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Controlling Flowering of Echinacea

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Scheduling plants for uniform flowering can be challenging. Flowering time of echinacea cultivars is often highly variable. We've been conducting research at Michigan State University over the past several years to improve our understanding of the factors influencing flowering of echinacea in an effort to develop commercial guidelines for uniform flowering.

Many plants flower in response to changes in day and night length—a phenomenon termed photoperiodism. Plants may be described as long-day, short-day or day-neutral for flowering. Within the long-day and short-day responses, plants can be further divided into having an obligate (or qualitative) response or a facultative (or quantitative) response. For example, plants with an obligate long-day response must be exposed to long days or flowering will not occur. In contrast, plants with a facultative response will flower earlier if exposed to the appropriate photoperiod, but will eventually flower under any photoperiod.

Long-day plants are induced to flower when the day length exceeds a species-specific “critical” length. It's actually the length of the night that's of primary importance. Thus, long-day plants are induced to flower when the night is shorter than a species-specific critical length. This explains why night-interruption lighting is effective for inducing flowering of long-day plants and also for preventing flowering of short-day plants, such as poinsettias and chrysanthemums.

Short-day/long-day plant

The photoperiodic response of echinacea appears to be more complex than a simple short-day or long-day response. In fact, echinacea appears to have a “dual” photoperiodic requirement. Flowering occurs earliest if plants have been exposed to a period of short days followed by a period of long days. Thus, echinacea is referred to as a short-day/long-day plant, which can complicate crop scheduling.

Determining the critical photoperiods to satisfy the short-day and long-day requirements for flowering of echinacea would aid in scheduling crops to flower early and uniformly. Some day lengths, in particular 14 hours, appear to satisfy both the short-day and long-day photoperiod requirements, and thus growing plants under a constant 14-hour photoperiod (with a 10-hour dark period) promotes early flowering.

The exact “critical” day lengths for the short-day and long-day requirements of echinacea are unknown. We were interested in determining whether a 12-hour day would be sufficient to satisfy both photoperiod requirements for echinacea cultivars that flower the first year from seed. In the northern hemisphere, the day length reaches 12 hours in mid-March. Thus, if 12-hour days were sufficient to satisfy both the short-day and long-day requirements, this would facilitate forcing of early season echinacea crops without using supplemental lighting.

The 12-hour test

To evaluate the effectiveness of 12-hour days in satisfying the long-day requirement, we grew four echinacea cultivars that flower the first year from seed: Cheyenne Spirit, Prairie Splendor, PowWow White and PowWow Wild Berry under a range of photoperiod treatments. Treatments included constant exposure to a particular photoperiod or exposure to 9-hour days for two, four, six or eight weeks, followed by exposure to either 12-hour days or night-interruption lighting. Constant photoperiod treatments were 9-, 12- or 14-hour days or 9-hour days plus four hours of night-interruption lighting.

For all cultivars, flowering was most rapid and uniform for plants grown under a constant photoperiod of 14 hours, confirming the effectiveness of this day length to satisfy both the short-day and long-day requirements. This experiment was performed twice, once in winter and again in the spring. In the spring replication for all cultivars, growing plants under 9-hour days for six or eight weeks followed by exposure to night-interruption lighting, resulted in a similar time to flower as growing plants under a constant 14-hour photoperiod, likely a result of the higher light levels for the spring experiment.

Growing plants under a 12-hour photoperiod after exposure to 9-hour days delayed flowering compared to plants grown under night-interruption lighting or constant 14-hour days, suggesting that 12 hours is not a sufficiently long photoperiod to be sensed as a long day by echinacea. Although a 14-hour day resulted in earliest flowering, “bulking” plants under 9-hour days for a few weeks before long-day exposure improved crop quality.

Our results indicate that for earliest flowering, exposure to day lengths less than 15 hours are necessary, followed by exposure to day lengths longer than 13 hours to satisfy the long-day requirement. Thus, constant growth under a 14-hour photoperiod would fulfill both requirements and result in early flowering.

What about the vegetative ones?

Understanding the flowering requirements of clonally-propagated cultivars can be more complex, as it can be difficult or impossible to know under what conditions the plugs were grown before you received them (whether they’ve been exposed to cold or to short photoperiods). We’ve compared the effectiveness of three different forcing environments to induce flowering: short-days (9-hour photoperiod) and two different long-day environments. The long-day environments were a 9-hour day plus low-intensity night-interruption lighting or a 16-hour day supplemented with $50 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ from high-pressure sodium (HPS) lamps.

The short-day treatment was ineffective at promoting flowering, with plants maintaining a compact rosette growth habit and only a low percentage of plants eventually flowering. Within the long-day environments, the 16-hour HPS treatment promoted earlier and more uniform flowering than night-interruption in some, but not

all, cultivars. This suggests that beyond a photoperiod effect, the overall amount of light provided to plants—called the daily light integral (DLI)—also influences flowering.

Echinacea has been the subject of intensive breeding efforts, bringing new flower colors and more compact habits. Over the years, our group has worked with a number of echinacea cultivars to evaluate greenhouse performance and flowering characteristics (see Tables). Common tips for successful production include:

- Start with uniform, non-flowering young plants.
- Grow seedlings initially under short days (10 to 11 hours is best).
- Start the flowering process by providing a 14-hour day, which satisfies both the short- and long-day requirements.
- When necessary, make PGR applications beginning just when plants begin to bolt. Avoid late PGR applications.

Cultivar & Description: ‘Amazing Dream’

Pictured above: Photo Credit: Terra Nova Nurseries, Inc.

Well-branched plants have pink flowers with petals held horizontally

Starting Material: 72-cell plugs from Terra Nova / Tissue culture

Weeks to flower under long days at 68F (20C):10-12

Height at flower (inches): 20

Cultivar & Description: ‘Bravado’ Common variety with deep bronze cone and slightly reflexed rose-colored petals

Starting Material: 128-cell plugs from Raker's

Weeks to flower under long days at 68F (20C):14-15

Height at flower (inches): 35

Cultivar & Description: ‘Cranberry Cupcake’ Compact with numerous double pink flowers

Starting Material: 72-cell plugs from Terra Nova / Tissue culture

Weeks to flower under long days at 68F (20C): 8-10

Height at flower (inches): 18

Cultivar & Description: ‘Fancy Frills’ Selection of *E. purpurea*; Double pink/purple flowers with frilly petals

Starting Material: 72-cell plugs from Terra Nova / Tissue culture

Weeks to flower under long days at 68F (20C): 17

Height at flower (inches): 23

Cultivar & Description: ‘Fragrant Angel’ Selection of *E. purpurea*; Fragrant white flowers with yellow cones

Starting Material: 72-cell plugs from Terra Nova / Tissue culture

Weeks to flower under long days at 68F (20C): 10

Height at flower (inches): 30

Cultivar & Description: ‘Green Eyes’ Selection of *E. purpurea*; Magenta flower color and green center

Starting Material: 72-cell plugs from Terra Nova / Tissue culture

Weeks to flower under long days at 68F (20C): 13

Height at flower (inches): 24

Cultivar & Description: ‘Harvest Moon’ Hybrid of *E. purpurea* and *E. paradoxa*; Large yellow flowers with golden cone

Starting Material: 30-cell plugs from Langeveld / Tissue culture

Weeks to flower under long days at 68F (20C): 10

Height at flower (inches): 26

Cultivar & Description: ‘Kim’s Knee High’ A dwarf selection of *E. purpurea*; Pink petals are reflexed

Starting Material: 30-cell plugs from Langeveld / Tissue culture

Weeks to flower under long days at 68F (20C): 9

Height at flower (inches): 22

Cultivar & Description: ‘Lilliput’ This *E. purpurea* selection has a dwarf habit and medium-sized rose purple flowers

Starting Material: 72-cell plugs from Terra Nova / Tissue culture

Weeks to flower under long days at 68F (20C): 14

Height at flower (inches): 17

Cultivar & Description: ‘Little Giant’ Selection of *E. purpurea*; Compact with large flowers; Deep pink petals

Starting Material: 72-cell plugs from Terra Nova / Tissue culture

Weeks to flower under long days at 68F (20C): 16

Height at flower (inches): 13

Cultivar & Description: ‘Little Magnus’ Another compact selection of *E. purpurea*; Wide pink petals are not reflexed

Starting Material: 30-cell plugs from Langeveld / Tissue culture

Weeks to flower under long days at 68F (20C): 9

Height at flower (inches): 18

Cultivar & Description: ‘Magnus’ *E. purpurea* Perennial Plant of the Year in 1998; Deep pink petals that stay horizontal or reflex only slightly

Starting Material: 30-cell plugs from Langeveld

Weeks to flower under long days at 68F (20C): 10

Height at flower (inches): 34

Starting Material: 128-cell seedlings from Raker’s

Weeks to flower under long days at 68F (20C): 10

Height at flower (inches): 39

Cultivar & Description: ‘**Mars**’ This selection of *E. purpurea* has large orange cones, surrounded by rose purple petals

Starting Material: 72-cell plugs from Terra Nova / Tissue culture

Weeks to flower under long days at 68F (20C): 12

Height at flower (inches): 37

Cultivar & Description: ‘**Orange Meadowbrite**’ Hybrid of *E. purpurea* and *E. paradoxa*; Narrow orange reflexed petals and dark brown cone

Starting Material: 30-cell plugs from Langeveld / Tissue culture

Weeks to flower under long days at 68F (20C): 7

Height at flower (inches): 24

Cultivar & Description: ‘**Raspberry Tart**’ Compact plants produce numerous flowers with dark pink petals that are slightly reflexed

Starting Material: 72-cell plugs from Terra Nova / Tissue culture

Weeks to flower under long days at 68F (20C): 8-9

Height at flower (inches): 14

Cultivar & Description: ‘**Razzmatazz**’ Selection of *E. purpurea*; Pink flowers with a cushion of short petals in the center and larger reflexed petals on the edge

Starting Material: 30-cell plugs from Langeveld / Tissue culture

Weeks to flower under long days at 68F (20C): 9

Height at flower (inches): 28

Cultivar & Description: ‘**Ruby Star**’ Selection of *E. purpurea*; Vigorous and tall-growing; Pink petals are not reflexed

Starting Material: Seedlings from Raker’s

Weeks to flower under long days at 68F (20C): 11

Height at flower (inches): 34

Cultivar & Description: ‘**Secret Passion**’ Good branching and unique salmon-pink double flowers

Starting Material: 72-cell plugs from Terra Nova / Tissue culture

Weeks to flower under long days at 68F (20C): 7-8

Height at flower (inches): 24

Cultivar & Description: ‘**Sunrise**’ Hybrid of *E. purpurea* and *E. paradoxa*; Petals are sunny yellow and not reflexed

Starting Material: 72-cell plugs from Ball / Tissue culture

Weeks to flower under long days at 68F (20C): 13

Height at flower (inches): 33

Cultivar & Description: ‘**Sunset**’ Hybrid of *E. purpurea* and *E. paradoxa*; Coral reflexed petals and rust-colored cone

Starting Material: 30-cell plugs from Langeveld / Tissue culture

Weeks to flower under long days at 68F (20C): 10

Height at flower (inches): 31

Cultivar & Description: ‘Tangerine Dream’ Showy orange flowers have broad reflexed petals

Starting Material: 72-cell plugs from Terra Nova / Tissue culture

Weeks to flower under long days at 68F (20C): 12

Height at flower (inches): 27

Cultivar & Description: ‘Tiki Torch’ Flowers are large with orange petals held horizontally

Starting Material: 72-cell plugs from Terra Nova / Tissue culture

Weeks to flower under long days at 68F (20C): 8

Height at flower (inches): 25

Cultivar & Description: ‘Twilight’ Hybrid of *E. purpurea* and *E. paradoxa*; Reflexed rose red petals with reddish cone

Starting Material: 30-cell plugs from Langeveld / Tissue culture

Weeks to flower under long days at 68F (20C): 10

Height at flower (inches): 29 GT

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