*Frankliniella occidentalis*), vector impatiens necrotic spot virus.

FUNGUS GNATS

Fungus gnat adults are winged, 1/8 inch long, deep black in color, with long legs and antennae. They tend to fly around the surface of the growing medium. Fungus gnat larvae are white, transparent to slightly translucent, legless larvae that are about

1/8 inch long. They have a black head capsule that is absent in shorefly larvae. Fungus gnat larvae are located in the growing medium, where they cause direct plant injury to roots, resulting in plant stunting and wilting. In addition, the larvae will bore into the crown of bedding plants at the soil line.

Fungus gnat larvae are also capable of transmitting soil-borne pathogens includ-

ing *Pythium* and *Thielaviopsis*. Also, the wounds they create through feeding provide entry sites for secondary soil-borne pathogens. Fungus gnats are mainly a problem of bedding plants under extreme moist conditions.

SHOREFLIES

Adult shoreflies, which resemble houseflies, are 1/8 inch long, with black bodies. Each wing usually has at least five white to light-

colored spots. The antennae and legs are short. Larvae are 1/4-inch long, opaque yellowish-brown in color, with no head capsule. Shorefly adults are stronger fliers (and are more noticeable) than fungus gnats. Shorefly larvae primarily feed on algae located on the surface of growing medium or other areas in the greenhouse where the conditions are conducive for algae growth. The larvae don't directly feed on plant roots. Shorefly adults are more of a concern during bedding plant production because they are more noticeable flying around. Adult shoreflies are generally considered a nuisance pest; however, they may leave black fecal deposits on plant leaves that may affect the plant's aesthetic quality. Just like fungus gnats, shoreflies are a problem under extreme moist conditions.

WHITEFLIES

Whitefly adults are white to slightly yellowish in color, narrow-shaped, and approximately 1/13 to 1/9 inches long. Whitefly adult females lay spindle-shaped eggs on the undersides of mature leaves. Eggs hatch into crawlers or nymphs that feed on plant fluids. This may result in leaf yellowing, plant stunting, plant wilting, and possibly plant death (if populations are high enough). Whiteflies, like aphids, are capable of producing honeydew. If noticed too late, the presence of large numbers of adults may be a visual nuisance, which may reduce bedding plant salability. Whiteflies are also capable of transmitting viruses.

SPIDER MITE

The primary spider mite pest that attacks bedding plants is the two-spotted spider mite (*Tetranychus urticae*), although there are others that may be a problem. Two-spotted spider mites are

oval-shaped and may be yellow-orange, green, or red in color. Mites prefer warm, dry conditions with low relative humidity. They are normally a problem in greenhouse sections with minimum airflow and on hanging baskets where temperatures are normally higher. They feed on leaf undersides and remove the chlorophyll (green pigment) from leaves. The mites generally feed near the midrib. Damaged leaves appear stippled with small silvery-gray to yellowish speckles. Webbing may be present if populations are high.

IMPACT OF CULTURE AND ENVIRONMENT ON PEST PROBLEMS

Insects and mites can be troublesome during bedding plant production primarily due to a number of basic plant operational procedures that occur during the production cycle.

First, bedding plants are well fertilized, which provides an attractive food source for insects and mites. Second, there is continuous production without a break, which means food is always available.

Third, environmental conditions such as temperature, light, and humidity that are maintained to promote plant growth are also conducive for insect and mite development. Fourth, not enough natural enemies such as parasitoids and predators are able to migrate into the greenhouse to suppress existing pest populations.

Fifth, doors and vents are left open, which allows flying insects including thrips, whiteflies, and leafminers to easily enter greenhouses. Sixth, air circulation fans, useful in reducing problems with foliar diseases such as *Botrytis*, can easily distribute insects such as thrips around the greenhouse; this is especially the



case with insects or mites in hanging baskets. Finally, movement of staff or people along benches, especially those wearing blue or yellow clothing, can easily carry insects within or between greenhouses.

Cultural management strategies should always be the primary method of minimizing problems with insects and mites even if insecticides and miticides are used. Proper fertility can lead to fewer problems with insects and mites. For example, overfertilizing plants, especially with nitrogen, results in the production of succulent growth and increases susceptibility to aphids, whiteflies, and spider mites. The reason for this is that the higher levels of amino acids, which is the primary food source utilized by insects and mites, increase their reproductive ability. In addition, overfertility may cause the leaf cuticle to be thinner, making it easier for insects and mites to penetrate with their mouthparts.

Reducing excess moisture by watering only when needed and repairing pipe leaks will minimize problems with fungus gnats and shoreflies. Both these insects thrive under wet conditions. Furthermore, excess moisture can lead to algae buildup, which provides an ideal breeding environment for fungus gnats and shoreflies.

Growing media, such as those containing coir (coconut husk fibers), where the top 1 to 2 inches can dry down without having problems with rewetting, provide an unfavorable environment

for fungus gnat females to lay their eggs. Eggs that are laid may have a higher mortality rate, which reduces the number of potential damaging larvae.

Weed management inside and outside the greenhouse will reduce problems with insects moving off weeds in the greenhouse or migrating from outside onto the main crop. For example, in a study conducted at a greenhouse operation in West Lafayette, Indiana we determined the migration of thrips (Western flower thrips) into a greenhouse from weeds outside by equally spacing five yellow sticky cards along a side vent located on the north side of the greenhouse (Figure 1, page 12).

As shown in Figure 2 (page 12), we initially trapped a total of more than 700 thrips adults on the sticky cards (using only one side of the sticky card). Aware of the problem, the grower sprayed the weeds with the herbicide glyphosate (Roundup) the next day, which eventually killed the weeds. Although the numbers were much lower, we were still trapping thrips on the sticky cards (Figure 1). It is possible that we were trapping adult thrips on the sticky cards that had emerged from the ground after pupating. In addition, many weeds are also a potential inoculum source for viruses vectored by thrips, aphids, and whiteflies.

PEST MANAGEMENT

Scouting is a very useful way to determine the status of the pest situation by either visually inspecting

Continued on page 12

INSECTS AND MITE PROBLEMS ON BEDDING PLANTS

Continued from page 11

plants or using colored (yellow or blue) sticky cards. Early detection through scouting will minimize having to deal with high insect and mite populations. The entire greenhouse doesn't have to be scouted; however, selected areas near vents, doors, and along the edge of benches should be scouted because these are areas where insect and mite infestations are most likely to start on bedding plants. Scouting can provide information on the effectiveness of your pest management program and track seasonal trends (late winter through early summer) of insect and mite populations.

Insecticides and miticides are still the primary means used to manage pest populations on bedding plants. Effective control is maximized when bedding plants are small, because it is easier to get coverage throughout the entire plant canopy including the upper and lower leaf surfaces. Despite your best efforts, it

may appear that you are not getting adequate kill with an insecticide or miticide. Reasons for poor insecticide and miticide performance may include coverage, timing, and frequency of application.

Poor coverage, especially when using short-residual contact insecticides, will lead to continued problems with insects and mites. These materials are most effective only when the wet spray makes contact with the target pest. All plant parts must be thoroughly sprayed in order to ensure adequate kill.

Improper timing of insecticide or miticide applications generally results in poor control. Better control will be obtained when the most susceptible stage of the pest is present. In general, the egg and pupae stages are tolerant of most insecticides or miticides, whereas the larvae and adult stages are more susceptible. If the age structure of the target pest is primarily in the less susceptible pupae stage and

an insecticide application is made, more than likely this will result in poor control.

The length of the spray interval or frequency of application also impacts the effectiveness of insecticide and miticide applications. If the time interval between spray applications is too long, for example 10 days, then this will most likely lead to inadequate insect or mite control, especially when dealing with overlapping generations. This means that the insect or mite population is at various stages of development (egg, larvae, pupae, and adult) at the same time. Spray intervals must be shortened in order to kill larvae and adults that were previously in the egg and pupae stages, respectively.

The use of biological control is another option in dealing with bedding plant pests. However, it may not always be feasible because the crop is sold or moved too fast, which may not give the biological control agents (parasitoids and predators) enough time to establish and provide adequate control. However, it is possible early in the bedding

plant production cycle to use pest control materials such as Botanigard[®], Naturalis[®], or Gnatrol[®]. Both Botanigard and Naturalis contain the entomopathogenic fungus, *Beauveria bassiana* as the active ingredient, which is registered for aphids, thrips, and whiteflies. Gnatrol is a microbially based pest control material, which contains the bacterium *Bacillus thuringiensis* var. *israelensis* as the active ingredient. This material only has activity on fungus gnat larvae. In order to maximize the effectiveness of Botanigard, Naturalis, and Gnatrol, it is recommended that these materials be used early in managing insect and mite pests, because they will not provide quick knockdown if pest populations are high.

Although the bedding plant season is a busy time of year, it is important to prevent problems from insects and mites by using proper cultural practices, scouting plants on a regular basis, and understanding the factors that may influence the performance of an insecticide or miticide. **OFA**



Figure 1. Broadleaf and grassy weeds located outside the side vent of a greenhouse operation (West Lafayette, Indiana). This situation allows insects such as Western flower thrips, *Frankliniella occidentalis* to migrate off weeds to the main crop(s) located inside the greenhouse.



Figure 2. Total number of Western flower thrips, *Frankliniella occidentalis* trapped per week from five yellow sticky cards placed equi-distant along the side vent of a commercial greenhouse (West Lafayette, Indiana) from July 14 to September 28, 1998.

THE NEW WORLD OF SHIPPING PLANT MATERIAL

Continued from page 1

As C. Raker & Sons, Inc. has expanded our production space, we have put considerable effort into increasing our shipping efficiency, so we can keep up with the increase in production. The article will examine some of the primary factors that influence shipping options, the shipping systems Raker uses, and how they relate to our specific customer base, as well as look at some challenges and opportunities for the future of shipping horticultural material.

PRODUCTION CONSIDERATIONS THAT AFFECT SHIPPING OPTIONS

Production and Product Mix

A grower's specific product mix will affect shipping options, and may limit the practical shipping possibilities and shipping region. Growers producing gallon containers will have different shipping needs than those producing bedding flats or plugs.

Raker specializes in providing plugs year-round to customers throughout North America. Our product list is quite diverse, emphasizing specialty and niche items and a wide range of tray sizes. A typical order might involve multiple tray sizes and product classes (perennials, bedding annuals, vegetables, pot crops, herbs, cyclamen, etc.).

Customer Base

A grower's customer base will influence numerous decisions about the best shipping method(s) for them. Those producing for their own retail sales will obviously have different challenges from growers who ship semi loads of material hundreds or more miles to market.

Approximately two-thirds of our business is with small to medium-sized growers who order less than 1,000 trays per year, and we also supply large customers (5,000+ trays ordered per year). Because of our broad geographical shipping area and our diverse customer base, Raker tries to provide enough flexibility in our shipping methods to be able to meet the needs of our customers.

Raker ships using a variety of methods, and we have made modifications to our shipping process for improved efficiency over the last few years. Because the bulk of our spring business is to our small- to medium-sized customers, Raker ships a large proportion of our spring production boxed, via Federal Express. In fall, our production shifts to mostly pansy and perennial plugs for larger growers, and the bulk of our production ships via truck on carts.

Product Location Systems

A tracking system which indicates exactly where every product is in the production area is very helpful when pulling orders to ship. At Raker, each bench has a number and a barcode assigned to it, which is tied to the barcode of each tray on the bench. This makes it easy to look up the location of any tray in the greenhouse, and allows us to print a tray location on all our picking tickets.

Shipping Boxes

A well-designed box helps ensure that product shipped in boxes arrives in good condition, without damage or jumbling. Raker has developed a boxing system which uses michelman (a water-resistant coating that is more compatible with cardboard recycling than wax) coated cardboard sleeves that plug trays can be slid into. Different sized sleeves are used

depending on the size of the plug trays on an order, and two to seven trays fit into a box. We can even mix the sleeve sizes within a box, which is helpful for the small and diverse orders we typically have.

The Raker box is a distinctive yellow color, with lots of custom printing for logos, agricultural inspection information, etc. We don't skimp on the cost or sturdiness of our box. It weighs about 4 pounds empty, and may cost close to \$4 once the sleeves are inserted. Our box is also certified by FedEx, which helps speed up claims if any product is damaged in transit.

But even an excellent box isn't necessarily the best choice for every customer. Large customers may find boxed orders to be a hassle, and they lead to significant labor unpacking the product, in addition to generating a large volume of cardboard that must be disposed of.

SHIPPING OPTIONS

Federal Express and UPS

In our peak spring season, Raker ships most product boxed, via FedEx overnight. We have minimal problems with shipping delays or product damage with FedEx overnight shipping. In our conversations with other growers, most growers who report having problems with FedEx are not using overnight delivery. Although the cost for overnight shipping is higher, we have found it to be justified with reduced shipping-related claims and improved service to the customer.

Over the past few years, we have integrated our shipping line with our FedEx PowerShip station, so that labels with FedEx barcodes are generated and applied to boxes automatically before boxes are sealed. Our customer database is also integrated with the FedEx system, so that we don't have to enter and update customer information into two separate databases. This integration has resulted in significant increases in shipping efficiency.

Because of the large volume of FedEx shipping at Raker, we have FedEx employees on-site to sort boxes and load them into air cargo canisters. Filled canisters are loaded onto semi-trucks and taken to Detroit Metro airport. On-site sorting reduces the time that our product spends in the FedEx system and actually saves FedEx time, since product doesn't have to be trucked to the regional sorting facility before going to the airport.

FedEx heavyweight palletized shipping is an option that we are beginning to explore. At comparable costs to Air Freight delivery, it has the added benefit of FedEx tracking and service. This may be a good option for medium to large boxed orders, and it is available with overnight, two-day, and three-day delivery.

UPS offers shipping options comparable to FedEx and a similar level of tracking ability. Raker currently ships our plant tags via UPS ground. The process of shipping via UPS has become much more efficient now that we have a UPS World Ship system which automatically generates shipping labels with UPS barcodes and keeps track of the volume of UPS shipping we do.

Customer Pick-Up

Raker does have a number of customers who pick up plugs at our facility. We call these customers the week before the product is ready to set up a pick-up time, so we can have the material ready when they arrive. Pre-arranged pick-up times help streamline the process and minimize the need for customers to wait while their order is processed.

Customers choosing to take advantage of customer pick-up range from small-scale local retail growers to large wholesale

Continued on page 14

THE NEW WORLD OF SHIPPING PLANT MATERIAL

Continued from page 13

growers that have their own fleet of trucks on the road. We offer customer pick-up orders boxed or unboxed, depending on customer needs. This is a nice option for both producers and for customers, but may not be feasible for a significant portion of your customer base, if your shipping region is large.

Truck Shipping

Raker uses truck shipping for large customers, primarily during our fall season when pansy and perennial plugs make up the bulk of our shipments. Due to our wide shipping area and large number of customers, putting together efficient truck routes can be challenging. And the nature of facilities at our customers' locations can make unloading trucks quite challenging – a scenic, long, winding driveway makes access with a semi-truck challenging, and lack of good loading docks can significantly slow down unloading.

Raker has begun to use a database for tracking truck deliveries, with the planned drops in order for each day. Drivers call in after each drop, so we know where they are and if they are behind schedule. The spreadsheet is also an excellent resource for our receptionist when customers call in asking for an update on when their product will arrive, which often happens late in the day after our shipping team has already left.

One sometimes overlooked consideration with trucking is the quality of the drivers. A truck driver is an extension of your company, and has the chance to make an impression – good or bad – on the customer when making deliveries. A trucker who understands the nature of a perishable horticultural product and can bring back feedback from the customers is invaluable.

One of the most logistically difficult issues with truck shipping is dealing with the shipping carts and racks. The initial investment for carts and racks can be quite significant. There are also costs and logistical challenges associated with returning empty carts after the product has been delivered. In addition, most growers who use truck shipping to any extent will be able to discuss at length the serious problem of cart losses associated with trucking product. Many growers are investing in durable name tags and even barcode systems to help track and ensure the return of carts.

Air Freight

Shipping boxed orders via air freight can be a cost-effective technique for medium- to large-volume customers. However, a significant disadvantage is the variable quality of product handling among the various airlines and even among hubs for a given airline. The level of detail available when tracking air freight shipments is also generally reduced compared to FedEx or UPS shipping.

Due to the uncertainty of air freight shipments, Raker does not consider air freight a preferred shipping method. This means that we do not guarantee delivery when customers request shipping by air freight, and customers are responsible for any product loss. As a service to our customers, Raker calls every customer receiving an air freight delivery the week before it ships, to verify information and determine if any changes need to be made. This also alerts the customer of the expected arrival date, so they can check with the airline and helps minimize problems with product not getting to the customer in a timely manner after it reaches the destination airport. We also routinely track shipments to determine when

they reach the destination airport.

During summer, airlines sometimes suspend air cargo shipments of perishable product into hot areas, so close communication with airlines is helpful in preventing wasted trips to the airport to drop off product when shipments are suspended.

CHALLENGES FOR THE FUTURE

Shipping Efficiency

Improving shipping efficiency is a key challenge for growers. How plant material is organized and moved in the facility, how orders are assembled, how material is packaged or loaded onto trucks, and staffing levels should all be considered in evaluating shipping efficiency.

With our current integrated shipping line, Raker can ship 1,200 to 1,300 boxes per day (approximately 6,000 to 6,500 trays) per day, in an 8-hour shift. This is a significant improvement from just a few years ago, when we had to work a long day to ship out 1,000 boxes (5,000 trays). Improvements that Raker has made to improve shipping efficiency include:

- Adding an automated box sealing system;
- Adding additional monorail lines for use in pulling orders and re-routing the flow of monorail carts, to increase the number of employees who can pull orders at once;
- Improved staging and grouping of product in shipping ranges;
- Use of a barcode system for tray location and verification of orders; and
- Integration of a FedEx shipping station into our shipping process, for automatic generation and application of FedEx shipping barcodes.

Cost Increases and Surcharges

One certainty is that shipping costs will continue to increase. We have seen cardboard costs increase 10 percent to 20 percent over the last few years, trucking costs increase about 6 percent over the last year, and an average increase in UPS and FedEx shipping costs of 4 percent to 5 percent annually. In addition, numerous companies have added fuel surcharges of 2 percent to 5 percent, to help cover added expenses when fuel costs are high.

Growers are wise to evaluate and compare suppliers to ensure they are obtaining the best price for the goods and services they are purchasing. Remember to factor in the value of good customer service when evaluating different suppliers. The cheapest supplier may not be a bargain if they cannot provide an acceptable level of service.

One-Way Shipping Options

To help reduce the logistics and expense of truck shipping, numerous growers and companies are looking for alternative systems to carts that can be used for one-way shipping. Plainview's disposable cardboard plug shipping rack is one example of this. Others are looking to design a system that will allow shipping containers to be broken down or consolidated for return shipping by common carrier.

CONCLUSION

Shipping is too often thought of as an afterthought, although it is critically important for plant producers. Growers who are willing to take a close look at their current system may identify multiple options for improved efficiency, and not all changes may require significant capital investment. A creative, flexible approach to shipping will help growers remain competitive in the future.

OFA

Diseases of Bedding Plants

Steve G.P. Nameth
The Ohio State University
Department of Plant Pathology
2021 Coffey Road
Columbus, OH 43210
614-292-8038
Fax: 614-292-4455
nameth.2@osu.edu

Plant pathogenic fungi, bacteria, and viruses are all microorganisms that are responsible for causing a variety of diseases in greenhouse bedding plants. Diseases induced by fungi are the most common, but not necessarily the most important. Depending on the host, other pathogens such as bacteria and viruses can cause many of the most economically important diseases.

The purpose of this article is to familiarize the reader with some of the most important pathogens and diseases associated with the production of bedding plants and to gain information on methods used to control/manage these diseases in an economically equitable manner.

ROOT AND CROWN ROT

Pythium Root Rot. This is one of the most common diseases in the greenhouse. It is caused by the fungus *Pythium* sp. The fungus infects the root tips of the host, and if favorable conditions continue, the fungus moves progressively up the root to the crown and the stem. Plant symptoms associated with *Pythium* root rot include lack of vigor, nutrient deficiencies and eventually wilt. Affected roots appear brown and mushy to the touch. In later stages, the whole root mass will be brown and rotted. Once the fungus has spread to the stem, it may appear black in color and soft to the touch. *Pythium* stem infection is called black leg and indicates advanced stages of root rot.

Growing plants in a well-drained medium that inhibits saturated conditions and not over-watering go a long way to control this disease. Fungicides that contain active ingredients such as mefenoxam and trifloxystrobin are some of the best in controlling this disease.

Black Root Rot. Black root rot is caused by the fungus *Thielaviopsis* sp. Some bedding plant species are more prone to be affected by black root rot than others. Plants such as viola, pansy, and vinca are very prone to black root rot if grown under adverse environmental conditions. Plants infected with black root rot appear stunted and malnourished. Leaf yellowing is a common symptom, and wilting of the entire plant is rare. Infected roots appear black and mushy. Plants stressed by pH and/or soluble salt imbalances are more prone to infection. Products containing thiophanate-methyl, triflumizole, and fludioxinil offer good-to-excellent control.

Rhizoctonia Crown Rot. Crown rot caused by *Rhizoctonia* sp. is a serious disease associated with bedding plant production. This pathogen infects the host at the crown (media line) and grows up the stem, forming a lesion. The stem becomes soft and mushy, and the plant starts to wilt. Eventually, the fungal lesion completely encircles the stem and the plant dies. In most plants, the roots still appear healthy, but the crown will be rotted. Water-saturated media help promote this disease. Chemicals such as azoxystrobin and thiophanate-methyl can control this disease.

VASCULAR WILTS

Vascular wilt diseases of bedding plants are caused by

a variety of plant pathogens. The most common of these are the fungi *Fusarium* sp. and *Verticillium* sp., and the bacterium *Xanthomonas campestris* pv. *pelargonii* (Xcp). *Fusarium* and *Verticillium* infect a wide variety of bedding plants hosts, while Xcp infects only geraniums.

Symptoms associated with all vascular wilt diseases are very similar. Infected plants wilt under conditions of moisture stress, primarily during the heat of the day. Affected plants may recover during periods of cool temperatures or after watering. If symptomatic plant stems are cut open to expose the vascular tissue, it will appear dark in color. This symptom is diagnostic for all of the vascular wilt diseases. *Fusarium* wilt is a common disease on cyclamen. The incidence of *Fusarium* and *Verticillium* wilt is relatively low when compared to other bedding plant diseases, and they usually do not lead to a major economic disaster. Bacterial wilt of geranium on the other hand has the potential to wipe out a large portion of the crop if left unchecked.

Prevention is the best way to control vascular wilt diseases. To prevent bacterial wilt of geranium, it is important to purchase geranium cuttings that are certified by the producer to be free of Xcp. For *Fusarium* wilt of cyclamen, fungicides that contain fludioxinil work well to control this disease.

FOLIAR DISEASES

Botrytis Leaf Blight. *Botrytis* leaf blight or gray mold is the most common disease in the greenhouse. *Botrytis* blight is caused by the fungus *Botrytis cinerea*. It has a very wide host range and can persist in the greenhouse year-round. The fungus produces a large amount of

spores that move throughout the greenhouse via air currents. Under favorable environmental conditions, the spores land on the plant surface, germinate, and penetrate the host plant. The optimum temperature for spore germination is 72 to 77°F with a relative humidity of 85+ percent. Germinating spores rarely penetrate actively growing tissue directly. However, penetration of actively growing tissue can take place through wounds. Tissue that is in the process of senescing is ideal for disease initiation.

Symptoms of *Botrytis* blight vary depending on the host and the environmental conditions associated with the host. The disease is characterized by the production of leaf spots, flower blight, bud rot, stem canker, stem and crown rot, cutting rot and damping-off. Fungal growth is characterized by the presence of fluffy, gray/brown mycelium that produces a cloud of spores if disturbed. Affected tissue is soft and brown, and sometimes has a water-soaked appearance. It is essential to maintain an environment within the greenhouse that will not permit the fungus to grow and sporulate. Excellent control can be achieved by keeping the relative humidity below 85 percent, as well as maintaining good air circulation and adequate plant spacing. Fans should be used to provide good air movement above the canopy. Plants with wounds should be either protected with a fungicide or removed from the greenhouse, because the wound is the perfect environment for the fungus to initiate the infection process. Many fungicides are labeled for *Botrytis* sp. Products that contain azoxystrobin,

Continued on page 16

DISEASES OF BEDDING PLANTS

Continued from page 15

chlorothalonil, and combination products such as thiophanate-methyl plus chlorothalonil all work well to control this disease.

Powdery Mildew. This disease is caused by a variety of different, yet host-specific fungi. The disease is characterized by the white fluffy growth of the fungus on the leaves and stems of the affected plant. Powdery mildew is most prevalent when the greenhouse conditions are cool and damp at night and sunny and warm in the day. If powdery mildew is a problem, change the environmental conditions to inhibit disease development. Good air movement and products that contain azoxystrobin, trifloxystrobin, and piperalin work well to inhibit this disease.

Bacterial Leaf Spot. Under conditions of high humidity and abundant moisture on leaf surfaces, bacterial leaf spot can be a problem. Most bedding plant bacterial leaf spots are caused by the bacteria *Pseudomonas* sp. and

Xanthomonas sp. Bacterial leaf spots are small, round, water-soaked, and can be surrounded by a purplish halo. If allowed to go unchecked, the leaf spots will coalesce and whole leaves will appear water-soaked and rotted. Disease spread can be inhibited by avoiding overhead and splashing water. Copper-based fungicides can slow down the spread of the bacteria from plant to plant if used in a timely manner.

Leaf Anthracnose. This common disease is caused by a variety of anthracnose-causing fungi, and it can be a significant problem on selected hosts. The disease is characterized by grayish to black, target-like leaf spots primarily on older leaves. In many cases, these spots start at the margins of the leaves and move inward. Salmon-colored spore masses may be evident on affected leaves during periods of high humidity. Avoid extended periods of leaf moisture to help control anthracnose leaf spot. Products that contain mancozeb help control this disease.

VIRUSES

A wide variety of plant pathogenic viruses can infect bedding plants; however, only a few of them are of significant economic importance. Viruses such as tobacco mosaic virus (TMV), cucumber mosaic virus (CMV), and tobacco and tomato ringspot viruses (TRSV and ToRSV) are all viruses which can infect bedding plants and, depending on the host, can cause crop loss. Symptoms associated with these viruses include mosaic or yellow mottling, yellow ringspots, yellowing overall, and stunting of plants.

Of all of the plant viruses that infect bedding plants, the most severe are the viruses in the tospovirus group – impatiens necrotic spot virus (INSV) and tomato spotted wilt virus (TSWV). The host range of these two viruses is very wide and diverse. Symptoms associated with these viruses include, but are not limited to, yellow or necrotic (dead) leaf or stem spots, leaf mosaic, leaf and stem death, black leaf or stem spots, black ringspots, overall yellowing, severe stunting, and rapid death of some plants, particularly small plants.

INSV and TSWV are moved about the greenhouse by thrips, particularly Western flower thrips. If left unchecked, these two viruses can move rapidly through the greenhouse and cause severe damage. If thrips are a problem, they need to be controlled.

The best way to control INSV and TSWV is to exclude these viruses from the greenhouse and control the insect vector if found in the greenhouse. If you are planting seed or cuttings, or bringing in unfinished plants, be sure this material is purchased from a producer who can certify that the material is free from virus or disease. Use yellow sticky cards to monitor thrips populations and treat with insecticides accordingly. If you suspect that your plants are infected, be sure to have them tested for virus infection at a university or private testing facility.

Bedding plant disease control is a three-step process: prevention, detection, and control. If you rely on the first one, the other two are not necessary.

OFA



OHIO FLORISTS'
ASSOCIATION

SPONSORS OF THE SHORT COURSE®

U.S. Floriculture's Premier Educational and Trade Show Event

2130 Stella Court, Suite 200
Columbus, Ohio 43215-1033 USA

Address Service Requested

NON-PROFIT ORG.
U.S. POSTAGE
PAID
COLUMBUS, OHIO
PERMIT NO. 644