The Flowering of Orchids

A Reality Check

BY ROBERTO LOPEZ AND ERIK RUNKLE, PHD

ORCHID ENTHUSIASTS PROBABLY HAVE HEARD AND READ COUNTLESS theories on how to induce their orchids to flower by manipulating water, nutrients, humidity, temperature or light. Of these theories, questions may linger about which are based on fact and which on myth. One thing is clear when reviewing the flowering physiology literature: The lack of science-based information on the control of flowering of most orchids limits greenhouse growers and hobbyists from flowering their plants outside of their natural flowering time. In an attempt to clear the air, we have selected some of the published information on the flowering of orchids, and differentiated scientific facts from observations or hunches. This article also reviews how environmental factors control flowering of many diverse species, including orchids.

THIS PAGE AND OPPOSITE *Phalaenopsis* requires a period of relatively cool temperatures to initiate flowering. Shown here is *Phalaenopsis* Baldan's Kaleidoscope 'Orchidheights', AM/AOS (Hausermann's Candy × Daryl Lockhart). Grower: Owens Orchids.

THIS PAGE AND OPPOSITE: GREG ALLIKAS

ABOVE *Cattleya mossiae* is among the species in this genus that flowers in response to short daylengths. In this species, the plant produces new growths with sheaths during the summer, then it rests before flowering the following May. Shown here is *C. mossiae* fma. *coerulea* 'Von Scholl', AM/AOS. Grower: Peter Von Scholl.

OPPOSITE Another short-day *Cattleya* is *Cattleya gaskelliana*, although it has a different developmental pattern than *C. mossiae*. In *C. gaskelliana*, the new growths emerge early in the spring and then it flowers in the summer, usually in June. The form *coerulea* 'Katarina's Blue', HCC/AOS, is shown here. Grower: Peter Von Scholl.

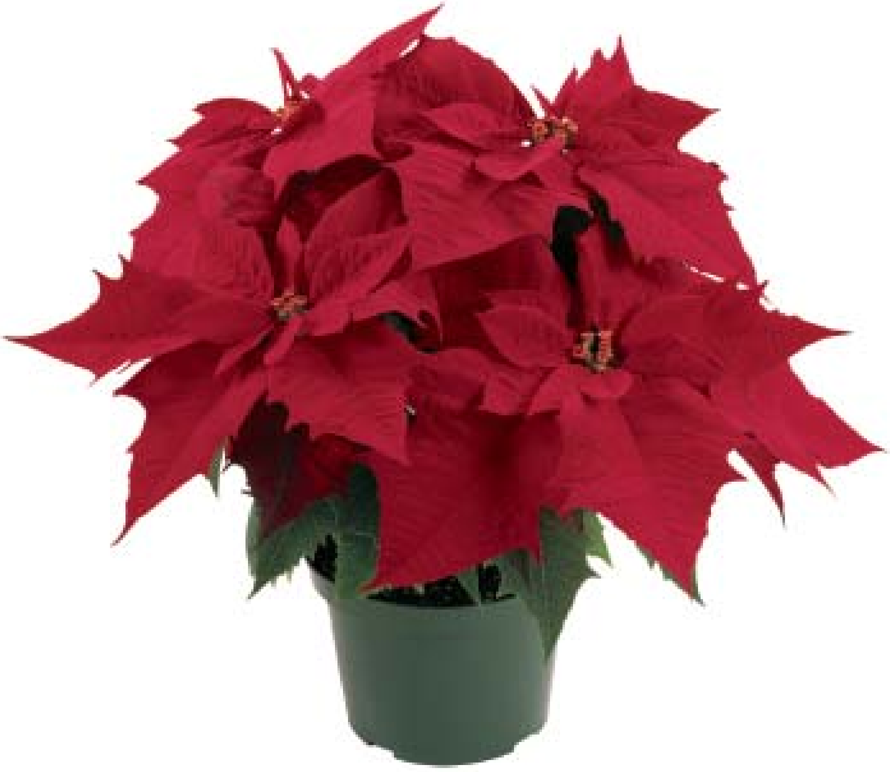
ENVIRONMENTAL CONTROL OF FLOWERING Plants often respond to changes in photoperiod and temperature so that they naturally flower when environmental conditions are favorable for reproduction. Plants that flower only in response to photoperiod are often classified by their response to the length of day, or more precisely, their response to the length of the night (dark period). Scientific studies have elucidated exactly how to manipulate the environment so that plant growth and development can be precisely controlled for a variety of floriculture crops.

For example, an abundance of research has been performed on poinsettia. Poinsettia is a short-day plant with a critical day length of about 13 hours. Thus, poinsettia plants are naturally induced to flower in the Northern Hemisphere around mid-September, when the biological day length decreases below 13 hours. Flower development is then controlled by manipulating temperature so that plants are at a marketable stage for a predetermined date. Commercial greenhouse growers utilize this information to produce millions of flowering potted poinsettias for the Christmas holiday.

While flowering of some plants is controlled by photoperiod, temperature can also influence flowering. For example, many plants flower after exposure to a period of cool temperatures. Similarly, Easter lilies are cooled for approximately six weeks at 40 to 45 F (4 to 7 C) before they are grown in a warm commercial greenhouse. This cooling process is required for rapid and uniform flowering. The optimum cool temperature and duration for flower induction varies among species.

If the environmental conditions that induce flowering of orchid plants were known, then greenhouse growers and hobbyists could potentially manipulate temperature, photoperiod, or both to flower their crops for a particular date. Today, this is possible for only a few orchid genera (especially *Phalaenopsis*).

SCIENTIFIC STUDIES ON THE FLOWERING OF ORCHIDS Controlled experiments are required to unequivocally elucidate flowering triggers of plants. This requires controlled environments so that light



and temperature (and often other factors) are measured and controlled. Such studies are generally possible only at universities or research institutions, as numerous growth environments are required. When information is published without adequate controls, precise delivery of treatments, an adequate number of replications or proper statistical analysis, then interpretation of results can be misleading. We've searched the scientific literature on flowering of orchids and have summarized what we've learned about several orchid genera. With the exception of a handful of genera, surprisingly little research has been performed and published.

Cattleya is a genus composed of 60 species native to tropical regions of Central and South America. This epiphytic plant is generally found growing on trees of moist and wet forests from sea level to 4,900 feet (1,500 m) in elevation. Several published scientific studies indicate that flowering of *Cattleya* species and hybrids is promoted by exposure to short daylengths and cool temperatures. For example, in *Cattleya warscewiczii*, *Cattleya gaskelliana* and *Cattleya mossiae*, flower induction occurred only when plants were placed under photoperiods of nine hours (nine hours of light per day) at 55 F (13 C), while flowering was inhibited under 16 hours of light (per day) at 55 F (Rotor, 1952, 1959). These represent but a small sample from this genus, which also contains long-day species, as well as both short-day spring- and autumn-flowering types.

Cymbidium is a genus of 50 species native from tropical Asia to Australia. Published studies suggest that *Cymbidium* cultivars are induced to flower by warm-day and cold-night temperatures (i.e., large diurnal fluctuations). Daylength (photoperiod) has not been found to have an effect on flower induction (Goh et al., 1982; Goh and Arditti, 1985).

Dendrobium is one of the largest genera within the orchid family, with more than 1,000 species that are native to tropical and subtropical Asia, Australia and various Pacific Islands. The optimum temperature for flower induction consequently differs among *Dendrobium* selections. In *Dendrobium nobile*, plants exposed to a constant 55 F (13 C) produced flowers regardless of the daylength, whereas plants placed at 64 F (18 C) remained vegetative and did not flower (Rotor 1952; Goh and Arditti, 1985). In contrast, *Dendrobium phalaenopsis* requires short day-lengths and warmer temperatures for flowering. For example, flower-bud development and flowering of plants placed under nine-hour daylengths at 64 F (18 C) were accelerated by six weeks compared with plants placed under longer daylengths at the same temperature (Rotor, 1952). A similar response was observed at 55 F (13 C), but flower bud development was slower due to the cooler temperature.

The genus *Phalaenopsis* is composed of 50 species originating from tropical and subtropical areas of the South Pacific Islands and Asia. Environmental regulation of the flowering process in *Phalaenopsis* is perhaps the best described among orchids. Most *Phalaenopsis* species and hybrids require a period of exposure to relatively cool temperatures less than 82 F (28 C) to trigger the elongation of the spike (Lee and Lin, 1984, 1987; Sakanishi et al., 1980; Yoneda et al., 1992; Wang, 1995). Lin and Lee (1984) showed that uniform spiking can be achieved when plants are grown at day/night temperatures of either 77/68 F (25/20 C) or 68/59 F (20/15 C) for four to five weeks. When induced plants are placed at high temperatures (greater than 82 F [28 C]), a spike can form a vegetative air plantlet, known as a keiki, instead of flower buds, or buds may abort.

A few papers have reported that short days enhance spiking and long days promote vegetative growth or the development of keikis in *Phalaenopsis* (DeVries, 1950; Rotor, 1952; Griesbach, 1985). However, this short-day enhancement is thought to be a result of the extension of cool-night temperatures and not the daylength itself (Sakanishi et al., 1980). Thus, it appears that photoperiod does not influence flowering of *Phalaenopsis* (Baker and Baker, 1991; Sakanishi et al., 1980).

MISCONCEPTIONS ABOUT THE FLOWERING OF ORCHIDS Flowering information found in trade and hobby publications often persuades orchid growers, in an effort to promote flowering, to reduce fertility levels (especially nitrogen) when plants are not actively growing. Does this alone control the flowering process? First, we must step back and look at the native growing environments of orchids. Orchids are native to a wide array of habitats, including tropical and temperate forests, prairies, tundra and even deserts. Orchids are found growing in soil, on rocks or on trees. In the tropics, orchids are distributed according to elevation gradients, and diversity is greatest in montane cloud forests at elevations of 3,300 to 6,600 feet (1,000 to 2,000 m). Scientifically, the nutrient stress theories have little or no merit because nutrient levels do not drastically fluctuate in natural environments from one season to the other. In addition, studies with other crops have shown that nitrogen deprivation delays flower initiation in plants that flower in response to cool temperature or photoperiod, particularly when grown under noninductive conditions (Atherton, 1987).

Plants under stressful conditions may flower to reproduce before they die from such a stress. However, as growers, we do not want to stress our plants to the point where they are no longer aesthetically pleasing (e.g., leaf necrosis). In addition, we are not aware of any scientific study with orchids that has shown flowering is controlled by watering or nutrient delivery strategies. As horticulturists, we'd like to induce flowering using environmental manipulations that do not cause physiological stress.

Another strategy found in the trade literature to induce flowering of orchids is to apply Epsom salts (magnesium sulfate). Magnesium is an essential plant macronutrient. It occupies a central position in the chlorophyll molecule and therefore plays a fundamental role in photosynthesis. Both magnesium and sulfur are involved in plant metabolic functions and enzyme processes and are essential plant nutrients. However, there is no scientific evidence that suggests the application of Epsom salts to orchids or any other plant will induce them into flower.

These are just a few examples of information that has been published on flowering of orchids that has essentially no scientific basis. Myths about flowering tend to spread, and certainly there is more misinformation about orchid flowering than is based on scientific studies. We can only separate fact from fiction by increasing the amount of research performed.

WHAT THE FUTURE HOLDS In recent years, orchids have become the second most valuable potted flowering plant in the United States, with a wholesale value of US $106 million in 2002. More than 12.7 million orchids were sold in the United States last year, with *Phalaenopsis* accounting for more than 75 percent of sales. Why are so many *Phalaenopsis* being sold and purchased when there are well over 25,000 described species of orchids from which to choose? One reason is

ROBERTO LOPEZ

(C)JUDYWHITE/GARDENPHOTOS.COM; ABOVE: BUTCH USERY

OPPOSITE Abundant research has been conducted on poinsettia, which is a short-day plant with a critical daylength of about 13 hours. Shown here is *Poinsettia* Chianti Red.

ABOVE *Zygopetalum* Redvale 'Fire Kiss' (Titanic × Artur Elle) exemplifies the exotic, fragrant and beautiful flowers of the genus.

LEFT In addition to daylength, temperature can also induce flowering. Easter-lily bulbs are cooled for approximately six weeks at 40 to 45 F (4 to 7 C) before they are grown in a warm commercial greenhouse.

KARL SIEGLER

ABOVE *Dendrobium nobile* plants exposed to a constant 55 F (13 C) produce flowers regardless of the daylength. *Dendrobium* Star Sapphire 'KOS', AM/AOS (Friendship × Sancyao) is shown here. Grower: Max C. Thompson.

OPPOSITEE *Dendrobium phalaenopsis* requires short daylengths and warmer temperatures for flowering. *Dendrobium* Doctor Poyck 'Ryan's Grand Slam', AM/AOS (Udomsri Beauty × Thailand), is shown here. Grower: Art Stone Orchids.

that we understand how to regulate the flowering process. As mentioned earlier, growers can prevent flowering by maintaining the day and night temperatures above 82 F (28 C). To induce flowering, plants need to be grown at cooler temperatures. Unfortunately, there is virtually no information available on the flowering of many other orchids, such as *Miltonia*, *Oncidium*, *Vanda* and *Zygopetalum*.

As a result, growers cannot reliably flower an orchid such as *Zygopetalum* for a holiday such as Valentine's Day or Mother's Day, which is when consumer demand is greatest. We do not know if we can manipulate temperature, light or perhaps some other factor to control flowering. Without this information, growers are not able to produce a flowering crop when demand — and likely profit — is greatest.

NEW ORCHID RESEARCH In collaboration with Royal Heins, PhD, we initiated a research program at Michigan State University to investigate how environmental parameters (primarily temperature and light) influence growth and flowering of several orchid genera, including *Miltoniopsis* and *Zygopetalum*. We're adapting our orchid research strategies based on successfully elucidating the flower induction requirements of more than 200 herbaceous perennials and potted flowering plants at Michigan State University over the past 10 years. We already know of several orchid genera (e.g., *Phalaenopsis*) that flower in response to environmental factors, and surely many other orchid genera have similar responses.

Our goal is to elucidate the flowering triggers of some orchid hybrids so that growers and hobbyists alike can predictably flower their crops to meet specific dates, whether for holiday sales or for an orchid exhibition. We've already obtained limited funding for this research, but are seeking additional support to enhance and expand the orchid research program at Michigan State University.

References

Atherton, J.G., D.J. Hand and C.A. Williams. 1987. Curd initiation in the cauliflower (*Brassica oleracea* var. Botrytis L), pp. 133–145. In: *Manipulation of Flowering*. Butterworths, London.

Baker, M.L. and C.O. Baker. 1991. *Orchid Species Culture*. Timber Press, Portland.

De Vries, J. 1950. On the flowering of *Phalaenopsis schilleriana* RCHB. f. *Annu. Bogorienses*. 1:61–76.

Goh, C.J. and J. Arditti. 1985. Orchidaceae, pp. 309–336. In: A.H. Halevy (Ed.). *Handbook of Flowering*, vol. I, CRC Press, Florida.

Goh, C.J., M.S. Strauss and J. Arditti. 1982. Flower induction and physiology in orchids, p. 213–241. In: J. Arditti (Ed.). *Orchid Biology: Reviews and Perspectives*, vol. II, Cornell Univ. Press, New York.

Griesbach, R.J. 1985. An orchid in every pot. *Florists' Rev*. 176(4548):26–30.

Lee, N. and G.M. Lin. 1984. Effect of temperature on growth and flowering of *Phalaenopsis* white hybrid. *J. Chinese Soc. Hort. Sci*. 30(4):223–231.

Lee, N. and G.M. Lin. 1987. Controlling the flowering of *Phalaenopsis*, pp. 27–44. In: L.-R. Chang. (Ed.). *Proc. Symp. Forcing Hort. Crops*. Special Publ. 10. Taichung District Agr. Improvement Sta., Changhua, Taiwan, Republic of China.

Rotor, G.B. 1952. Daylength and temperature in relation to growth and flowering of orchids. *Cornell Univ. Agric. Expt*. Sta. Bull. 885:3–47.

Rotor, G.B. 1959. The photoperiodic and temperature responses of orchids, pp. 397–416. In: C.L. Withner (Ed.). *The Orchids*. Ronald Press, New York.

Sakanishi, Y., H. Imanishi, and G. Ishida. 1980. Effect of temperature on growth and flowering of *Phalaenopsis amabilis*. *Bull. Univ. Osaka, Series b. Agriculture and Biology* — Osaka (Prefecture) Daigaku. 32:1–9.

Wang, Y.-T. 1995. *Phalaenopsis* orchid light requirement during the induction of spiking. *HortScience* 30(1):59–61.

Yoneda, K., H. Momose and S. Kubota. 1992. Comparison of flowering behavior between mature and premature plants of *Phalaenopsis* under different temperature conditions. *Trop. Agr*. 36(3):207–210.

Roberto Lopez is a PhD student in the Department of Horticulture, Michigan State University. Roberto's Masters thesis research focused on the effects of photoperiod and temperature on growth and flowering of six orchid hybrids. (e-mail lopezro4@msu.edu). Erik Runkle, PhD, is an assistant professor of horticulture and floriculture extension specialist in the Department of Horticulture, Michigan State University. Erik has given several national and international talks on the flowering of orchids. (e-mail runkleer@ msu.edu). A288 Plant and Soil Science Building, Michigan State University, East Lansing, Michigan 48824.

DONALD F. WILSON

LINKS

http://www.plantideas.com/etera/

Plantideas.com's "Welcome to Your How to Garden Site" page is an excellent resource for a wide variety of gardening topics, flowering orchids among them. Just scroll down to the "Artificial Lighting" listing, and click "Building a Light Rack" and "Growing Orchids Under Lights" for simple and well-illustrated information and directions.

http://ma.essortment.com/buildyourowng_ripn.htm

PageWise, Inc.'s article, "Build Your Own Green House," by Yvonne Quarles, offers a useful overview of the many options available for anyone considering embarking on this means of flowering one's orchids.