

# BULLETIN

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## Supplemental Lighting on Bedding Plants – Making it Work for You

by Ryan Warner

The dark days of winter are an excellent time to review the importance of light in plant growth and development. Light is a resource that is often in short supply during the early stages of the bedding plant production season. Providing supplemental lighting can benefit bedding plant crops in many ways. For example, controlling the day length, or photoperiod, with supplemental lighting will influence when flower induction occurs in many crops, allowing you to reduce production time and, therefore, costs. This article will discuss the benefits of both photoperiodic lighting (day length control) and photosynthetic lighting (increasing

light quantity to increase plant growth) and provide you with information on how to best use supplemental lighting for your bedding plant crops.

### Photoperiodic Lighting

Many bedding plant crops grown for spring sales are photoperiodic, meaning they flower in response to the length of the day and night. Growing crops under the appropriate photoperiod for early flowering can greatly reduce crop production time, thereby reducing



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## Commercial Production of Potted Orchids

by Yin-Tung Wang

Between 1996 and 2004, the wholesale value of potted orchids increased by 172 percent, from \$47 million to \$128 million. Andy Matsui switched from producing cut flowers to potted orchids in the very late 1990s and now owns the world's largest orchid nursery in Salinas, California. His nursery today produces more than 25 percent of all potted orchids sold in the United States. Matsui predicts that 70 million pots of orchids will be sold annually in North America by the year 2014.

There are over 800 genera of orchids (including the species and hybrids), with more than 25,000 known species and over 150,000 artificial hybrids. Compared

with cut flowers, the blooms of most orchids are very long-lasting. In addition to their exotic appearance, flowers of many orchids are fragrant, making them even more attractive to consumers.

### Cymbidiums

Cymbidiums have long grass-like leaves, spindle-like pseudobulbs, and thick roots. Since they are relatively large plants, these orchids are commonly sold in 1- to 2-gallon or larger pots. Inflorescences emerge from the base of the pseudobulbs that mature in late summer. The lengths of the inflorescences depend on the hybrid



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## OFA Mission Statement

To support and promote floriculture professionals through lifelong learning, career enhancement, and public awareness.

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# ofa Forum

## The 2006 GPN/OFA State of the Industry Survey

**Editor's Note:** This is reprinted courtesy of the September 2006 issue of *GPN* magazine. If you wish to purchase the full report, please contact Judy Paul at [jpaul@sgcmail.com](mailto:jpaul@sgcmail.com). OFA members may also visit the members-only area of the OFA web site at [www.ofa.org](http://www.ofa.org) to see the results. Each month the results from one of the survey questions will be posted.

Ask any grower what he or she thinks about the current state of the green industry, and you are sure to get an earful. Ask more than 570 growers and you get the 2006 *GPN/OFA* State of the Industry Survey. This survey provides a snapshot of today's floriculture market.

Taking the pulse of the floriculture industry is not a simple task, but we wanted to gain some insight into what growers are thinking and doing. Earlier this year *GPN* partnered with OFA – an Association of Floriculture Professionals to see how growers felt about the current state of the green industry and in which direction they feel it is headed.

*GPN* and OFA, working with ABR Research Inc., an independent research company specializing in custom research, developed a 26-question Internet survey for growers. The survey asked these individuals for their opinions on a wide-ranging list of issues and topics currently

facing growers. The list includes their personal demographics as well as those of their growing operations, what concerns are impacting their bottom lines, how they use immigrant labor, and what they think about the industry standardizing pot sizes.

After the survey was created, a random sample of *GPN* subscribers was notified by e-mail and asked to participate in the study; more than 570 individuals completed the survey. The margin of error based on the number of returned surveys is calculated to be no greater than +/- 4.1 percent at a confidence level of 95 percent.

This article looks at just some of the issues covered in the 2006 *GPN/OFA* State of the Industry Survey. The results of the survey were also the topic of a panel discussion session at the 2006 OFA Short Course in Columbus, Ohio, in July.

### The Participants

Who were the growers that participated in the *GPN/OFA* State of the Industry Survey? Here are the demographics of an "average" respondent.

- 65 percent: The amount that categorize themselves as a company owner and/or president.
- 81 percent: Use the Internet for business.
- 32 years: Average number of years respondents' companies have been in business.
- 11 years: Number of years with current company.
- \$4.8 million: Average gross sales in 2005.
- 49 years old: The respondents' average age.
- 76 percent: Belong to a local, state, or national trade association.

### 2004-05 – A Marginal Year?

According to survey respondents, the change in average overall profit margin from 2004 to 2005 was 7 percent. The



change in average gross revenue over that same period was 1.6 percent. For those growers whose margin went up, the average gross revenue increased 17 percent. For those growers that saw a decline in profit margin, the gross revenue decreased 11.7 percent.

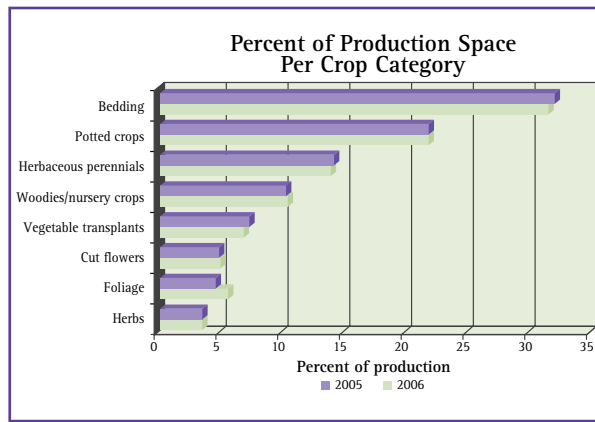
One grower expressed his concern about current and future profit margins. He said he worries about “the viability of the industry in terms of growers receiving a reasonable return on investment” over the next five years.

### Production Space and Crops

When asked about production space size, 36 percent of respondents said their total growing area was less than 50,000 square feet. Twenty-six percent said their growing area was 500,000 square feet or greater. As we continue examining the information from the survey, try to keep the following size breakdowns in mind because growers of different sizes answer questions very differently. Large growers are going to use more automation and immigrant labor; smaller growers are going to be more inclined to try unusual crops. Additionally, by watching how this number fluctuates over the years, we will be able to better know if growing operations are really polarizing to small and large, as many people think.

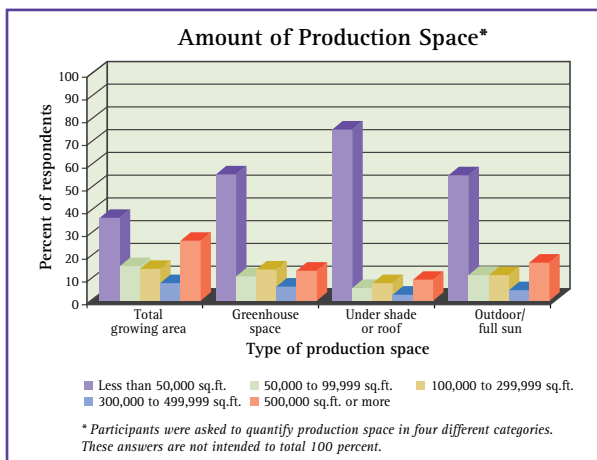
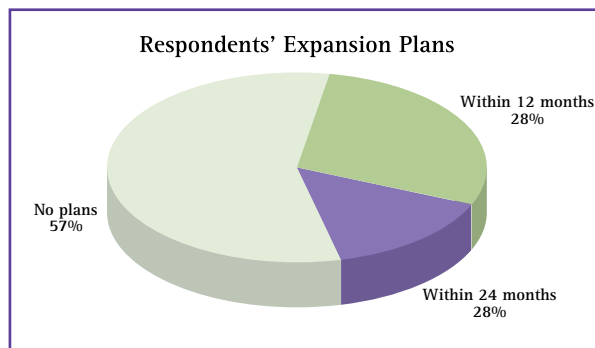
Bedding plants continue to be the largest crop produced by growers. According to the survey, bedding plants made up an average of 32 percent of all crops grown in 2006. Potted crops were the second most produced crop at approximately 22 percent. Across the board, there was very little movement in total percentages when comparing 2005 to 2006.

The average cost of production per square foot was \$8.30. Nearly 17 percent said the production costs were \$11 or more per square foot.



### Expansion on the Horizon?

It seems most growers are content to sit tight when it comes to expanding their operations in the near future. Nearly 57 percent said they currently had no plans to expand their operations, while 28 percent said they are planning to expand within the next 12 months. It also seems the past few years of higher steel prices and shrinking margins may have growers putting off plans for expansion. Another factor that might explain the reluctance to build new greenhouses is the availability of contract or lease facilities. Many growers we talk to are now doing some contract growing, preventing other growers from needing to expand.



### Working with Immigrant Labor

As officials in Washington continue to struggle with the nation’s current immigration laws, the issue of immigrant labor continues to vary widely for growers. According to respondents, more than one-quarter (28 percent) said the majority of their workforce is comprised of immigrant laborers. The readers also said, on average, 23 percent of their company’s workforce is made up of immigrant laborers.

However, 58 percent said they do not use any immigrant workers in their growing operations. It is not surprising to find that smaller growers said immigrant labor made up a very small percentage of their workforces. These are typically family-operated businesses with few additional employees. But for larger growers

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## The 2006 GPN/OFA State of the Industry Survey

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with gross sales of \$5 million or more, immigrant labor is almost half (49.2 percent) of their workforces.

### To Standardize or Not?

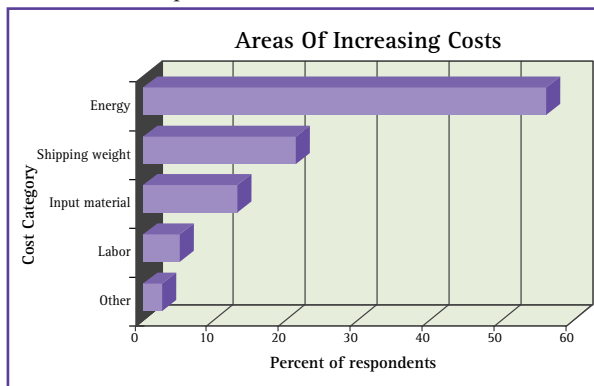
When asked if the industry needs to standardize container sizes, 60 percent were in favor of the idea, while 40 percent were not. One grower said standardized container sizes would “benefit the industry by leveling the playing field.” Ease of automation, less confusion for consumers, and improved overall consistency were some of the other reasons cited for the industry to move to standardized pot sizes. Another grower said standardized pot sizes “would make ordering materials easier across the board.”

On the other hand, one reader feared that the cost of switching to standardized pot sizes “could cripple the industry.” Another respondent said pot standardization “is just another regulation, and we already have enough of them.”

### The Impact of Energy Costs

Skyrocketing energy costs continue to be the number-one item affecting the overall business operations of growers. Fifty-seven percent of participants said the increased price of energy had the biggest impact on their businesses over the last 12 months followed by shipping/weight, input materials, and labor. One grower said his biggest concern over the next five years was

how to control “cost increases in all economic areas due to increased oil prices.”



### What is the Most Important Issue You Expect to Face Five Years from Now?

A sampling of random verbatim responses:

- “How will our customer base change over the next five years due to Baby Boomers getting older?”
- “Caring for the first generation in our second-generation family business and the transfer of assets.”
- “Finding profitable items to sell in light of energy costs.”
- “Mechanization, distribution, and demands for perfect product quality.”
- “Reduced demand for floriculture crops as customers get older.”



## ofa Garden Center

### If I Knew Then What I Know Now: A Story about a Short but Profitable Season



by Larry Houser

It's every retailer's dream: a modern facility, great location, high-end market, great return on investment, and oh yes, one more thing, *only open three months out of the year!* Well, actually five if you consider production time. You say, “Not possible.” For many it isn't, but for some it can be. It certainly has been for this “old-timer.”

Most avid gardeners, when making major purchases, will drive any distance to find quality plant material, a great selection, and a friendly and knowledgeable sales

staff. However, when those same customers need only a few items and they are already at the “Big Box” buying a new drill and practically anything else they need, they take a look at those lovely plants they saw on the way in. As much as we hate to admit it, there are some great values at many of the box stores now. And, if you put a mile between two plants, most customers don't realize a quality difference between the “Box” plants and ours. Add to the equation \$3+ per gallon fuel and the busy schedule of

“soccer moms” and suddenly destination garden centers just aren’t cost effective for smaller purchases.

Why do people say, “Never go to a grocery store when you’re hungry?” The answer is simple: you typically buy more than you need. If you catch a customer at the right time, with the right product, in the right atmosphere, there’s no stopping them. However, by removing even one of these elements, that same customer may buy little or nothing at all.

In the spring your greenhouse becomes the grocery store for the hungry customers. Their appetite is more powerful than at any other time. If you do your job correctly in the spring, many of you could take the remainder of the year off and possibly have more money in the bank at the end of that year.

Before you go out and start boarding things up for the winter, you need to take a look at the following considerations.

### Geographic Location

If are you located in a moderate year-round climate, you are likely to have more consistent and profitable sales throughout the year, thus compromising the advantages of an early closing. However, for those in areas that experience the full effect of all the seasons, a late spring or early summer closing could become positive.

### Regional Location/Traffic Count

Where are you located in your market area? For those in the “ideal location,” possibly tied in with other unique retailers and blessed with a consistently high traffic count, an early closing could be very costly. If, however, you are in an outer area (a destination) with less traffic, the opportunities become greatly extended.

### Employee Needs and Options

Unless you are strictly a family operation, you rely on employees and those employees rely on the paycheck for part or all of their needs. Many operations only have seasonal or part-time employees, while others may have one or more that are full-time. Often finding great employees is more difficult than finding great customers. It is a retailer’s obligation to take care of both.

Is it possible to close and still maintain key employees? For some operations it can be, for others maybe not. One solution could be cutting back hours during the off-season. This allows time for needed maintenance and possible renovation or construction projects while still providing income for key employees.

Helping your employees find alternate sources of seasonal employment with other area businesses that have different time periods for peak employment can benefit you, your employee, and other area businesses. Retailers whose main focus is the winter holiday season are always in need of dependable help.

Unemployment benefits can be costly to you and a burden for the employee; however, they can provide

the relief for those employees dependent on regular compensation. As a possible solution, consider what the employee’s unemployment benefits would be and arrange for enough hours to meet that amount.

One of the most desirable solutions would be finding employees that only need or want employment a few months of the year. On a personal note, I have had great luck with retired individuals, parents of school-age children, and Master Gardener/garden club types that love gardening but don’t want full-time employment.

### The Competition's Reaction and Opportunities

What opportunities would closing early provide your competition? It could allow them to gain market share on a segment of your goods and services. It could allow them to “spin” your closing in a negative way to the public. Be prepared; keep your customers and the general public informed as to what you are doing. Keep it upbeat, positive, and make it fun . . . perhaps even have a seasonal closing party!

### Maintaining Presence in Your Customers' Minds

Again, keep them informed. If you have a mailing list, send out periodic newsletters and/or mailers reminding them of your business and the upcoming season. Also, be active in community events and associations. You may find that with some of your “extra” time you can even be a functioning member!

### Seasonal Operating Benefits

There can be numerous benefits of seasonal operating. Some can contribute to your financial bank account and some can contribute to your (and your employees’) physical and mental bank account.

### Reduced Costs

Payroll, fuel, advertising, utilities, and the list goes on. If you can cut costs without adversely affecting your bottom line you might just be a better businessperson than you are a horticulturalist!

### Less Stress

Few retailers in our industry are without a certain level of stress. In this industry STRESS comes with the territory. Eliminate seven or eight months of operation and you eliminate a lot of stress!

### Time for Maintenance, Cleaning, Renovation, or Expansion

Such an important category, but one that often gets pushed aside because of lack of time.

### Employees Come Back F-R-E-S-H!

If you get a great night’s sleep, you are fresh and ready to go again. The same can apply to employees who have had some time off between the seasons. Our industry is tough both physically and mentally on our employees. Their spirits wear down and their bodies wear

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## If I Knew Then What I Know Now

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out. A few months away from the grind can yield tremendous benefits.

### The "Light at the End of the Tunnel" is Much Closer

It's tough starting out the month of April knowing it'll be at least nine long months before the selling season is over. Imagine greeting your first customer of the year on April 1 and thanking your last customer 90 days later! What a boost for both employees and employers!

### Off-season Employment Opportunities

Many greenhouse and nursery owners have very marketable talents and expertise that go well beyond horticulture. Off-season jobs outside our industry can be very lucrative. I've heard many reports of individuals who greatly supplement their greenhouse income by working off-season in occupations such as construction, truck driving, teaching, etc. The money can be good, and it can also be a great break from their daily management routine.

### You Can Shut the Gate and Get Away

If the maturity of your business and/or your age is such, you can, at the end of each season, "cash in" and take the rest of the year off. Not possible you say? Well it is for many business owners, this author included! It may take a few years but for many this can be the case and it could well happen before you think!

You are probably now thinking, "Well, this all sounds good, but I don't think it'll work for me." You could be right! For it to work you may well have to change more than your hours of operation. You will need to evaluate your entire business plan. What are your strengths? What areas need improvement? How can I make my place "the grocery store" to go to when my customers are hungry?

Many independent retailers across the country have done just that. I am one of them. Two years ago I took a big step. My 50,000 square foot retail greenhouse was doing well. We had a loyal, high-end customer base that enjoyed shopping at our facility from spring through October. However, as I studied the numbers, I began to question the profitability being open July through October. The great profits of spring were being eroded as we hit the "slow" summer season.

I had two choices: increase sales to increase profit or reduce costs to increase profit. I was old (nearly 60), I was tired (I still am), and I was sitting on some very valuable property. So, I took the big step (reduce costs) and closed on July 10. This year I closed on July 1. Over the past two years, I have seen a \$50,000 decrease in total gross sales; however, I am able to report the highest bottom line ever in my 30 years of retailing!

That didn't just happen. I spent significant effort in the early years of my business (which is now 10 years

old) identifying its focus and place in our market. Following are highlights of those efforts:

**Our primary focus is growing and selling quality herbaceous plant material.** Yes, we sell a limited line of nursery and hard goods, but the thing that has made our name and fame has been on-site produced top quality annuals and perennials!

**"We Grow Our Own, That's The Difference."** That's the common mantra to our advertising and a major key to our success. We grow practically all of our herbaceous plant material on site allowing us the ability to differentiate our product and our operation.

**We sell to a high-end retail market.** This translates to very solid pricing. Most of our customers are willing to pay a good price if they can see the value of the product.

**We have fun with our customers.** You can't afford not to! People want to spend their money where they know it's appreciated. Take a little time to have fun with your customers. Let them know you're glad to see them and their money!

**We "Hit and Run" – When the season is hot, so are we.** Our customers now know that when the season hits so do we. We do our very best to provide them with the best product and service at the time they really need and expect it. They also know, and most applaud the fact, that we will close down as the season winds down!

**When we have a sale, WE HAVE A SALE!** Our last two weeks of the season we treat our customers to a great sale. Our goal is to reduce all inventories. We offer 50 percent off all plant material. This comes at a time when most of the area competition is offering 25 percent to 30 percent off "selected" plant material.

Because we grow most of our own product and sell at a solid retail price, we can offer our customers a great value and still be at a price point that is above the average wholesale price. Yes, many customers wait for the sale, but many others buy at regular price before the madness starts!

**We close just after the season peaks.** Don't wait too long or you'll lose much of the advantage. Also by early summer everyone is having a sale and your efforts are greatly reduced.

We all have different operations and run them with different philosophies. What works well for one business may not work for another. I think we all agree the marketplace has changed dramatically in the past few years and it will most certainly change much more in the next few.

Our industry produces a wonderful product. Our goal as retailers is to get that product from our sales yard to the customer's yard and be rewarded for our efforts!

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production costs. Photoperiodic plants are classified into the following groups:

- *Long-day plants* are those that flower when the night length is shorter than a certain critical length.
- *Short-day plants* are those that flower when the night length is longer than some critical length.
- *Day neutral plants* are those that flower at a similar time under either long days or short days (i.e. flowering is not regulated by photoperiod).

The “critical” day lengths vary by crop but, generally, short-day plants will flower when the day is less than 11 hours (night length >13 hours), and long-day plants will flower when the day is longer than 14 to 16 hours (night length < 8 to 10 hours).

Within the long day and short day classifications are plants that can have either a facultative response or an obligate response. Plants with an obligate requirement for a particular photoperiod will only flower if grown under the appropriate photoperiod. Plants with a facultative response will flower earlier under the appropriate photoperiod, but will eventually flower under any photoperiod. The photoperiodic response group of many bedding plant crops is shown in Table 1 (page 8).

Potted plant growers have used photoperiod manipulation for decades to control flowering of crops such as chrysanthemum. The practice of covering chrysanthemum, a short-day plant, with blackout cloth when the days are naturally long has allowed growers to produce flowering chrysanthemums at any time of the year. Photoperiod manipulation has not been common practice in the bedding plant industry. However, as we learn more about how bedding plants respond to photoperiod, it is clear that growers can greatly reduce production time of many bedding crops by manipulating the photoperiod to induce earlier flowering.

For example, *Salvia farinacea* (blue salvia), a facultative long-day plant, flowered 27 days earlier when grown under long days compared to short days! The less time a crop spends in your greenhouse, the lower your heat and labor costs to grow that crop.

Long days can be provided in the greenhouse either by extending the day with supplemental lighting, or by breaking up the dark period by turning lights on for four or more hours in the middle of the night (known as night-break, night-interruption, or “mum lighting”), traditionally from 10 p.m. to 2 a.m. Plants must generally

be exposed to a minimum light intensity of  $2 \mu\text{mol m}^{-2} \text{s}^{-1}$  (approximately 10 footcandles) for photoperiod control, whether as a day extension or a night-interruption.

Intermittent (cyclic) lighting can also be used during a night-interruption to provide long days. Cyclic lighting offers the opportunity to provide long-days while reducing electrical costs compared to standard night-interruption lighting. One way to provide cyclical lighting is to have incandescent lamps on a timer, with lights being on for 6 minutes, then off for 24 minutes for 4 to 6 hours total. This strategy should not be employed with high-pressure sodium (HPS) or metal-halide lamps because these bulbs take 10 to 15 minutes to warm up to their full output, resulting in very inefficient use of electricity, and the bulb life for these bulb types decreases the more they are turned on and off.

High-pressure sodium lamps have been successfully used for cyclical lighting in two ways: mounting lamps onto an irrigation boom and having the boom move over the plants every 5 to 10 minutes, and using a stationary lamp with a rotating reflector.

Short days can be provided by pulling a blackout cloth over the crop to ensure that the day length is less than 11 hours. Although there are many more long-day plants than short-day plants among bedding plant crops, there are several important crops that are short-day plants (Table 1, page 8), including African marigold, cosmos, celosia, and *Zinnia elegans*. For short-day bedding plant crops, research at the University of Minnesota and Michigan State University has determined that three weeks of short days are generally enough to induce flowering. After flowering is induced, plants can be grown under any photoperiod (long days or short days) without a delay in flowering.

### Photosynthetic Lighting

Plant growth is the result of photosynthesis, where plants use the energy from light to convert gaseous carbon dioxide into simple sugars and, ultimately, plant tissues. The rate of photosynthesis increases as light intensity increases up to a certain point (called the “light saturation point”); therefore plant growth also increases as light intensity increases. Bedding plant crops, particularly in northern regions, are typically produced during times of the year when light levels are far below the optimum for plant growth. The exceptions are

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pansies and other bedding crops produced during the summer for fall sales. Adding supplemental lighting from HPS lamps can greatly increase the amount of light available for plant growth during low light periods of the year. The total amount of light (photosynthetically active

radiation, or PAR) received during a day is referred to as the daily light integral (DLI).

As an example, consider a plug grower starting a crop in Michigan in February. On an “average” February day, the DLI in the greenhouse will be around 8 mol m<sup>-2</sup> d<sup>-1</sup>.

Table 1. Photoperiodic response groups for numerous annual bedding plants.

<b>Obligate Long-Day Plants</b>	
<i>Ammi majus</i>	Asperula
Bachelor's Buttons ( <i>Centaurea</i> )	Catananche
China Aster ( <i>Callistephus</i> )	Dill
Flax ( <i>Linum</i> )	<i>Fuchsia x hybrida</i>
Gazania	Ipomopsis
Lavatera	Legousia
Leptosiphon	Limnanthes
Lobelia	Love-In-The-Mist ( <i>Nigella</i> )
Monkey Flower ( <i>Mimulus</i> )	Nierembergia
Primrose ( <i>Oenothera</i> )	Petunia ('Purple Wave')
Platystemon	Rudbeckia
Strawflower	Sweet Pea (Lathyrus)
Tuberous begonia ( <i>Begonia tuberhybrida</i> )	
<b>Facultative Long-Day Plants</b>	
African Daisy ( <i>Dimorphothica</i> )	Ageratum
Basil	Calendula
Collinsia	<i>Dianthus chinensis</i>
Linaria	Mexican sunflower ( <i>Tithonia</i> )
Pansy ( <i>Viola</i> )	Petunia (Grandiflora types)
Phacelia	Reseda
Salpiglossus	Salvia
Snapdragon	Statice
Sunflower	
<b>Obligate Short-Day Plants</b>	
Mina Vine	Hyacinth Bean
African Marigold ( <i>Tagetes erecta</i> )	
<b>Facultative Short-Day Plants</b>	
Celosia	Cosmos
Creeping Zinnia ( <i>Sanvitalia</i> )	Globe amaranth ( <i>Gomphrena</i> )
Hiemelis begonia	Moonflower ( <i>Ipomea</i> )
Morning Glory ( <i>Pharbitis</i> )	Signet marigold ( <i>Tagetes tenuifolia</i> )
Zinnia ( <i>Zinnia elegans</i> )	
<b>Day-Neutral Plants</b>	
Amaranthus	<i>Asclepias curassavica</i>
Balsam ( <i>Impatiens balsamina</i> )	<i>Begonia semperflorens</i> (Wax begonia)
Carpanthea	Centranthus
Cleome	Cobea
<i>Dianthus barbatus</i>	French marigold ( <i>Tagetes patula</i> )
Geranium	Impatiens
Nemophila	New Guinea impatiens
Oxypetalum	Stock
Verbascum	<i>Zinnia angustifolia</i>

If the greenhouse is equipped with HPS lamps delivering  $60 \mu\text{mol m}^{-2} \text{s}^{-1}$  (approximately 450 footcandles; greenhouse HPS installations typically provide between 50 and  $80 \mu\text{mol m}^{-2} \text{s}^{-1}$  PAR) for 16 hours each day, the lamps will deliver an additional  $3.45 \text{ mol m}^{-2} \text{d}^{-1}$ , increasing the total DLI by almost 50 percent! The percent increase in DLI when HPS lamps are used for supplemental lighting can be much higher during cloudy days. Clearly, the relative amount of the DLI provided by HPS lamps will decline as the days of spring get longer and brighter. Using an environmental control computer to ensure that lamps are only on when the ambient light levels are low will greatly increase the efficiency of using the lamps.

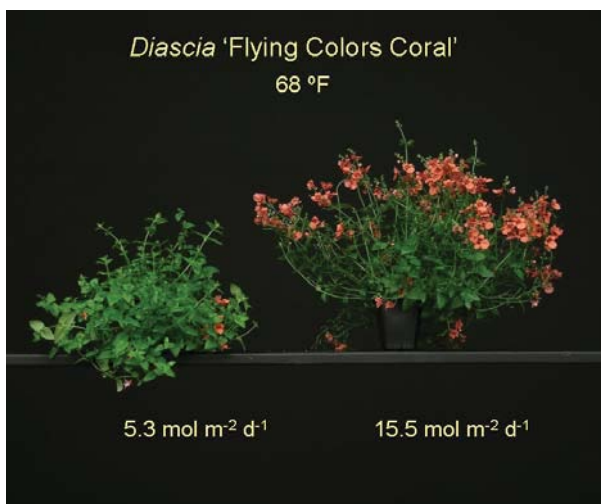
The rate of development (leaf unfolding rate) of a plant is regulated by temperature. Due to the high amounts of heat given off by HPS lights, providing supplemental lighting will increase plant temperature. In general, providing  $60 \mu\text{mol m}^{-2} \text{s}^{-1}$  of supplemental light from HPS lamps will increase plant temperature 2 to  $3^\circ\text{F}$ . Therefore, plants grown under HPS lamps will develop faster than plants grown without supplemental lighting.

In addition to increasing photosynthesis, supplemental photosynthetic lighting can also greatly increase other crop quality parameters. As DLI increases, plants tend to produce more flowers (Figure 1), larger flowers, and more lateral branches. Additionally, internode elongation generally decreases as DLI increases.

### Irradiance Response Groups

In addition to photoperiod effects on flowering, the total amount of light a plant is exposed to each day, or DLI, impacts the point in plant development when flowering occurs for several important bedding plant crops. Plants are classified into the following categories:

- Facultative irradiance response – increasing DLI reduces leaf number below the first flower, meaning plants flower earlier developmentally.



**Figure 1.** Increasing daily light integral from  $5.3 \text{ mol m}^{-2} \text{d}^{-1}$  (a typical greenhouse value in Lansing, MI in January) to  $15.5 \text{ mol m}^{-2} \text{d}^{-1}$  (a typical value in April) greatly increases flower number of *Diascia* 'Flying Colors Coral'. Both plants were grown at constant  $68^\circ\text{F}$ .

- Irradiance indifferent response – increasing DLI does not impact leaf number below the first flower.

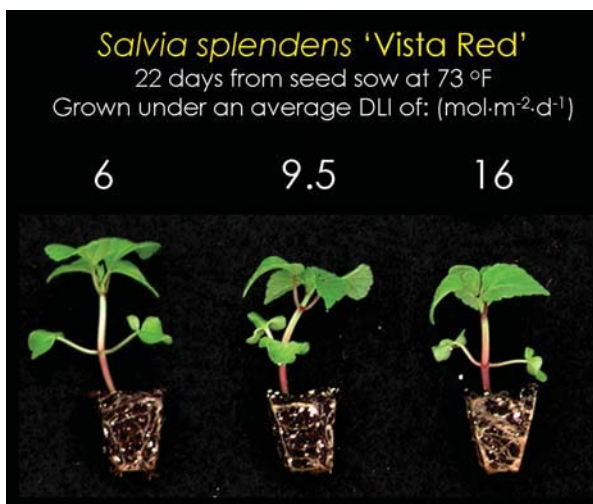
When defining an irradiance response, we use the leaf number below the first flower to separate whether flowering occurred earlier under a higher DLI simply because the heat from the lamps increased the leaf unfolding rate (i.e. plants under high and low DLI flower with the same number of leaves below the first flower, but days to flower is lower for plants grown under the high DLI due to the extra heat), or because plants flowered earlier in development (i.e. with fewer leaves below the first flower). Irradiance response groups of several bedding plant species are listed in Table 2 (page 10).

### Lighting during the Plug Stage

There are several advantages to lighting during the young plant stage. The increased photosynthesis under supplemental lighting will produce plugs with thick, strong stems. Supplemental lighting also greatly increases root growth (Figure 2), leading to a more “pullable” plug for transplanting. The extra heat coming from the lamps, combined with the extra light available for shoot and root growth, often reduces plug production time, allowing you to produce more crop cycles per season. Lighting during the plug stage can also result in significant “carryover” effects for finished crops. When supplemental lighting is used to extend the day length, flowering of long-day plants is promoted, reducing production time for the finisher.

### Growing Under HPS Lamps May Change Your Cultural Practices

Due to the extra light and heat given off by HPS lamps, your production practices will have to be altered accordingly. For example, plant stomata (the pores on the leaves that allow carbon dioxide to move into the plant for photosynthesis and water vapor to move out of the plant through transpiration) will be more widely



**Figure 2.** *Salvia splendens* 'Vista Red' root growth is much greater at a daily light integral or  $16 \text{ mol m}^{-2} \text{d}^{-1}$  compared to 6 or  $9.5 \text{ mol m}^{-2} \text{d}^{-1}$ , resulting in reduced plug production time. (Photo courtesy of Erik Runkle, Michigan State University).

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## Supplemental Lighting on Bedding Plants – Making it Work for You

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Table 2. Irradiance response groups of several annual bedding plants.

<p><b>Facultative Irradiance Response</b></p> <p>Blue Salvia            Centranthus            Cosmos            Dwarf Morning Glory (<i>Convolvulus</i>)            Flowering Tobacco (<i>Nicotiana</i>)            Lavatera            Limnanthes            Pansy            Poppy            Snapdragon            Wax Begonia</p>	<p>Catananche            Cleome            Cyclamen            English Primrose            Gazania            Love-In-The-Mist (<i>Nigella</i>)            Nemophila            Petunia 'Purple Wave'            Silene            Sweet Pea</p>
<p><b>Irradiance Indifferent</b></p> <p>Ageratum            Calendula            Dianthus            Gomphrena            Lobelia            Mina Vine            Statice            Thunbergia            Zinnia</p>	<p>Amaranthus            Cobea            Dimorphothica            Ipomopsis            Mimulus            Sanvitalia            Stock            Verbascum</p>

open under higher irradiance. Therefore, plants will transpire more and your irrigation schedule will have to be adjusted to provide more frequent watering.

Plants generally grow shorter under higher irradiance. This will require you to adjust your plant growth regulator (PGR) practices. Plants grown under supplemental lighting will generally require fewer PGR applications, or applications of a lower rate of chemical compared to crops grown without supplemental lighting.

Supplemental lighting will also accelerate flowering on many crops. This is a result of the increase in temperature for plants grown under supplemental lighting, resulting in a higher leaf unfolding rate, and promotion of flowering in long-day plants by extending the day length with supplemental lighting. Therefore, your production schedules will have to be adjusted as crops will finish earlier. Plug producers can take advantage of this to get more “turns” through the greenhouse each season, making the investment in supplemental lighting economical.

### Is Supplemental Lighting Right for You?

All growers should use photoperiodic lighting during production of spring bedding plant crops. The installation and operation costs are relatively low, and production time of many crops can be reduced by several weeks,

substantially reducing production costs. Remember, the less time your crops spend in the greenhouse, the less you have to heat them.

Adding HPS lights is a significantly larger financial investment. For a positive return on the investment, you either need to produce and sell more product, or get a higher price for a premium quality product. Plug growers should strongly consider investing in HPS supplemental lighting, as supplemental lighting can increase the number of plug crops that can be produced, and offers the opportunity to get a higher price for plugs that will flower faster in the finishing environment. Similarly, yield of vegetative cuttings often increases as DLI increases. Growers that produce plugs for finishing “in-house” should consider installing HPS lamps in the greenhouse sections used for producing the plugs, then using those sections to finish crops with a facultative irradiance response.

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## Commercial Production of Potted Orchids

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and range from 1.5 feet to over 3 feet in height. Flower size varies from 3 to 5 inches in diameter. Cymbidium flowers usually last for about four to six weeks. They are mostly produced in central to southern coastal California due to the favorable climates.

### Growing Requirements

- Bright light – up to full sun in areas with cool climates
- Warm conditions (up to 86°F or 30°C) during vegetative growth
- A cool to cold environment (50 to 59°F or 10 to 15°C) for flower induction and bud development
- Deep pots to accommodate the root mass
- High fertility during vegetative growth and flower bud initiation

### Dendrobiums

The commercially important Dendrobiums have erect pseudobulbs (stems or canes). They include two distinctly different types: the phalaenopsis dendrobiums and the nobile dendrobiums. The former are evergreen plants and must be grown in a warm environment. Cold temperatures can cause undesirable leaf drop. Inflorescences are produced on the top nodes of the erect pseudobulbs. The 2.5-inch to 4-inch flowers easily last over two months. The nobile dendrobiums require warm conditions during vegetative growth, but have an absolute requirement for low temperature (<59°F or 15°C) for flower induction. The 2-inch to 2.5-inch flowers are born on the lateral nodes and last for about four weeks. We are currently conducting extensive research on the nobile dendrobiums to learn more on its propagation, nutritional and cold requirements, and flower bud initiation for possibly year-round flowering. The mini phalaenopsis type dendrobiums have been increasing in their popularity in recent years. They often stay in bloom for two to three months.

### Growing Requirements

- High light (best  $\geq 3,500$  f-c or  $700 \mu\text{mol m}^{-2} \text{s}^{-1}$ )
- Medium to high fertility during vegetative growth
- Keep temperature no lower than 75°F (24°C) during vegetative growth of both types
- Terminate fertilization on the nobile dendrobium no later than September 1
- Give 59°F (15°C) treatment for six weeks to vernalize the nobile dendrobium after pseudobulb maturation

### Cattleyas

Cattleyas, the queen of orchids, appear to be on the comeback in the mass market. These orchids have a

single leathery leaf on a swollen pseudobulb. The standard cattleyas are often too large to fit well in a home. Their flower buds are differentiated during maturation of the new growth, but remain dormant until the fall when the photoperiod becomes short. Mature plants can be programmed to flower by black-clothing for six weeks. Medium to small size cattleyas have been increasing in popularity. Many of these smaller plants bloom freely without short photoperiod. Most cattleya flowers are highly fragrant. Flowers last only two to three weeks. Once flowers have opened, strong light is still required for the flowers to reach their potential size and to develop color. Since cattleya requires high light to grow well, most inexperienced people have trouble reblooming this orchid.

### Oncidiums and Their Intergeneric Hybrids

Oncidiums and their intergeneric hybrids are a popular group of potted orchids. Flowers of oncidiums range from 1 to over 5 inches and last about six weeks. Their broad leaves arise from the pseudobulb. One to several inflorescences start to develop once a pseudobulb nears maturity. Many are relatively large plants and the inflorescences of certain hybrids can reach 3 to 4 feet in height. There are also hybrids that are less than 1 foot tall and produce tens to hundreds of half-inch fragrant flowers. The flowers of *Oncidium* 'Sharry Baby' have a chocolate-vanilla fragrance. Many oncidiums and their intergeneric hybrids require a cool environment to grow and bloom well.

### Miltoniopsis

Miltoniopsis, the pansy orchids (Figure 1, page 12), are small plants with 3-inch to 4-inch flowers that last more than two months. They have fragrant flowers, prefer mild to cool conditions (70 to 50°F or 21 to 10°C), and are good crops for northern climates. They require low fertilizer rates. An application of GA promotes earlier flowering.

### Paphiopedilums and Phragmepediums

The commercially important slipper orchids belong to two main categories: the Asian-native Maudii type paphiopedilums and the South American-native phragmepediums. The mostly single-flowered Maudii paphiopedilums tolerate higher temperatures (up to 86°F or 30°C) than the multiple-flowered phragmepediums (no higher than 70°F or 21°C for best quality). Many paphiopedilums have mottled leaves. Those with a single "bull-dog" flower have light green leaves. Unlike the other orchids which prefer the roots to become dry before

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## Commercial Production of Potted Orchids

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**Figure 1.** *Miltoniopsis* (the pansy orchid)

being rewatered, the roots of slipper orchids should never be allowed to dry out for too long. Many can be grown in standing water year long. They require low fertility (no more than 0.5g N/liter). Flowers last for 6 to 12 weeks.

### Zygopetalums

The zygopetalums have a relatively small stature (12 to 15 inches; 30 to 45 cm) and many produce extremely fragrant 2-inch flowers. They require medium light (approximately 1,500 to 2,000 f-c), mild days (<low 70°F or 23°C), and cool or cold nights (approximately 50 to 59°F or 10 to 15°C) to flower well. They are great for northern climates. One or two inflorescences, each bearing three to five flowers, appear soon after the new growth has started. Flowers last four to six weeks.

### Phalaenopsis and Doritaenopsis

By far, phalaenopsis and doritaenopsis take the largest share of the potted orchid market, believed to account for more than 80 percent of all potted orchids. They can bloom in a short two years from seed. Taiwan leads the world in breeding and supplying phalaenopsis hybrids. The 1- to 5-inch (or more) flowers nearly occupy all colors in the rainbow. The individual flowers can each last for three to four months. A well-cared-for plant often remains in bloom for more than five months. The standard phalaenopsis have large flowers on long, arched inflorescences, whereas the multiflora type hybrids have many small flowers on short, erect inflorescences.

Phalaenopsis requires heavy shade. Light intensity between 800 to 1,500 fc (160-300  $\mu\text{mol m}^{-2} \text{s}^{-1}$  PPF) is adequate. Small, young plants require high temperatures (82 to 90°F days and 75 to 80°F nights; 28 to 32°C days and 23 to 27°C nights) for fast leaf production and maturation. Once matured, plants require temperatures at/or below 77°F (25°C) to effectively trigger the lateral bud or buds to elongate (called spiking) and develop into inflorescences. After spiking, 77°F (25°C) days and 68°F nights (20°C) are ideal for flower bud differentiation and high flower count. Higher temperatures result in fewer flowers. Prolonged exposure to above 82°F (28°C) after spiking causes the tip of the flowering stem to remain

vegetative or to produce an aerial plant. Although lower temperatures increase bud count and increase the chance for multiple inflorescences, remaining under such conditions after flower bud differentiation results in a much longer time to reach flowering. Low temperatures (<59°F or 15°C) can cause deformed flowers. Air conditioned greenhouses are used to trigger spiking and flowering during the warm months. This practice is particularly popular in Japan and Taiwan.

If kept at or above 82°F (28°C), phalaenopsis remains vegetative. Many commercial growers keep their greenhouses very warm in the fall and winter to defer spiking and flowering. It requires a tremendous energy input and is expensive. Orchids like well-drained root medium with plenty of air. Medium selection must consider the following factors: aeration, weight, water- and nutrient-holding capacity, capillary action, stability, availability, and cost. Ground Douglas fir or redwood bark, pine bark (fresh, composted, or aged), coarse peat, coarse perlite, coconut husks (chips or shredded), diatomite, synthetic fiber or floral foam, pumice or rocks, and sphagnum moss (alone or mixed with others) have all been used to grow orchids. Most phalaenopsis propagators use sphagnum moss from New Zealand or Chile as the sole root medium.

When grown in a bark medium, high fertility (200 ppm nitrogen) is required. Fertilizer concentration may be reduced to one-third or one-quarter when grown in sphagnum moss due to its high degree of water and nutrient retention. Phalaenopsis roots are sensitive to salts. Leach the medium well when watering and maintain an EC no higher than 2.0 mmho/cm (1 to 1.5 preferred). Many growers install a reverse osmosis system to improve their water quality. However, calcium and magnesium must be supplemented to avoid deficiency symptoms. For more details, refer to the July through October 2005 issues of *Greenhouse Grower Magazine* for a four-story series on growing phalaenopsis.

Keeping proper air movement, particularly during the night, is vital to producing a profitable orchid crop. High humidity and stagnant air are conducive to Botrytis infection on the flowers.

Flowers of all orchids are extremely sensitive to ethylene. Fumigating with 0.2 ppm 1-MCP provides protection against ethylene. However, this protection is short-lived, less than 6 days at 77 to 86°F (25 to 30°C), 6 to 10 days at 68°F (20°C), and 10 to 14 days at 59°F (15°C).

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## Water-Soluble Fertilizer Labels: Beyond the Basics

by Karen Kackley and Cari Peters

In our previous *OFA Bulletin* article (September/October 2006), *Anatomy of a Water-Soluble Fertilizer Label*, we examined the five components required by law on all fertilizer labels: brand and grade, the guaranteed analysis, the net weight of the product, the name and address of the registrant/licensee, and directions for use. In addition we reviewed the “derived from” statement, the potential acidity or basicity of a product, and the macronutrients, nitrogen (N), phosphorus (P), and potassium (K). While it is common for growers to focus on the three big numbers of a fertilizer’s grade (N, P<sub>2</sub>O<sub>5</sub>, and K<sub>2</sub>O), it is also important to examine the information contained in the label’s fine print. The information provided in fine print is frequently more essential to making a proper fertilizer selection than the three big numbers and can reveal the difference between brands of fertilizer. In this article we will discuss the items contained in the fine print.

To begin, we return to the guaranteed analysis, defined as the percent weight of the nutrients the formula claims to contain, and we will focus on the secondary nutrients, micronutrients, and the synergistic or antagonistic interactions between them.

### The Secondary Nutrients

Calcium (Ca), magnesium (Mg), and sulfur (S) are often referred to as secondary nutrients. Typically they are required by the plant in concentrations slightly lower than N, P, and K but higher than the micronutrients. It is important to note that most “all purpose” fertilizers and soilless growing media do not supply secondary nutrients; however, many irrigation water sources do provide adequate supplies of these nutrients. High alkalinity waters may contain elevated concentrations of calcium, magnesium, and sulfur while relatively pure waters are usually deficient in these nutrients. A standard nutrient analysis conducted by a horticultural laboratory can provide you with the level of these and other nutrients in your irrigation water. Each irrigation water source should be tested at least once a year to monitor the concentration of these nutrients. The proper amount of secondary nutrients is determined by the crop being grown. If the secondary nutrients are not present in your irrigation water you should plan to supply them through the fertilizer.

### Calcium

Since calcium is integral in cell wall development, it is essential for root and shoot development and provides strength to the plant structure. Most crops grow best when supplied with 50 to 60 ppm of calcium on a continuous basis; however, others such as poinsettia, may require levels as high as 100 ppm. Because it is immobile in the plant, calcium deficiency is first exhibited in the upper leaves and at the growing points. Low calcium levels can slow or stunt root growth and can progress to blackening and rot. Low levels in the shoots can result in poor expansion and edge burn of young leaves, terminal bud abortion, reduced bud count, and poor bract formation. Calcium deficiency is more pronounced when the pH of the growing medium drops below 5.5 and under environmental conditions that reduce transpiration, such as cool, dark weather. It may appear that the simplest solution is to always supply calcium via a water soluble fertilizer. The problem is that most calcium containing fertilizers are potentially basic and can raise the pH of the growing medium. This can be particularly problematic for growers with high alkalinity water. In fact, the best solution is to apply just enough calcium to satisfy the crop’s requirements and maintain an environment conducive to optimum transpiration.

Calcium nitrate (CaNO<sub>3</sub>) is the most common source of calcium in water soluble fertilizers. Fertilizer formulas such as 15-0-15 Dark Weather (11% Ca) or 20-0-20 (6% Ca) are blended using calcium nitrate as the major form of nitrogen and contain a full and balanced micronutrient package. In addition, you can use straight calcium nitrate 15.5-0-0 (18.8% Ca) as an amendment to your fertilizer program to increase Ca concentrations (a 100 ppm N solution will supply 120 ppm Ca). There are numerous “Cal-Mag” formulas on the market, such as 15-5-15, that supply most of the nutrients essential for plant growth.

### Magnesium

Magnesium is actively involved in photosynthesis as the central component of the chlorophyll molecule. It serves many functions including the activation of many plant enzymes and in phosphate usage. Deficiency

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## Water-Soluble Fertilizer Labels: Beyond the Basics

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symptoms appear on the older, lower leaves first as a marginal or interveinal chlorosis.

Water-soluble sources of magnesium include magnesium nitrate ( $\text{MgNO}_3$ ; 10.8% Mg) and magnesium sulfate. The latter source is the most common and can be found in two forms, Epsom salts ( $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ ) and anhydrous magnesium sulfate ( $\text{MgSO}_4$ ). The anhydrous form (19.9% Mg) provides a higher concentration of magnesium per unit weight compared to Epsom salts (9.7% Mg); however, the anhydrous form takes longer to dissolve at lower temperatures. For many crops, magnesium addition is required in order to keep a proper calcium to magnesium balance. An application of Epsom salts at a rate of 2 ounces per 100 gallons will supply approximately 15 ppm Mg to your fertilizer program. To correct a severe Mg deficiency, it may be necessary to apply up to 1 pound of Epsom salts per 100 gallons of water. This supplies 120 ppm Mg.

### Sulfur

In addition to magnesium, magnesium sulfate compounds contribute sulfur (S) as sulfate ( $\text{SO}_4$ ). Plants readily absorb sulfate, making sulfur immediately available to the plant. Sulfur, like nitrogen, is a component of plant proteins. Deficiency symptoms are similar to N, with first signs of deficiency showing on the plant's lower leaves. However, a plant low in S will exhibit a pale green color over the entire plant, and in severe cases the leaves may shrivel and plant growth may be stunted. Most components of media mixes (peat, bark, vermiculite, etc.) contribute little or no sulfur

for plant uptake; therefore, water-soluble fertilizers containing sulfur may be a necessary addition to balance your plant nutrition program.

### The Trace Elements or Micronutrients

Micronutrients are required by plants in relatively small amounts; however, they are essential for plant growth and life cycle completion. The micronutrients typically supplied in water-soluble fertilizers are iron, manganese, copper, zinc, boron, and molybdenum. Micronutrient availability is largely controlled by the pH of the growing media. High pH (greater than 6.5) may cause micronutrient deficiencies while low pH (less than 5.4) may cause micronutrient toxicities. Molybdenum is an exception to the rule in that it follows the reverse trend and is more available at a higher pH and less available as the pH drops.

Most micronutrients exist in one of two forms, a sulfate salt or a micronutrient chelate. The exceptions to this are boron and molybdenum. Table 1 displays the most common forms of micronutrients used in water soluble fertilizers. Micronutrient packages such as MOST or STEM contain a mix of micronutrients, most of which are bound to sulfates. These forms are less soluble in solution than the chelates but they provide a balanced mix of micronutrients that can be used to amend your fertilizer program or as a booster application to combat micronutrient deficiencies.

The chelated forms of micronutrients are often regarded as superior because they are more soluble and therefore more readily available to the plant. Chelates

Table 1. Some common forms of micronutrients used in water-soluble fertilizers.

Micronutrient	Chemical Form	Formula
Iron (Fe)	Iron sulfate (20%) Fe-chelate (13%) Fe-chelate (11%) Fe-chelate (6%)	$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ $\text{EDTA-FeNa} \cdot 3\text{H}_2\text{O}$ $\text{DTPA-FeHNa}$ $\text{EDDHA-FeNa}$
Manganese (Mn)	Manganese sulfate (31%) Mn-chelate (13%)	$\text{MnSO}_4 \cdot \text{H}_2\text{O}$ $\text{EDTA-MnNa}_2$
Copper (Cu)	Copper sulfate (25%) Cu-chelate (15%)	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ $\text{EDTA-CuNa}_2$
Zinc (Zn)	Zinc sulfate (35%) Zn-chelate (15%)	$\text{ZnSO}_4 \cdot \text{H}_2\text{O}$ $\text{EDTA-ZnNa}_2$
Boron (B)	Boric acid (17.5%)	$\text{H}_3\text{BO}_3$
Molybdenum (Mo)	Sodium-based (46%) Nitrogen-based (54%)	$\text{Na}_2\text{MoO}_4$ $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24} \cdot 4\text{H}_2\text{O}$

keep micronutrients available in solution by surrounding the element by a chemical ring compound (the chelating agent). The ring structure keeps the micronutrient from binding with other compounds and available for absorption by the plant. Chelation is a naturally occurring biological process. Several chelating agents exist in nature, including humic acid, citric acid, and tartaric acid; however, these chelates often form weak bonds that can be easily broken under less favorable conditions. Synthetic chelates are used in water soluble fertilizers to keep the micronutrients available and prevent clogging of lines or equipment by insoluble precipitates.

The most common synthetic chelates are:

- EDTA (Ethylenediaminetetraacetic acid) – usually found as the sodium salt of the metal being chelated. Most available and effective at pH levels lower than 6.0 to 6.5.
- DTPA (Diethylenetriaminepentaacetic acid) – available as an iron chelate (Sprint 330). Most available and effective at pH levels lower than 7.0 to 7.5.
- EDDHA (Ethylenediaminedi-o-hydroxyphenylacetic acid) – available as iron chelate (Sprint 138). This chelating agent keeps the micronutrient available over the entire pH spectrum, but it is very expensive and has a lower micronutrient content. The cost-in-use of this chelate may be four times that of EDTA.

In addition to considering the form of the micronutrients, you should review the level of the micronutrients in the formula. For example, the common 20-10-20 fertilizers are available both as “Peat-Lite” and “General Purpose” formulas. Typically, “Peat-Lite” formulations contain two to three times the standard micronutrient content found in “General Purpose” formulas. Zinc and manganese levels can be considerably higher than three times in a “Peat-Lite” formula. These higher concentrations help to compensate for the characteristics of a peat-lite or soilless mix. “General Purpose” formulations contain a combination of micronutrients at levels that are suitable for growing in field soil or mixes containing some soil and mixes that have a high micronutrient additive in the starter charge.

The micronutrient content of a water-soluble fertilizer is listed in the guaranteed analysis on a percentage basis

and in the form in which it is supplied. However, some companies may supply additional information on the micronutrient content of their fertilizers in a ppm format. For example, the ppm delivered in a 100 ppm total nitrogen solution. This allows the customer to compare formulas on an equal “in use” basis. Table 2 presents an example of the two ways that micronutrient concentrations may be displayed for a fertilizer formula.

As the fertilizer industry has evolved, there have been great advances in research through media and tissue analyses that has spawned the development of specialty formulas. Micronutrient levels have been adjusted based on how specific crops respond, leading to new specialty water-soluble fertilizer formulations. Keep in mind that what may be optimum for poinsettias may prove to be marginally adequate for another crop like pansies. Using crop specific formulas on a different crop may result in poor plant growth and micronutrient deficiencies.

### Nutrient Antagonisms and Synergisms

Just as important as the amount of each individual plant nutrient is the balance between them. Plant nutrients exist in the soil solution in a delicate balance of positive and negative ions that compete for binding sites and uptake by plant roots. An overabundance of one nutrient can result in a deficiency of another, while some nutrients can increase the uptake of others. The relationship between potassium, calcium, magnesium, and sodium illustrates this principle well.

Potassium (K), calcium (Ca), magnesium (Mg), and sodium (Na) all exist in solution as positively charged ions or cations. The uptake of these cations can be increased by the presence of nitrate ( $\text{NO}_3^-$ ), a negative anion, while ammonium ( $\text{NH}_4^+$ ) decreases their uptake. Optimum uptake of K, Ca, and Mg occurs when the ratio in the soil solution averages 8 parts K to 2 parts Ca to 1 part Mg. Calcium levels should equal or exceed the level of sodium in soil solution. While it is not necessary that these ratios be exact, the closer they are to the desired range, the better the plant’s nutrient status. If excess K is present, it will first induce a magnesium deficiency and then a calcium deficiency. Calcium uptake is negatively affected by an overabundance of Mg and Na.

Table 2. The micronutrient concentration in “Peat Lite” and “General Purpose” formulas expressed as percent (%) and parts per million (ppm).

Fertilizer Formula		% B	% Cu	% Fe	% Mn	% Mo	% Zn
20-10-20	GP	0.0068	0.0036	0.0500	0.0250	0.0009	0.0025
20-10-20	Peat-Lite	0.0200	0.0100	0.1000	0.0500	0.0100	0.0500

PPM of Individual Nutrients in a 100 ppm N Total Nitrogen Solution							
Fertilizer Formula		B	Cu	Fe	Mn	Mo	Zn
20-10-20	GP	0.034	0.018	0.250	0.125	0.005	0.013
20-10-20	Peat-Lite	0.100	0.050	0.500	0.250	0.050	0.250

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As the above scenario illustrates, an excess of one nutrient may cause a “perceived” deficiency in another even though there is sufficient quantity of the “deficient” nutrient available. The following chart outlines some of the more common nutrient antagonisms.

Nutrient in Excess	“Perceived” Nutrient Deficiency
N	K
K	N, Ca, Mg
Na	K, Ca, Mg
Ca	Mg, B
Mg	Ca, K
Fe	Mn
Mn	Fe, Mo
NH <sub>4</sub> <sup>+</sup>	Ca, Cu
Cl	NO <sub>3</sub> <sup>-</sup>
P	Fe or Zn first, then Cu and other micronutrients
Zn	Mn, Fe
Cu	Mn, Fe, Mo, Zn
Mo	Cu

This chart can be used to help diagnose and correct a problem. For example, a pansy grower may use a “blossom booster” fertilizer high in phosphorus. Accumulated phosphorus in the root medium may antagonize the availability of iron, zinc, and other metals. The tissue may then develop deficiency symptoms of those micronutrients causing the grower to apply corrective applications of micronutrients. In fact, excess phosphorus in the fertilizer formulation is the “cause” of the problem and changing to a lower phosphorus fertilizer may likely correct the situation.

### Maximum Solubility and Fertilizer Compatibilities

Manufacturers usually print the maximum solubility of each fertilizer on the bag. Attaining maximum solubility is difficult and most growers do not try this.



**Figure 1.** Incompatible formulations: These four beakers contain a concentrate of 15-0-15 Dark Weather fertilizer. The clear beakers contain a No-Dye formula. Magnesium sulfate (Epson salts) was added to the two beakers on the left. The precipitate that formed is calcium sulfate. Potassium phosphate was added to the two beakers on the right and the precipitate that formed is calcium phosphate.

Remember that fertilizers dissolve best in hot water. More fertilizer can be dissolved in warm water compared to cold water. As soon as you begin adding fertilizer to water, it lowers the temperature (an endothermic reaction). Most fertilizers, if they are completely soluble to begin with, will go into solution within a reasonable period of time.

Certain fertilizers and amendments will form insoluble precipitates when mixed together in concentrate. These products are said to be incompatible. Most products can be mixed when in their final or ready-to-use strength.

### Mixing Don'ts for Concentrates

To avoid incompatible reactions and the precipitates that follow, it is best to avoid the following combinations.

**Calcium-Sulfur:** Do not mix concentrates of fertilizers containing calcium (e.g., calcium nitrate) with sulfates (e.g., Epsom salts, sulfuric acid, sulfated micronutrient packages). This combination will quickly result in a precipitate in the solution, gypsum (calcium sulfate), and it can be a mess!

**Calcium-Phosphorus:** Do not mix concentrates combining standard phosphate-containing fertilizers with calcium sources. The result will be insoluble calcium phosphate. For example, do not mix 15-0-5 and 20-20-20 together in concentrate. Exceptions to this rule include fertilizers utilizing urea phosphate or citric acid to create a low-pH stock solution. Check with the manufacturer for fertilizer compatibility because citric acid is not always indicated as an ingredient on the package label.

### A Few Words about Dye

Most companies include dye in their water-soluble fertilizer products. The purpose of the dye is to serve as an indicator that a solution contains fertilizer. The intensity of the dye color can be affected by a number of factors including the raw materials in the formula, the environmental conditions during manufacturing, transport and storage, and the age of the product. The color of a fertilizer solution is not an accurate way to determine its concentration. The best way to monitor the strength of a fertilizer solution is to measure the electrical conductivity of the solution (EC) or to send a sample to a laboratory for analysis.

Remember that your fertilizer manufacturer should be able to provide you with answers to your fertilizer questions. If you have questions about any aspect of the label or the product, contact their technical service department.

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# Interior Plantscape

## Market Your Holiday Cheer and Give a Big Gift to Your Bottom Line This Holiday!

by MJ Gilhooley

**P**icture a North Pole scene featuring elves that sprinkle snow and 200 twinkling trees. To think, it all started with a few poinsettias! At one point holiday accents and décor sales were merely a way to stay afloat during the down months. Today, according to interior industry guru Barb Helfman of TopSiders Inc., the holiday market represents 15 percent of the average plantscaper's gross revenue.

In order to ensure Santa will be bringing your company lots of holiday revenue, take a closer look at your marketing tactics. To be most effective, holiday marketing must be year-round. Luckily, there are plenty of creative and inexpensive ways to make holiday marketing automatic.

### Nine Easy Ideas for Your Business

**1. Start when you are in the spotlight.** Believe it or not, the best time to sell and up sell holiday décor is when your designs are on display. Consider the atrium of a large office to be your grand stage on which you get to reveal your creative genius to all the offices within a building, as well as neighboring facilities. Consequently, make sure you "sign" your work. Build in to every holiday agreement the right to display a compatible sign: "Décor by XYZ Co." Remember, your work is your best advertisement, so make the most of it.

**2. Get noticed!** If a site is appropriate for public traffic, then arrange a reasonable flow of holiday tours for key facility managers within a 10- to 15-mile radius of each major project you have installed. Send them personal invitations for peppermint mochas and a "Tour Décor" of your most dramatic sites. Use photos of your best displays on your invitations.

**3. Get the money shot, and share, share, share!** Yes, a picture is worth a thousand words, but only if it is well lit, in focus, and says, "Wow!" Invest in a professional one-day photo shoot to capture your most recent top 10 projects.

**4. Warn them: Don't be left without bells on.** When clients and prospects get the word in February that your holiday displays and scheduled time are in limited supply for the coming season, just watch the commitments flow in. Nobody likes to be left out.

**5. Create the holiday CD they fight over.** Your high-end prospects and those just too busy to steal away for

peppermint mochas need to be shown your designs in grand style at their convenience. The solution: grab a friend who is handy with their "iMovie" or an alternative musical slide show program, dust off your holiday music, and put together your own holiday special featuring your greatest hits. Burn plenty of leave-behind copies for sales calls.

**6. Snail mail still works.** Once you have your holiday hits CD, design a simple mailer using your own photos and your handy design friend. This mailer should serve as a good introduction to your CD and your best work. Send it to existing clients who have not yet purchased holiday décor and those who manage properties near your largest holiday projects. Follow up shortly with a call, arranging to visit for 15 minutes with your cool holiday special and – yes, some steamy peppermint mocha.

**7. Your front line speaks loudly.** Marketing is not only for your external customers, but also your employees. If your internal "elves" are truly excited about your flair for holiday, then they will be bragging wherever they go. In fact, many interiorscape companies have landed big, new holiday installs because their technicians spoke vividly about the beautiful work they do.

**8. Remind them: it's not annoying if it's fun.** June arrives and you have not heard from a few of your primary prospects. Pull out the big guns: Shoot over Santa sunglasses with a note of warning: "It's later than you may realize. Much later! Time to order has almost passed." You'll motivate your prospect to make a decision – and fast.

**9. The snow is the thing!** If you have the space, then try what the owner of one of Brazil's largest holiday decorating companies does. Cipolatti customers visit the company's showroom, decide on a theme, and set a date for installation – done.

Sure, all of these holiday marketing activities may not always go exactly as planned, but practice makes profit. You may have to keep throwing a lot of holly at the wall before something sticks. Just go with your strengths, keep it simple, have fun, and you'll be a success.



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## Outdoor Potted Chrysanthemums Results: Part II



by Mark Bridgen

In the July/August 2006 issue of the *OFA Bulletin*, the basics of growing potted garden mums were outlined. In this issue, I will begin to review the results from our 2005 research. Due to the length of the data and information, this issue will only cover the flower dates of the cultivars that were tested. In the next article, results from our Florel research and slow release fertilizer research will be presented.

During the late summer and fall of 2005, the chrysanthemum plants were examined daily. There were four key dates that were recorded for each pot:

- The date that the plants first showed color (Crack Date)
- The dates that the plants reached full bloom (Full Bloom Date)
- The dates that the plants first started to go bad (First Ugly)
- The dates that the plants were no longer marketable (Dead)

Although each of the major breeders/producers of garden mums provides tables of when the plants will bloom, their information is based on averages taken around the country. The data in the following tables were collected on Long Island at Cornell's Horticultural Research and Extension Center ([www.LongIslandHort.cornell.edu](http://www.LongIslandHort.cornell.edu)). The Season of Bloom column was determined by looking at both the Crack Date and the Full Bloom Date. These are the different categories:

- Very Early Season Cultivars = August 16-August 31
- Early Season Cultivars = September 1-15
- Mid Season Cultivars = September 16-30
- Late Season Cultivars = October 1-15
- Very Late Season Cultivars = After October 16

The year 2005 was very hot on Long Island, and most of the mum cultivars showed heat delay. They flowered later than they did in 2004. In spite of the heat delay, growers can still look at the tables and determine the approximate time that flowering will occur. In addition,

growers can tell which cultivars have the longest postharvest life in the pots by looking at the dates on these tables. Each Season of Bloom is 15 days. If cultivars crack color and reach full bloom in the same season, these two stages of development happened within 15 days. If, on the other hand, a cultivar has cracked color in one season of bloom and then reached full bloom in the next season of bloom, these different stages of development have occurred over 30 days.

Each year, we have some "winners" and some "losers" as far as how the plants look and perform. In 2005, there were some plants that "split" or pulled apart as they grew larger. Splitting is a problem that usually occurs close to the time of flowering when the canopy of flowers cannot stand upright; the weak stems flop over and require staking in order to have a nice looking pot. Some of the cultivars that demonstrated splitting were 'Golden Helga', 'Sharon', 'Victoria', 'Zesty Victoria', and 'Delightful Victoria'. There was another problem observed that we coined "purple veinosis." With this disorder, the leaves of the plant turn purple as the plants flower and age. The two cultivars with this problem were 'Discover Pink' and 'Caesar Bronze'. Some of our less favorite cultivars were 'Natalie', because it was a small plant, 'Tabitha', because the flowers opened under the foliage, and 'Calisto Pink', because it had an irregular shape and the flowers opened under the foliage.

Most of the cultivars that were tested produced very nice plants. However, there were several cultivars that stood out as especially attractive during the 2005 trials. These included 'Amor Coral', 'Castilio', 'Dazzling Stacy', 'Fiona', 'Harmony', 'Jenny Wren Red', 'Juno Yellow', 'Katelli Bronze', 'Lipsi Salmon', 'Manakin Red', 'Milano Orange', 'Milano Pink', 'Miranda', 'Spicy Cheryl', 'Sweet Stacy', 'Tatoi Bronze', 'Tiffany', and 'Venus Purple'.

Cornell University's chrysanthemum trials on Long Island have been conducted each year since 2002. Over the years, as we collect these data annually, consistent trends and flowering times are being determined.



Table 1. Dates of Season of Bloom for 2005 Ball Horticulture chrysanthemum cultivars.

Cultivar	2005 Season of Bloom on Long Island	Crack Date	Full Bloom	First Ugly	Dead
Adonis Purple	Very Early - Mid	8/28	9/16	10/18	11/3
Amor Coral	Early - Mid	9/14	9/18	11/11	Frost 11/19
Amor Yellow White	Early - Mid	9/9	9/28	10/20	11/14
Amphion Purple	Early - Mid	9/13	9/28	10/18	10/25
Argos Orange	Mid - Late	9/22	10/5	10/30	11/4
Babita Salmon	Mid	9/19	9/27	10/18	10/31
Babylon Bronze	Mid	9/23	9/29	10/17	10/24
Caesar Bronze	Late - Very Late	9/29	10/17	11/11	Frost 11/19
Calisto Pink	Very Early - Early	8/16	9/4	9/18	9/29
Castor Yellow	Early - Mid	9/5	9/28	10/8	11/4
Crete White	Mid	9/19	9/27	10/15	10/18
Delphi Purple	Mid - Late	9/23	10/8	11/13	Frost 11/19
Estrada Salmon	Mid - Late	9/28	10/12	11/3	11/12
Feniks Bronze	Very Early - Early	8/14	9/11	10/15	10/20
Firecracker Yellow	Very Early - Early	8/28	9/14	10/18	10/25
Freya Salmon	Early - Late	9/5	10/8	10/17	11/3
Gothic Purple	Early - Mid	9/14	9/28	10/24	11/10
Hermes Purple	Early - Mid	9/5	9/19	11/2	11/7
Jason White	Very Early - Mid	8/28	9/16	10/24	11/4
Jenny Wren Crimson	Very Early - Early	8/23	9/9	9/20	9/30
Jenny Wren Red	Very Early - Early	8/19	9/9	9/19	10/1
Juno Yellow	Mid - Late	9/27	10/9	10/29	11/3
Katelli Bronze	Early - Mid	9/8	9/19	10/15	10/20
Kepa Purple	Early - Late	9/14	10/8	11/4	11/14
Lipsi Salmon	Very Early - Mid	8/27	9/16	10/9	10/14
Lyra Pink	Very Early - Early	8/26	9/14	10/14	10/27
Manakin Red	Early - Mid	9/6	9/28	11/2	11/6
Minerva White	Early - Mid	9/10	9/23	10/18	10/31
Mylos Yellow	Very Early - Mid	8/30	9/19	10/24	11/3
Nighthawk Coral	Early - Mid	9/12	9/23	10/20	11/2
Pluto Red	Early - Mid	9/6	9/27	10/20	11/4
Rio Dark Pink	Mid - Late	9/16	10/9	11/2	11/6
Roadrunner Bronze	Very Early - Mid	8/28	9/20	10/20	11/2
Sirena Pink	Very Early - Early	8/23	9/14	10/9	10/20
Tatoi Bronze	Very Early - Mid	8/30	9/18	10/24	10/31
Unicorn White	Mid	9/16	9/23	10/11	10/21
Venus Purple	Mid - Late	9/24	10/8	11/5	11/12
Xanthus Yellow	Early - Mid	9/11	9/20	—	10/14

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## Outdoor Potted Chrysanthemums Results: Part II

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Table 2. Dates of Season of Bloom for 2005 GroLink chrysanthemum cultivars.

Cultivar	2005 Season of Bloom on Long Island	Crack Date	Full Bloom	First Ugly	Dead
Aresso	Mid	9/20	9/30	10/20	11/3
Aviano	Mid	9/17	9/27	10/31	11/5
Camina	Mid	9/18	9/28	10/20	10/30
Canelli	Late - Very Late	10/5	10/16	11/14	Frost 11/19
Castilio	Very Early - Mid	8/27	9/23	10/18	10/25
Cesaro	Mid - Late	9/23	10/7	11/4	11/14
Compo Orange	Mid - Late	9/23	10/6	10/30	11/4
Conaco Orange	Mid - Late	9/23	10/6	11/1	11/6
Confetti Rose Dark	Early - Mid	9/4	9/29	11/5	11/11
Confetti Rose	Early - Late	9/5	10/10	11/9	Frost 11/19
Confetti Rose Pink	Mid - Late	9/19	10/7	11/10	11/14
Cornico	Mid - Late	9/29	10/13	11/10	Frost 11/19
Discover Pink	Mid - Late	9/25	10/7	10/19	10/31
Fiotto	Mid - Late	9/25	10/10	11/6	Frost 11/19
Lucera	Mid - Late	9/27	10/8	11/6	11/14
Milano Orange	Very Early - Mid	8/24	9/27	10/31	11/11
Milano Pink	Early - Late	8/31	10/8	11/4	11/11
Padre	Early - Mid	9/8	9/24	11/2	11/6
Padre Orange	Early - Late	9/12	10/1	10/21	11/7
Padre White	Mid - Late	9/19	10/1	10/18	11/3
Pink Parfait	Early - Mid	9/8	9/29	11/4	11/12
Pizarra Red	Very Early - Early	8/26	9/15	11/3	11/14
Pobo Lavender	Early - Mid	9/8	9/29	10/31	11/4
Salmon Splash	Very Early - Early	8/26	9/14	11/4	11/6
Savona	Mid - Late	9/23	10/5	10/30	11/4
Vesper Cherry Red	Late - Very Late	10/5	10/20	11/13	Frost 11/19
Vesper Coral	Late - Very Late	10/5	10/21	11/13	Frost 11/19
Vesper High Flyer	Late - Very Late	10/3	10/20	11/13	Frost 11/19


  
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Table 3. Dates of Season of Bloom for 2005 Yoder chrysanthemum cultivars.

Cultivar	2005 Season of Bloom on Long Island	Crack Date	Full Bloom	First Ugly	Dead
Alberta	Mid - Late	9/24	10/8	11/18	Frost 11/19
Alexis	Mid - Late	9/28	10/9	11/6	Frost 11/19
Andrea	Late Season	10/5	10/15	11/11	11/14
Barbie	Late - Very Late	10/5	10/20	11/6	Frost 11/19
Beth	Very Early - Early	8/19	9/10	10/7	11/3
Bethany	Late Season	10/3	10/14	11/13	Frost 11/19
Bianca	Mid	9/20	9/26	10/14	10/31
Bold Vanessa	Mid - Late	9/22	10/7	11/6	11/14
Brandi	Early - Late	9/4	10/5	11/3	11/6
Bravo	Very Early	8/15	8/30	9/10	9/19
Bright Gretchen	Early - Mid	9/11	9/27	10/24	10/31
Brigitte	Late - Very Late	10/8	10/18	11/6	11/14
Camille	Mid	9/15	9/24	10/18	10/20
Carmella	Late - Very Late	10/3	10/18	11/11	Frost 11/19
Cecilia	Early - Mid	9/14	9/25	rain	10/15
Cheryl	Mid - Late	9/27	10/8	11/11	11/14
Dazzling Stacy	Mid	9/19	9/26	10/18	11/3
Delightful Victoria	Early - Mid	9/13	9/23	10/20	11/3
Diana	Very Early - Early	8/19	9/12	10/9	10/18
Draga	Mid - Late	9/20	10/7	10/31	Frost 11/19
Erica	Early - Late	9/14	10/8	11/3	11/11
Festive Ursula	Very Early - Mid	8/24	9/16	10/9	10/15
Fiona	Early - Mid	9/2	9/16	10/20	10/25
Flashy Gretchen	Early - Mid	9/7	9/22	10/18	10/20
Foxy Marjorie	Mid - Late	9/27	10/9	11/9	11/15
Foxy Natasha	Early - Mid	9/10	9/23	10/13	10/16
Frosty Jeanette	Mid - Late	9/23	10/7	10/25	11/3
Gentle Alberta	Mid - Late	9/24	10/7	11/18	Frost 11/19
Glenda	Mid - Very Late	9/19	10/20	11/10	Frost 11/19
Golden Andrea	Late - Very Late	10/5	10/18	10/30	11/4
Golden Cheryl	Mid - Late	9/15	10/9	11/4	11/14
Golden Helga	Very Early - Mid	8/26	9/16	10/9	10/14
Golden Marilyn	Early - Mid	9/8	9/26	10/25	11/4
Gretchen	Very Early - Mid	8/16	9/16	10/9	10/17
Gwendolyn	Very Early - Early	8/30	9/13	9/26	10/8
Hankie	Mid - Late	9/23	10/5	10/18	10/25
Hannah	Early - Mid	9/4	9/16	10/17	10/20
Harmony	Very Early - Late	8/25	9/16	10/20	11/4
Heidi	Very Early - Early	8/19	9/14	10/9	10/15
Helen	Very Early	8/12	8/27	9/10	9/16
Helga	Very Early - Mid	8/22	9/20	10/13	10/19
Jenna	Early - Mid	9/7	9/20	11/3	11/6
Jessica	Very Early - Early	8/20	9/14	10/13	10/18
Kristen	Mid - Late	9/17	10/7	10/25	11/4
Kristi	Mid - Late	9/18	10/9	11/6	11/14

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## Outdoor Potted Chrysanthemums Results: Part II

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Table 3 (cont.). Dates of Season of Bloom for 2005 Yoder chrysanthemum cultivars.

Cultivar	2005 Season of Bloom on Long Island	Crack Date	Full Bloom	First Ugly	Dead
Linda	Very Early - Early	8/22	9/15	10/14	11/6
Lisa	Very Early - Mid	8/30	9/27	11/4	11/11
Lovely Cheryl	Mid - Late	9/26	10/9	10/29	11/11
Madeline	Late - Very Late	10/3	10/18	11/6	11/14
Marilyn	Early - Mid	9/7	9/26	10/20	11/2
Marjorie	Mid - Late	9/28	10/9	11/10	11/14
Melanie	Mid - Late	9/23	10/15	11/10	11/15
Melissa	Mid	9/24	9/26	11/10	11/15
Mia	Mid	9/16	9/29	10/30	11/3
Michelle	Very Early - Early	8/19	9/6	9/24	10/1
Miranda	Early - Mid	9/14	9/27	10/20	10/24
Nancy	Late Season	9/23	10/6	11/2	11/6
Natasha	Early - Mid	9/5	9/23	10/9	10/14
Nattie	Early - Mid	9/8	9/23	10/20	11/2
Okra	Mid	9/16	9/26	10/18	10/31
Olivia	Early - Late	9/15	10/6	10/31	11/6
Priscilla	Early - Mid	9/13	9/19	10/8	10/14
Regal Cheryl	Mid - Late	9/27	10/8	11/10	11/13
Regina	Very Early - Late	8/16	10/8	11/10	11/13
Rosy Denise	Late - Very Late	10/5	10/18	11/11	Frost 11/19
Rosy Victoria	Early - Mid	9/13	9/23	10/20	10/31
Sharon	Very Early	8/14	8/30	9/15	10/1
Sherry	Early - Late	9/15	10/7	11/6	11/14
Sofe Cheryl	Late Season	9/22	10/7	11/5	11/9
Spicy Cheryl	Mid - Late	9/24	10/9	x	Frost 11/19
Stacy	Mid	9/17	9/27	10/17	11/2
Sunny Brigitte	Late Season	10/5	10/14	11/6	Frost 11/19
Sunny Gretchen	Early - Mid	9/5	9/20	10/9	10/15
Sunny Kristen	Late Season	9/29	10/9	11/3	11/11
Sunny Ursula	Very Early - Mid	8/19	9/17	10/7	10/13
Sweet Stacy	Mid	9/19	9/26	10/17	10/24
Symphony	Very Early	8/14	8/28	9/21	10/8
Tabitha	Very Early - Early	8/14	9/12	10/14	10/24
Tiffany	Very Early - Early	8/19	9/5	9/22	10/8
Ursula	Very Early - Mid	8/30	9/20	10/7	10/13
Victoria	Early - Mid	9/11	9/26	10/26	11/3
Zesty Victoria	Early - Mid	9/14	9/26	10/30	11/3

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## Plant Health Strategy to Greenhouse Weed Control

by Hannah Mathers

There are many reasons why ornamental growers should control weeds in a greenhouse. Weeds compete with the crop by absorbing essential nutrients and water, and blocking light or air circulation. Weeds dramatically reduce the growth of the crop. What most people don't realize, however, is that the greatest damage is often done when the weeds and crop are small. Weeds also interfere with harvesting by physically hindering workers. Weeds reduce the marketability of the crop. They lower crop quality further by harboring insects, such as whiteflies, thrips, and other pests such as mites, slugs, snails, and diseases. Weeds also have tremendous reproductive potential. A single mullein plant can produce 223,000 seeds; a redroot pigweed can produce 117,400 seeds. A healthy plant is more resistant to stress and can compete better against weed infestations.

Growing under optimal conditions for the crop will reduce the ability of weeds to compete against the crop. Controlling humidity/ventilation, water, light, pH, nutrients, and temperature all figure prominently in providing optimal crop conditions. A plant health strategy to ornamental greenhouse weed control contains three principal elements: prevention/sanitation, evaluation of water quality, and using all physical, cultural, and chemical controls available. In this article, we will discuss these three elements and focus with the chemical controls on the most prevalent weeds found in ornamental greenhouse production.

### Prevention/Sanitation

Prevention and sanitation can include the use of mulches in greenhouse weed control. Rice hulls (Alam et al., 2001), perlite, pumice, corn gluten meal (Bingman and Christians, 1995), bark (Neal and Senesac, unpublished; Fretz and Dunham, 1971), Penn Mulch-pelletized recycled paper (1-3-1) (Wooten and Neal, 2000), and human hair have all been used for this purpose. Prevention also includes eliminating air borne weed seeds from entering the greenhouse by screening vents and other openings and preventing perennial weeds (bindweed and quackgrass) from growing under foundations. A 3 to 10 foot weed free zone should be maintained immediately adjacent to the greenhouse. In order to accomplish this many growers spray Roundup or Finale once per month and every two to three months spray Roundup or Finale mixed with Surflan. Mow beyond the 3 to 10 foot zone to limit potential blow in

of weed seeds. When spraying in adjacent areas close windows and vents to prevent drift and never use auxin-type herbicides such as 2, 4-D containing products. If you do have to use a 2, 4-D product, always use the amine formulation around ornamentals. Esters are more volatile than amines. Always use an amine product where volatilization is a concern. Even the "low volatile esters" are more volatile than the amines.

The use of disinfectants is also critical in your prevention/sanitation program. Disinfectants should be used daily especially in propagation areas. There are several disinfectants registered in greenhouses, Virkon, Greenshield, 0.5% bleach solution, Physan 20, Quatro, and Triathlon or pond disinfectants such as Bromine, Chlorine, Ozone, K-Tea, and Copper Z -4/4. A widespread disinfectant used in recent years is Zero-Tol. In a prevention/sanitation program growers have found good results using Zero-Tol at a 1:5000 (200 ppm) rate every time they water. However, Zero-Tol costs approximately \$2,000 per 55 gallons. Tonya Albert at Spring Meadow Nursery, Inc. in Michigan published in the International Plant Propagators Society (IPPS) 2003 proceedings a method to reduce the expense associated with Zero-Tol use but maintain similar results. One of the active ingredients in Zero-Tol is hydrogen peroxide ( $H_2O_2$ ).  $H_2O_2$  can be purchased as a 30 percent solution for approximately \$35 per 15-gallon drum.  $H_2O_2$ , however, is less stable than Zero-Tol, so Spring Meadow needed to invest in some start-up costs such as the purchase of an acid injector pump head for their HE Anderson system (coated with Viton) (non-corrosive) and install filters for all their watering booms to collect the iron precipitate that developed with the injection of  $H_2O_2$ . The rate of  $H_2O_2$  Spring Meadow Nursery reported, for nursery use, was 1:5000 (200 ppm); the recommended nursery rate is 30 to 50 ppm. Ppm can be calculated by dividing the ppm required X total amount of water in liters by the grade of hydrogen peroxide X 10.

However, 30 percent hydrogen peroxide, as recommended in the Spring Meadow article, cannot be used alone as a general sterilant. It must be used in conjunction with another product to be a registered use. 27 percent  $H_2O_2$  or less is fine but not 30 percent. The following EPA website is a good source for information on hydrogen

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## Plant Health Strategy to Greenhouse Weed Control

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peroxide: [http://www.epa.gov/pesticides/biopesticides/ingredients/factsheets/factsheet\\_000595.htm](http://www.epa.gov/pesticides/biopesticides/ingredients/factsheets/factsheet_000595.htm)

On this site you will find the registrants of products that contain hydrogen peroxide – certainly BioSafe Systems is a legal registrant and the Zero-Tol product is a stable, safe, and registered product to use.

Proper ventilation cannot be over emphasized in the prevention/sanitation program. First, determine number and size of fans you will need by calculating the total cubic feet of air in the structure and dividing by total cubic feet of air each fan will replace. The result is the number of fans needed to exchange air once per minute. Retractable-roof greenhouses offer superior ventilation benefits. The idea of natural ventilation is driving innovation in greenhouse structures today, and retractables are clearly out in front (Grey, 2001). The retractable roof design allows for the roof to retract 90 percent, which guarantees temperatures are essentially at ambient. Many of the houses that use curtains also have roll-up end walls and sidewalls. This ability to retract the roof and sidewalls provides the ability to control humidity as well as temperatures, wind, and light conditions. It has long been known that 80 percent of greenhouse crop success depends on proper management of water, light, and relative humidity. Proper management of water, light, and relative humidity will improve plant health and result in improved insect and disease resistance, nutrient utilization, and weed control.

Water quality also has a major influence on greenhouse and nursery plant nutrition, growth, and quality, and the influence is greatest when the plants are young.

If you have never tested your water you should do two tests each year, one in the spring and one in late summer. The spring test will tell you what your water quality is at the best of times and the late summer test will tell your worst water quality scenario. After this first year of measuring you should test your water once per season, usually in the spring. You should consider testing more than once per season if any of the following apply: 1) there has been a very wet season; 2) a high usage period has occurred; 3) an unusual drought has occurred; and, 4) you are using water from various sources, including city water.

One of the first steps in prevention is starting right. Starting right involves taking cuttings from only healthy stock plants. Starting right also includes using only stock that is free at planting of all weed propagules including seed, nodes, rhizomes, tubers, and in the case of moss and liverworts, spores and sporangium. You should always isolate new plant material coming into your greenhouse from outside sources for at least two weeks to evaluate what is germinating and growing in the media of these new plants. I know it sounds like a pain; however, it is momentary compared to the pain of dealing with difficult to control weeds for potentially years. Another part of starting right is starting with clean media. I had experience with a grower who could never get weeds under control regardless of the expense and herbicide applications used. The problem was their media pile had a nice crop of snapweed or bittercress (*Cardamine sp.*) growing all around it and a large seed bank of weeds was mixed in with the media each time they planted a crop.

Table 1. Bioassay species used for ten selected herbicides (Washington State University, Cooperative Extension, 1987).

Herbicide	Trade Name	Bioassay Species
Atrazine	Atrazine	Cucumber, oats, wheat, Japanese millet, tomato, pumpkin, pea
Dichlobenil	Casoron 4G	Carrot
Diuron	Diuron 4L, 80DF, 80 WDG	Cucumber, barley, oat, pumpkin, ryegrass
Metolachlor	Pennant Liquid	Japanese millet
Napropamide	Devrinol	Wheat
Oryzalin	Surflan	Oat, barley, wheat
Pronamide	Kerb	Wheat
Simazine	Princep Liquid	Oat, ryegrass, wheat, mustard, sugarbeet, tomato
Trifluralin	Treflan	Oat, barley, annual ryegrass, cucumber
2,4-D	Various	Cucumber, mustard, tomato



## Test Your Soil: Seed-bank and Herbicide Residue?

All potting mixes should be tested whether they are purchased or mixed on site to see what weed seed-bank is present in the mix. Take samples from several bags or locations in the pile. Place the mix in 4-inch containers and see what grows. If several weeds germinate you probably want to contact the supplier and use another mix. If you suspect herbicide residue in the mix, an inexpensive and fairly reliable way to determine this is to make a crop biological assay (bioassay). Soils can be chemically analyzed for herbicide residues, but this is expensive, complicated, and can be done only in specialized laboratories. Moreover, the results of the analysis do not indicate the effects on the next crop. When conducting the bioassay, if possible use a non-treated or check mix sample for comparison to suspected herbicide residue sample. Certain plant species are better indicators of specific herbicide residues than others. The plants in Table 1 (page 24) are suggested bioassay species for the corresponding herbicides. About 10 seeds should be planted per container. Do not plant too many seeds or the amount of herbicide in the soil may be diluted between too many plants. Injury symptoms on seedlings should become apparent anytime between emergences to three weeks, depending on the herbicide being tested. Water plants sparingly, but do not allow the soil to dry out.

## Chemical Controls and Common Weeds

There are no preemergents currently registered for use in enclosed structures. However, the following six postemergents are registered for use when greenhouses are empty. Reward L&A (diquat) is a contact, non-translocatable, rapid acting herbicide best used beneath benches. Scythe (pelargonic acid) is best used at temperature above 80°F has rapid action, but it is odorous and expensive. Roundup Pro (glyphosate) is a systemic, non-selective herbicide best used when the house is empty. Finale (glufosinate-ammonium) is a non-selective, contact + systemic that is faster acting than Roundup; however, fans must be turned off, and it provides less control of perennials than Roundup. Finale cannot be used on edible crops. Fusilade II (fluzafop-p-butyl) and Envoy (clethodium) are grass killers that can be used in non-crop areas and will not be effective on broadleaf weeds or crop plants.

The most common container and greenhouse weeds across the United States are listed in Table 2 (page 26). Seven of the more difficult are Bittercress (*Cardamine hirsuta*), Yellow woodsorrel (*Oxalis* spp.), Liverwort (*Marchantia polymorpha*), Silver thread mosses (*Bryum argenteum*), Prostrate Spurge (*Chamaesyce maculate* or *Euphorbia maculata*), Annual Bluegrass (*Poa annua*), and Pearlwort (*Sagina procumbens*). Controls for each of these seven will be presented including some preemergent controls that have been found effective. Again, no preemergents are registered for within enclosed structures; therefore, the preemergents listed

are for use when the houses are empty, houses not to be covered for at least three weeks from time of application, or in non-crop areas.

Annual bluegrass is very difficult to control. The best strategy with this weed is to start clean using a preemergent or fumigant in the house prior to planting, allowing sufficient time to elapse between the application and crop planting as prescribed on the label. When using a pre-plant fumigant the range must be clear. One pre-plant fumigant registered for annual bluegrass control is Basamid (granular) which is a restricted use herbicide. Preemergents that can provide control when used under benches, aisle-ways, and other non-crop areas are PrePair or Devrinol 2G or 50DF (napropamide) and Surflan AS T/O (oryzalin). PrePair needs to be watered in promptly, is highly water soluble so it can go off target easily, and for these reasons should be used with care. Fusilade and Envoy are other possible choices as postemergents; however, neither provide good control of annual bluegrass.

Bittercress or snapweed has many life cycles in greenhouses and container nursery production. It sets seed quickly, is time-consuming, and very expensive to hand weed. This is a weed that can quickly become a big problem because of its potential for spread, mainly by seed dispersal as the seed pods are dehiscent (like all members of the mustard family). Controls include PrePair (not in enclosed structures), Snapshot (isoxaben + trifluralin + fertilizer) (not within 3 weeks of enclosing), Surflan (not enclosed structures) (provides poor control), and Roundup Pro.

Pearlwort can be a very troublesome weed as it reproduces not only by seed but also vegetatively. Every little piece can create a new plant. Pieces of the plant get caught in crevices and cracks on benches, edges of pots and flats, and is left behind after weeding and even pot washing. SureGuard 51WDG and Broadstar 0.17G (flumioxazin) have been reported to control Pearlwort but are not registered for use in enclosed structures. Roundup Pro is best used when there is no crop in the house. Even as a direct spray under benches there can still be drift issues. Therefore, if using in the house where a crop is present, spray at low volumes and pressures to reduce the potential of drift. Mulch, sanitation, and proper watering practices will go a long way in controlling and preventing infestations of Pearlwort.

In a survey of 32 Alabama nurseries in 1987 by Gilliam et al. (1990), prostrate spurge (*Euphorbia maculata*) and oxalis (*Oxalis corniculata* and *O. stricta*) were two of the most difficult weeds to control. Oxalis, which is in the woodsorrel family, also has explosive seed pods similar to the mustards. There is a creeping perennial species and an annual species of oxalis. The creeping perennial has the potential to root out at each node and

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## Plant Health Strategy to Greenhouse Weed Control

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Table 2. Common container and greenhouse weeds listed by family and life cycle. (Source: Case, Mathers, and Senesac, 2005).

Common Name	Scientific Name	Division or Family	Life Cycle
Hairy bittercress	<i>Cardamine hirsuta</i>	Brassicaceae	Winter annual
Pennsylvania bittercress	<i>Cardamine pennsylvanica</i>	Brassicaceae	Winter annual
Creeping red woodsorrel	<i>Oxalis corniculata</i>	Oxalidaceae	Perennial (spreads by stolons)
Yellow woodsorrel	<i>Oxalis stricta</i>	Oxalidaceae	Perennial (spreads by rhizomes)
Liverwort	<i>Marchantia polymorpha</i>	Hepatophyta	Perennial
Silver thread mosses	<i>Bryum argenteum</i>	Bryophyta	Perennial
Prostrate spurge	<i>Chamaesyce maculata</i> or <i>Eurphorbia maculata</i>	Eurphorbiaceae	Summer annual
Annual bluegrass	<i>Poa annua</i>	Poaceae	Winter annual
Common groundsel	<i>Senecio vulgaris</i>	Asteraceae	Winter annual
Northern willowherb	<i>Epilobium ciliatum</i>	Onagraceae	Summer annual
Birdseye pearlwort	<i>Sagina procumbens</i>	Caryophyllaceae	Perennial
Creeping charlie or Ground ivy	<i>Glechoma hederacea</i>		Perennial
Annual sowthistle	<i>Sonchus oleraceus</i>	Asteraceae	Summer annual
Prickly lettuce	<i>Lactuca serriola</i>	Asteraceae	Winter or summer or biennial
Dandelion	<i>Taraxacum officinale</i>	Asteraceae	Perennial
Common purslane	<i>Portulaca oleracea</i>	Portulacaceae	Summer annual
Common chickweed	<i>Stellaria media</i>	Caryophyllaceae	Summer or winter annual
Large crabgrass	<i>Digitaria sanguinalis</i>	Poaceae	Summer annual
Yellow nutsedge	<i>Cyperus esculentus</i>	Cyperaceae	Perennial
Henbit	<i>Lamium amplexicaule</i>	Labiatae	Summer or winter annual
Horseweed (marestail)	<i>Conyza canadensis</i>	Asteraceae	Summer or winter annual
Smooth pigweed	<i>Amaranthus hybridus</i>	Amaranthaceae	Summer annual
Redroot pigweed	<i>Amaranthus retroflexus</i>	Amaranthaceae	Summer annual
Eclipta	<i>Eclipta alba</i>	Asteraceae	Summer annual

establish a new plant. For postemergent control of oxalis, Finale is effective and registered but must be used very carefully. As with the Roundup Pro on Pearlwort spray at low volumes and pressures, and turn off all fans to reduce drift issues. For preemergents, Surflan and PrePair are registered; however, they are not registered for use in enclosed structures. Prostrate spurge (*Chamaesyce maculata*) or (*Eurphorbia maculata*) in the greenhouse is a very serious weed if left unrestrained. Preemergents that work, but are not registered for use in enclosed structures, are Barricade (65 WG, 4 FL) (prodiamine) and Pendulum (2G, WDG) (pendimethalin). Postemergents that are

effective are glyphosate and Finale.

Weed problems in the greenhouse are not limited to higher plants. Plant forms such as silver thread mosses (*Bryum argenteum*) and common liverwort (*Marchantia polymorpha*) can also be problematic (Mathers, 2003). Much can be done to control liverwort with attention to proper watering and fertility. PrePair and Ronstar (oxidiazon) are preemergents that will offer some level of control. Some recent trials regarding other preemergent controls have yielded interesting results. Mervosh and Ahrens (2003) working in a heated greenhouse in late February in Connecticut with 4-inch pots of Azalea

**Table 3. Liverwort control rated from 0-10 with 10 representing complete control. (Source: Mervosh and Ahrens, Connecticut, NEWSS 2003).**

Treatment	LB/A	4/9/02	6/4/02
Copper Sulfate	13.6	8.7	5.7
Oxadiazon + Copper	4 + 13.6	9.2	10.0
Flumioxazin	0.34	9.0	10.0

(Rhododendron 'Orchid Lights') and a granular application of flumioxazin 0.17G (0.34 lb/A ai), sprays of copper sulfate (13.6 lb/A ai), oxadiazon 50-WP (4 lb/A ai) plus copper sulfate (13.6 lb/A ai), and flumioxazin 51WDG (0.34 lb/A ai) found good control with the WG and granular flumioxazin (Table 3). Flumioxazin is not registered for use in enclosed structured or greenhouse crops but can be used on containerized woody plants. They also noted that Birdseye Pearlwort was not controlled by any of the chemicals tested.

Newby et al. (2004) working in Alabama with a new preemergent quinoclamine (Mogeton 25 WP) at the 1X rate of 0.25 oz ai/gal and 0.5 oz ai/gal, Terracyte, and Broadstar found good control with both rates of Mogeton in the spring, good control with Terracyte in the summer, and poor control with the flumioxazin. Terracyte is a granular formulation of sodium carbonate peroxyhydrate that breaks down into sodium carbonate and hydrogen peroxide upon contact with water (Newby et al. 2004). Quinoclamine is an algaecide that has been used in Japanese rice production. Crompton Uniroyal Co. is seeking a label for its use in nursery and greenhouse crops in enclosed structures in the United States.

Silver thread moss is usually a problem in ornamental crops until the canopy develops and shades the pot surface. Excess moisture on the surface of the container will also exasperate this weed problem. Scythe can offer some control as a postemergent used on very young moss plants, and Ronstar offers limited control as a preemergent (not in enclosed structures).

Algae is the last greenhouse weed we will discuss. Algae can grow on floors, walls, and plant material and leads to an increase in fungus gnats and difficulty with irrigation water penetrating the container surface. Many of the disinfectants that were listed earlier (Greenshield, Triathlon, Zero-tol, H<sub>2</sub>O<sub>2</sub>) are effective when used on a regular basis at controlling algae. Reward and Kocide (copper hydroxide) can be used as postemergents and K-Tea or Copper Z-4/4 can be used as pond water disinfectants. For more information regarding copper and algae control in ponds visit <http://ohioline.osu.edu/a-fact/0003.html>. Other pond disinfectants are ozone, bromine, chlorine, and dried barley straw. Dried barley straw inhibits algae growth when placed in the pond in April. Bill Hendricks of Klyn Nurseries in Perry, Ohio recommends using two bales per acre of pond and

floating one-quarter to one-half of the bales on pipes to speed the breakdown of the barley. For more information on using barley straw to control algae in ponds visit <http://ohioline.osu.edu/a-fact/0012.html>.

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## Improving Floriculture by Improving the Supply Chain



by Claudio Pasian

Over the last several months, I have been conducting an information and communication technology (ICT) project under a grant from the USDA focused on improving the competitiveness of the Ohio floriculture industry. A detour from my regular work, the ICT project responds to information requests that I have received from the industry and needs I have identified during my many years of involvement in Ohio floriculture. ITC is an integral part of supply chain management, a major factor in day-to-day operations and commercial profitability.

Through my intuition more than through my knowledge (this supply chain issue is new to me), I realized that information and communication technology offers something useful for the greenhouse industry. The challenge was to find a company specializing in supply chain ITC that is focused on medium- and small-sized businesses.

Timing is a major issue for an industry that deals in perishables. The weather affects growth rates and, more importantly, the demand for plants. If a grower isn't ready with saleable products at the right time, the plants may have to be discounted for off-peak sale or might even spoil and have to be discarded.

The question is how do we control "readiness" if we cannot control things like the weather? One answer is by being better able to respond to demand when it occurs. A lot of demand in the floriculture industry is seasonal and rigid (meaning that you cannot produce more plants overnight if there is more demand), but that is only half the story. While we know that demand will surge in spring, Mother's Day, Christmas, etc., we don't know exactly how that demand surge will be distributed. In an increasingly globalized world, competition comes from many corners. Thus, readiness is also about driving demand to our supply and building competitive advantage.

In our industry, we often think of competitive advantage in terms of things such as low price, high quality plants, varieties mix, pest resistance, etc. However, as a business, floriculture has a unique supply chain, and, therefore, its own set of business processes that can yield efficiencies and effectiveness. It is precisely this form of competitive advantage that I explored under the grant from the USDA.

### Information as an Advantage

I have recently gained an increased appreciation for the importance of information management as the

lifeblood of any effective supply chain. Customers need to know you exist and what you sell in order for you to continue to exist and sell for another season. When considering how disseminating business information relates to competitive advantage, there are five key factors to take into account: cost, speed, accuracy, availability, and format. The cost of getting information to customers or potential customers has to be in line with the plants we sell, and lowering the cost of information drives value. The speed with which information moves is particularly critical for a perishables industry, since slow moving information can result in product that's no longer saleable or an inability to meet a customer's changing demand. It's also not enough for information to move cheaply and quickly; it must be accurate to be worthwhile. Finally, information must be available when the customer wants it and in the format one can use, otherwise it may have no value at all. I have been told by the experts in this field that a simple formula for creating competitive advantage with floriculture information is to lower costs, increase speed, increase accuracy, increase availability, and get the format right (-+++f). Despite the fact that it looks like an expletive, this formula can add up to real money. How many times have you had to phone one of your clients about an unreadable fax? How many times has one of your employees entered in your computer the wrong number of plants requested by one of your clients?

The Internet and software products that leverage the Internet offer us new ways to move information. In particular, Internet-oriented software products offer viable ways to fulfill the "-+++f" formula for saving time and money. The project I am conducting implements a supply chain solution (called Scarborough FairSM) with a test group of growers to determine how this could work for the Ohio floriculture industry. I believe this solution will work for floriculture because it meets the "-+++f" formula criteria and is also compatible with floriculture businesses that have either well-established or little existing technology infrastructure. I wanted one solution that would be applicable to growers of all sizes and allied industries as well.

### Project Description

Late last year, I identified ten members of the floriculture industry interested in participating in an ICT supply chain pilot project. They are growers of different sizes as well as

some floriculture material suppliers. We worked in two phases, beginning with an initial group of three and then including the second group of seven. The project covered the cost of software licenses, web hosting, training, project management, and industry-related customization. The participants had to provide the critical asset of an open mind to new ways of doing business. Thankfully, the supply of open-mindedness has been bountiful.

The project's goal is to create a competitive advantage for the Ohio floriculture industry via electronic supply chain linkages – a task that we are accomplishing in two ways. First, we are testing software which allows trading partners to send electronic requests for price quotations, purchase orders, shipping confirmations and invoices, or any other business documents. This eliminates the cost of mailing, telephoning, and faxing, while speeding up the movement of the documents. We are in the process of integrating the software with the enterprise resource planning systems (ERP) resident at some of the participant companies, so that information can be fed directly into the system in the appropriate format. By eliminating the need to retype information through direct electronic transfers, we also improve the information's accuracy.

The second way that we are creating electronic linkages is by using Internet web sites. Unlike most floriculture businesses, the Internet is always "open." Software allows companies to automatically post (with access by permission) their on-hand balances and/or pricing at secure web sites for 24-hour access. That means a qualified, authorized buyer can query a grower's web site at anytime of the day or night to determine its inventory level – over the weekend, while the grower is at lunch, while the grower's telephone is busy, and even

when the grower's computer is turned off. That buyer is then able to place an electronic order or request an electronic price quotation.

These two areas of functionality – document transfer and visibility – meet the “-++++f” formula for saving time and money. While the project is still in its early stages, the industry response has been positive – so much so that a member of the supply chain of one of the project participants has already independently purchased a copy of the software. I expect to be able to report detailed results on the project soon.

**Conclusions**

ICT supply chain solutions can offer Ohio growers significant gains in efficiency and effectiveness. In our industry, information is perishable the way our products are perishable, because lost communication can lead to lost product. Therefore, improving the flow of information has real, measurable value. Looked at another way, being able to offer customers simplified, immediate ways to access our supply of products helps retain existing customers and drive new buyers to our doorstep. In a globalized world, our potential to come up against new competitors is constantly increasing and finding a competitive advantage in information is another way to keep Ohio at the forefront of the floriculture industry.

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# Teaching Employees to Understand Material Safety Data Sheets

by Gary W. Hanson

Every employer that has one or more hazardous chemicals must comply with the OSHA Hazard Communication Program. This includes having a written program, having an individual responsible for overseeing the program, having a labeling program, and securing and maintaining material safety data sheets.

The Hazard Communication Standard still accounts for more OSHA violations each year than any other single standard. OSHA is also mandated to check each company's Hazard Communication Program. They usually will interview employees during an inspection; during that interview they often ask employees if they know what types of hazardous chemicals they are exposed to; if they know where the Material Safety Data Sheets (MSDS) are; and if they know how to read an MSDS. Unfortunately all too often the answer to the latter question is no.

When I begin working with a new client I often start with the review of the Hazard Communication Program and how to read an MSDS. Reading and understanding an MSDS can be difficult and confusing. There is no set standard format for an MSDS. Many times the headings are different and they are not always in the same order. The amount of detail in each varies and even the type of information provided differs from one MSDS to another. Many companies have also expanded the information they provide on an MSDS to cover EPA information, D.O.T. information, and other regulatory information. All of this makes it difficult to teach employees how to read one, let alone getting them to understand one.

As a result of doing Hazard Communication over the years, I discovered that MSDS don't have to be so confusing no matter how much information is provided. MSDS usually only have 9 sections that relate to safety. Maybe 10 if there is a section on First Aid. These sections include:

- The Chemical Identity
- Hazardous Ingredients
- Physical Properties
- Fire and Explosion Data
- Health Hazards (First Aid Procedures)
- Reactivity
- Spill and Leak Control
- Special Protection (Employee Protection)
- Special Precautions (Handling and Storage)

These sections may differ in order and titles slightly but they are usually on every MSDS. Each of these sections is in bold letters and usually underlined so that they can be identified easily. I review these sections during my training class. Each of these sections contain important safety information, but at first glance the amount of information can be intimidating.

Employees, however, very seldom need to read all of the information on an MSDS. Most employees want a MSDS to answer a very specific question or questions. That is the key to teaching employees how to read the MSDS. Advise employees not to get lost in all this data, but simply go to the particular section on the MSDS that contains the information they are interested in. Once they have obtained the information they need then go to the next section for which they have a question.

The questions most employees have about a chemical is what does the chemical do to me? This can be found in the Health Hazard Section. This section tells an employee what the health hazards are, the symptoms, how long it takes to be impacted, and what employees can do to protect themselves. If an employee wants to know how the chemical burns, the section on Fire and Explosion Data provides this information. If Personal Protective Equipment is required, that is covered in the section on Special Protection. Each question an employee has can be answered in one of the sections on the MSDS.

Reading and understanding an MSDS does not have to be overwhelming. It is simply as easy as knowing the question and going to the appropriate section. I found that using this technique makes the training easy and the employees have the confidence to get the information they need quickly. The MSDS becomes much less complicated and the valuable resource that OSHA had intended.

If you need any help with your Safety Program or employee training, please feel free to give me a call at 1-800-356-1274.

**Gary Hanson**  
American Safety & Health Management  
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# ofa News

## Stock Your Library for the New Year!

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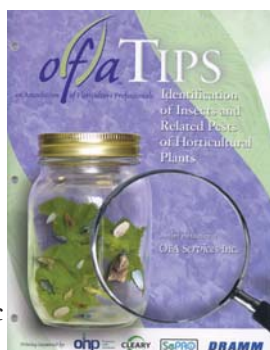
### Tips on Growing Vegetative Annuals

The book features sections on 21 vegetative annuals. A page for each crop contains production information on topics such as media, pH, light, temperature, and fertilizer requirements. It also provides comments from the breeders about producing the best crops. For each crop, color pictures show detailed flower, stem, leaf, habit/form, and combination and landscape plantings.



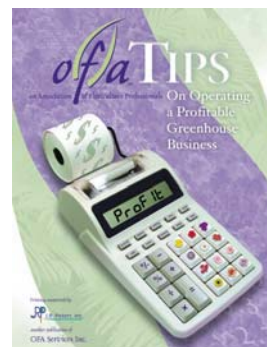
### Identification of Insects and Related Pests of Horticultural Products

This new edition illustrates the life stages and crop damage of the major insect, mite, and related pest groups of greenhouse crops. Common species, life cycle illustrations, developmental stages, economic importance, biological control, where species are found, and stages for effective pesticide use are listed for each pest group.



### Tips on Operating a Profitable Greenhouse Business

A comprehensive text with a cost analysis spreadsheet, as well as numerous charts and photo illustrations. This book addresses how growers can manage their operations most cost-effectively and increase their profit margins – working smart in today's marketplace. The theme of the book is the basic equation: Profit = Revenue – Cost.



In addition, the OFA bookstore has publications on growing bedding plants; growing and marketing garden mums; growing specialty potted crops; managing floriculture crop problems; regulating growth of floriculture crops; designing, growing, and marketing mixed baskets and containers; and managing problems in interior plantscapes.

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 Colin Dodd – Dodd's Greenhouses, Niagara on the Lake, ON, Canada  
 Ron Dubena – Acorn Farms Inc, Galena, OH  
 Kevin Duerfeldt, Falls City, NE  
 Ernest Glasgow – Keeler Glasgow Company Inc, Hartford, MI  
 Denita Hadziabdic, Knoxville, TN  
 Timothy Hartmann, Blanco, TX  
 Cassandra Hummel, Wooster, OH  
 Vera Krischik – University of Minnesota, St Paul, MN

JC Large – BP Flower Farm, Owaneco, IL  
 Beke Lindsay, Casar, NC  
 Karen Mallon – Uncle Buck's Greenhouse, Laingsburg, MI  
 Julie Meder – The Web Law Firm, Pittsburgh, PA  
 Lowell Null – White Owl Farm, Hoopeston, IL  
 Patty Olosky – The Web Law Firm, Pittsburgh, PA  
 Steve Ostrowski – Scranton Gillette, Arlington Heights, IL  
 Eric Pitzen, Stacyville, IA  
 Andrew Pulte, Knoxville, TN  
 Sue Schleis – Oswego County BOCES, Mexico, NY  
 Holly Smith, Morgantown, WV  
 Suzanne Spencer, Lake Oswego, OR  
 Megan Staley, Hampton, IA  
 Sara Stiller, Solon, OH  
 David Vos, Sioux Center, IA

# ofa News



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## Welcome!

OFA - an Association of Floriculture Professionals is a member-focused national organization of greenhouse growers, garden center operators, retail and wholesale florists, interior plantscapers, green industry suppliers, students, and educators.

OFA's mission is to support and promote floriculture professionals through lifelong learning, career enhancement, and public awareness.

[Find out more about OFA >](#)

### OFA Partners



### OFA Short Course

#### Miss the Short Course?

Catch all 120+ educational sessions and PowerPoint Presentations in an interactive CD-ROM Set! **check it out!**



### What's New

July 17, 2006  
[Floriculture Professionals Provided Opportunity to "Learn & Grow" at the 2006 OFA Short Course](#)  
[Complete Article >](#)

July 16, 2006  
[OFA Partners with SNA for ColorWorld™](#)  
[Complete Article >](#)

July 1, 2006  
[America in Bloom Symposium to be Held in September](#)  
[Complete Article >](#)

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## OFA Event Calendar

November 5, 2006	Ohio Certified Florist (OCF) Test - Columbus, OH
November 7, 2006	Pest-B Gone Seminar - Lansing, MI
December 12, 2006	Surviving the Looming Energy Crisis: Conservation Strategies, Greenhouse Technologies, and Alternative Fuels - Michigan State University East Lansing, MI

## Visit the New [www.ofa.org](http://www.ofa.org)

The OFA web site has received a recent makeover. It's been developed as an even better resource to learn about Association activities, the OFA Short Course, and links to the industry. It's been redesigned to help you stay connected.

The "Members Only" section features a searchable directory of all OFA members, archives of the *OFA Bulletin*, floriculture and nursery research abstracts, free "Ask the Doctor" advice, and links to industry resources.

A new feature in the members-only section is the E-Learning Community, an on-line community forum for OFA members, Short Course attendees, and other groups to learn, share, and network with one another in a virtual learning environment.

[www.ofa.org](http://www.ofa.org)



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