

**ROYAL D. HEINS**  
**Department of Horticulture**  
**Michigan State University**  
**East Lansing, MI 48824-1325**

**EDUCATION**

B.S. Colorado State University 1975  
Ph.D. University of Minnesota 1978

**DATE JOINED MICHIGAN STATE UNIVERSITY FACULTY** - July 1, 1978

**PROFESSIONAL EXPERIENCE**

1978-1983 Assistant Professor  
1983-1988 Associate Professor  
1989-2004 Full Professor  
2004-present Professor Emeritus  
Department of Horticulture, Michigan State University  
1998-2012 Owner, Partner and President, Oro Farms, Inc.  
2012-2017 Technical Manager, Fides-Oro and Dummen Group  
1980-present Owner and consultant, HRT Services, LLC  
2021-present Adjunct Professor, Utah State University

**HONORS AND AWARDS**

Phi Kappa Phi, Colorado State University - 1975  
Pi Alpha Xi, Colorado State University - 1975  
Gamma Sigma Delta, Colorado State University - 1975  
The Kenneth Post Award, American Society for Horticultural Sciences - 1980  
Sigma Xi, Michigan State University - 1988  
Futura Award, Bedding Plants, Inc. - 1988  
The Alex Laurie Award, The Ohio Florists' Association - 1989  
The ASHS Ornamentals Publication Award, American Society  
for Horticultural Sciences - 1992  
The Alex Laurie Award, Society of American Florists - 1996  
Board of Education, Bath Community Schools - Trustee, 1995 - 1997; Treasurer, 1997;  
Vice President, 1998, President, 1998 -2000  
Certified Professional Horticulturist, ARCPACS - 1997  
Fellow of the Society, The American Society for Horticultural Sciences - 1998  
The ASHS Ornamentals Publication Award, ASHS - 1999  
Professional Perennial Growers Academic Award - 1999  
Distinguished Faculty Award - Michigan State University – 2001  
Greenhouse Grower's Medal of Excellence Industry Achievement Award - 2018

**OTHER MAJOR RESPONSIBILITIES**

At Michigan State University, Dr. Heins has taught courses in crop production and greenhouse environmental physiology. He advised both undergraduate students and graduate Masters and Ph.D. students. His major research interests were flowering physiology, the quantification of plant responses to the environment, and the development of decision-support tools for growers in the greenhouse industry. Sixteen students received their Masters degree and/or Ph.D. with Dr. Heins as their thesis advisor. From this research, he has authored or co-authored 130 scientific articles or conference proceedings, and over 260 extension and grower articles. He spoke at over 155 grower meetings and 25 scientific meetings.

After retiring from Michigan State University, Dr. Heins pursued business and consulting activities in the private sector. As a business partner in Oro Farms, he assisted his partners build

greenhouses in Guatemala from open ground to produce floriculture annual and perennial species cuttings for export to the USA, Canada, Japan, and Europe. From no production, Oro Farms grew to produce over 120 million vegetative cuttings before sale of the company to an investment company in 2012.

Following sale of Oro Farms, Dr. Heins provided consulting services to the purchasing company in the USA, The Netherlands, Guatemala, El Salvador, and Uganda at cutting production farms.

During the same time, he expanded his floriculture consulting in the USA to floriculture growers having over 800 acres of greenhouses.

Starting in 2019, Dr. Heins helped hemp greenhouse growers produce over 10 million hemp liners for production of hemp in greenhouses and farms.

Dr. Heins in 2020 continues to provide consulting services to floriculture greenhouse growers, hemp greenhouse growers, and cannabis greenhouse growers.

## **EXAMPLE RESEARCH ACCOMPLISHMENTS**

### **Thermomorphogenesis**

He showed that for many plant species, mature internode length and stem length increases as day temperature increases and that they decrease as night temperature increases. More importantly, he showed that the mathematical Difference between day temperature and night temperature ( $DIF = DT - NT$ ) was highly correlated with stem elongation and final stem length in most plants. Because height control is so important in floriculture production, the use of the DIF concept has gained wide acceptance in greenhouse production throughout the world as a method to control height of flowering plants with little use of growth regulators. The DIF response has also become a widely studied research topic at many universities throughout the world.

### **Modeling and Decision Support**

He has modeled development of several flowering plants including Easter lily, chrysanthemum, poinsettia, hibiscus, African violet and several herbaceous perennials. In Easter lily for example, he determined that leaf unfolding was a linear function of average daily temperature in the temperature range of 10 to 30°C. This information is being used in combination with the DIF concept to accurately time Easter lilies while controlling plant height.

Models relating flower bud size, temperature, and time to flower have been developed for a number of plant species including Easter lily, Thanksgiving cacti, Stargazer Oriental lily, African Violet, and hibiscus. These models are being used by growers to help time crops for specific production dates.

He has also developed a mathematical models of stem elongation from pinch to flower in poinsettia and chrysanthemum. Models have included the classical Richard's function as well as a novel three-phase function that more closely describes stem elongation over a wide range of environmental and cultural conditions. These models were developed into a decision-support tool called graphical tracking. In graphical tracking, actual plant height is plotted against predicted plant height. DIF and growth regulators are modified as needed to keep the actual plant height near the predicted plant height so plants finish within a window of specified heights. Most poinsettias now produced in North America and Europe are grown using the graphical tracking technique developed by Dr. Heins.

Dr. Heins also quantified Easter lily elongation from emergence to flower. As with poinsettia

and chrysanthemum, he developed a graphical tracking decision support tool from this relationship; this graphical-tracking relationship is now used in the production of most Easter lilies in the United States and Canada.

The graphical tracking decision-support techniques were incorporated into a commercial computer program called the Greenhouse CARE system. Modules for graphical tracking of chrysanthemum, poinsettia, and Easter lily were developed. Decision-support modules were developed for poinsettia and Easter lily to assist growers in making height-control decisions.

### **Poinsettia Growth and Development**

Dr. Heins has conducted research on poinsettias for most of his professional career. In addition to the graphical tracking work described before, he identified that the cause of premature cyathia abscission was carbohydrate depletion in the plant due to low light or high temperature. He also showed that flower initiation under short days required night temperatures less than 23°C.

Another line of research showed that the type of pinch given a poinsettia influenced the initial rate of stem elongation due to apical dominance being controlled by both the meristem and immature leaves. Lateral shoots on plants given a soft pinch (roll-out type of pinch) initially develop slower than lateral shoots on plants given a hard pinch or a soft pinch with the immature leaves being removed.

Branching can be limited or absent in some poinsettia cultivars following propagation and pinching. Dr. Heins showed that high temperatures (> 30°C) are responsible for incomplete bud development during the period when lateral buds are developing on stock plants. Growers now avoid production of these cultivars or control stock-plant temperature via cooling or misting so lateral buds develop normally.

Height of a plant at flower is dependent on both the length of internodes and the number of internodes. Dr. Heins determined a relationship between the leaf number on lateral shoots at the start of short days (flower induction) and final desired plant height that minimizes the grower effort necessary to achieve the final height. Achieving this leaf number is made easier by the development of a model relating leaf unfolding rate to temperature.

### **Easter Lily Growth and Development**

The other crop Dr. Heins has researched extensively is the Easter lily. DIF was first discovered/quantified on the Easter lily. Other contributions to this crop include graphical tracking of height, graphical tracking of leaf number, development of a more accurate bud meter, and control of foliar chlorosis. Chlorosis of the lower leaves in Easter lilies can be severe when plants are grown under high density conditions. Based on work that showed combinations of BA and GA<sub>4&7</sub> were effective in preventing foliar chlorosis of Easter lily, he developed commercial strategies for application of these hormones to prevent foliar chlorosis without excessive stem elongation, even after cold storage of plants.

### **Seedling Storage**

Production of plug seedlings does not always perfectly match market demand. One alternative is to hold seedlings in cold storage until desired. Dr. Heins has quantified and developed recommendations for impatiens, petunia, pansy, geranium, fibrous begonia, tuberous begonia, New Guinea impatiens, salvia, ageratum, alyssum, and tomato plug response to dark and light storage for up to 6 weeks in the 0 to 12.5°C temperature range.

### **Herbaceous Perennials**

Dr. Heins has been actively involved in quantifying the juvenility, vernalization, and photoperiod requirements for a wide range of herbaceous perennials (several hundred species and cultivars). Time to flower as a function of temperature and growth regulator responses for height control have also been developed. From this research, commercial recommendations for flowering of numerous herbaceous perennial species at any time of year have now been developed.

### **Orchids**

Dr. Heins initiated an orchid research program at MSU to determine flowering control mechanisms of commercial orchids and to quantify flower development rate as a function of temperature. Initial research was conducted on *Phalaenopsis* where the base temperature for flower development was quantified at 10.8C. Additional research on flowering mechanism have been conducted on *Zygopetalum* and *Miltoniopsis*.

## Selected Publications

Heins, R.D. and H.F. Wilkins. 1979. Effect of soil temperature and photoperiod treatments on Alstroemeria 'Reginal' vegetative and reproductive growth. J. Amer. Soc. Hort. Sci. 104(3):359-365.

Thimijan, R.W. and R.D. Heins. 1983. A review of conversion constants and procedures for photometric, radiometric, and quantum light units of measure. HortScience 18(6):818-822.

Miller, Steven H. and R.D. Heins. 1986. Factors influencing premature cyathia abscission in poinsettia 'Annette Hegg Dark Red'. J. Amer. Soc. Hort. Sci. 111:114-121.

Erwin, J.E., R.D. Heins, and M.G. Karlsson. 1989. Thermomorphogenesis in Lilium longiflorum. Am. J. Bot. 76:47-52.

Hausbeck, M.K., C.T. Stephens and R.D. Heins. 1989. Relationship between silverthiosulfate and premature plant death of seed-propagated geraniums caused by Pythium ultimum. Plant Disease 73:627-630.

Berghage, R.D. and R.D. Heins. 1991. Quantification of temperature effects on poinsettia stem elongation. J. Amer. Soc. Hort. Sci. 116:14-18.

Moe, Roar, Royal D. Heins and John Erwin. 1991. Stem elongation and flowering of the long-day plant Campanula isophylla Moretti in response to day and night temperature alternations and light quality. Scientia Horticulturae 48:141-151.

Heins, Royal D., Nathan Lange and Thomas F. Wallace, Jr. 1992. Low-temperature storage of bedding-plant plugs. Transplant Production Systems, p.45-64. In: K. Kurata and T. Kozai (eds.), Transplant Production Systems, Kluwer Academic Publishers, The Netherlands.

Erwin, John, Peter Velguth and Royal Heins. 1994. Day/night temperature environment affects cell elongation but not division in Lilium longiflorum Thunb. Journal of Experimental Botany 45(276):1019-1025.

Karlsson, Meriam G. and Royal D. Heins. 1994. A model of chrysanthemum stem elongation. J. Amer. Soc. Hort. Sci. 119(3):403-407.

Shimizu, H. and R.D. Heins. 1995. Computer-vision-based system for plant growth analysis. ASAE 38(3):959-964.

Erwin, John E. and Royal D. Heins. 1995. Thermomorphogenic responses in stem and leaf development. HortScience 30(5):940-949.

Fisher, Paul R., Royal D. Heins, J. Heinrich Lieth. 1996. Quantifying the relationship between phases of stem elongation and flower initiation in poinsettia. J. Amer. Soc. Hort. Sci. 121(4):686-693.

Faust, J.E. and R.D. Heins. 1996. Axillary bud development of poinsettia 'Eckespoint Lilo' and 'Eckespoint Red Sails' (Euphorbia pulcherrima Willd.) is inhibited by high temperatures. J. Amer. Soc. Hort. Sci. 121(5):920-926.

Heins, R.D., A.C. Cameron, W.H. Carlson, E.Runkle, C. Whitman, M.Yuan, C. Hamaker, B. Engle, and P. Koreman. 1997. Controlled flowering of herbaceous perennial plants, p. 15-31. In: E. Goto et al. (eds.). Plant production in closed ecosystems. Kluwer Academic Publishers, The Netherlands.

Fisher, Paul R., Royal D. Heins, Niels Ehler, J. Heinrich Lieth. 1997. A decision-support system for real-time management of Easter lily (*Lilium longiflorum* Thunb.) Scheduling and Height - I. System Description. Agricultural Systems 54(1):23-37.

Fisher, Paul R., Royal D. Heins, Niels Ehler, J. Heinrich Lieth. 1997. A decision-support system for real-time management of Easter lily (*Lilium longiflorum* Thunb.) Scheduling and height - II. Validation. Agricultural Systems 54(1):39-55.

Faust, E. James, and Royal D. Heins. 1998. Modeling shoot-tip temperature in the greenhouse environment. J. Amer. Soc. Hort. Sci. 123(2):208-214.

Yuan, Mei, William H. Carlson, Royal D. Heins, and Arthur C. Cameron. 1998. Effect of forcing temperature on time to flower of *Coreopsis grandiflora*, *Gaillardia xgrandiflora*, *Leucanthemum xsuperbum*, and *Rudbeckia fulgida*. HortScience 33(4):663-667.

Yuan, Mei, William H. Carlson, Royal D. Heins, and Arthur C. Cameron. 1998. Determining the duration of the juvenile phase of *Coreopsis grandiflora*, *Gaillardia xGrandiflora*, *Heuchera sanguinea*, and *Rudbeckia fulgida*. Scientia Horticulturae 72:135-150.

Runkle, Erik S. Royal D. Heins, Arthur C. Cameron, and William H. Carlson. 1998. Flowering of herbaceous perennials under various night interruption and cyclic lighting treatments. HortScience. 33(4):672-677.

Whitman, Catherine M., Royal D. Heins, Arthur C. Cameron, William H. Carlson. 1998. Lamp type and irradiance level for daylength extensions influence flowering of *Campanula carpatica* Blue Clips' *Coreopsis grandiflora* 'Early Sunrise', and *Coreopsis verticillata* 'Moonbeam'. J. Amer. Soc. Hort. Sci. 123(5):802-807.

Moe, Roar, Royal D. Heins. 2000. Thermo- and photomorphogenesis in plants. Advances in Floriculture Research, Agricultural University of Norway, Report no. 6, pp. 52-64.

Runkle, Erik S., Royal D. Heins. 2001. Specific functions of red, far red, and blue light in flowering and stem extension of long-day plants. J. Amer. Soc. Hort. Sci. 126(3):275-282.

Clough, Emily A., Arthur C. Cameron, Royal D. Heins, William H. Carlson. 2001. Growth and development of *Oenothera fruticosa* is influenced by vernalization duration, photoperiod, forcing temperature, and plant growth regulators. J. Amer. Soc. Hort. Sci. 126(3):269-274.

Whitman, Catherine M., Royal D. Heins, Roar Moe, Keith A. Funnell. 2001. GA<sub>4+7</sub> plus benzyladenine reduce foliar chlorosis of *Lilium longiflorum*. Scientia Horticulturae 89:143-154.

Runkle, E. S., R. D. Heins, A. C. Cameron, W. H. Carlson. 2001. Photocontrol of flowering and stem extension of the intermediate-day plant *Echinacea purpurea*. Physiologia Plantarum 112: 433-441.

Liu, Bin, Royal D. Heins. 2002. Photothermal ratio affects plant quality in 'Freedom' poinsettia. J. Amer. Soc. Hort. Sci. 127(1):20-26.

Runkle, Erik S., Royal D. Heins. 2002. Stem extension and subsequent flowering of seedlings grown under a film creating a far-red deficient environment. Scientia Horticulturae 96:257-265.

Shimizu, H., E.S. Runkle, R.D. Heins. 2004. A steady-state model for prediction of poinsettia plant shoot-tip temperature. J. Amer. Soc. Hort. Sci. 129(3):303-312.