Pot plant growers have proved MSU's cool days/warm nights work with Easter lilies and poinsettias. Bedding plant growers are next in line.

Do cool days/warm nights work with plugs?
You bet!

Controlling height of plants grown in plugs with temperature

by John E. Erwin, Royal D. Heins, William H. Carlson and John Biernbaum

The plug industry is a rapidly growing sector of the bedding plant industry. Production of high quality plugs requires technical expertise in controlling plant growth from seed germination through transplanting. Research at Michigan State University is showing how control of plug height and development rate is possible through manipulating day and night temperatures.

Using cool day/warm night technology to control plug height is successful, as indicated by these photos of salvia, dusty miller, geranium and impatiens. For compact plugs on the left, day temperatures—15 degrees C (59 degrees F)—and night temperatures—25 degrees C (77 degrees F)—combined to give a negative DIF of minus 18 degrees F. Taller plants on the right had 59-degree F days and 77-degree F nights, experiencing an 18-degree F positive DIF.
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A two-hour drop in temperature at sunrise is almost as effective in reducing plant height as dropping the day temperature all day.

We have reported several times during the past two years how day and night temperature influences stem elongation and plant height. To summarize, plant height at maturity increases as day temperature (DT) increases; plant height at maturity decreases as night temperature (NT) increases.

More important than a particular DT or NT is the relationship between DT and NT. We have developed a term called “DIF,” day temperature minus night temperature. When day temperature is less than night temperature, DIF is negative. In contrast, when day temperature is greater than night temperature, DIF is positive. As DIF increases from a negative to a positive number, plant elongation and height increase.

Most of our reported research on DIF has dealt with crops like Easter lilies, chrysanthemums and poinsettias. This article reports on our experiences using DIF on bedding plant plugs.

Negative DIFs reduce plug height
Research to date has shown that DIF can be used as a tool to control plant height in plugs. The figures accompanying this article show responses of geranium, dusty miller, impatiens and salvia to a two-week period with a cool day/warm night (positive DIF). In all cases, plant height was reduced by a negative DIF.

We determined that a two-hour drop in temperature immediately at sunrise is almost as effective in reducing Easter lily plant height as dropping day temperature all day. We have no data yet...
on how effective a two-hour morning temperature dip is on plants grown in plugs. But, we believe bedding plants will also respond to a morning low temperature pulse.

So the cool day/warm night concept works on plants when grown in plugs. Not only have we observed the DIF response in our research, but several plug growers have also reported that they have successfully used DIF to help control plug plant height.

Small DIFs prevent chlorosis
Cautions are necessary when using a negative DIF. In addition to reducing plant height, chlorophyll is reduced in the expanding leaves of plants exposed to a negative DIF. This reduction appears as foliar chlorosis or a yellowing of the young, immature leaves.

On larger plants, such as lilies or mums, chlorosis normally is not severe and not a problem, as mature leaves have enough chlorophyll to support photosynthesis for proper growth. In addition, chlorosis is normally only temporary as the young leaves “green up” as they mature.

On seedlings, a negative DIF greater than 5 to 10 degrees F can cause severe chlorosis of all leaves as young seedlings don’t have mature leaves. Such chlorosis can reduce photosynthesis and delay plug development.

Therefore, we don’t recommend seedlings younger than one to three weeks old be grown with a negative DIF of more than about minus 2 to minus 3 degrees F. As seedlings mature, DIF can become more negative to control height further if a separate environment is available to separate small seedlings from more mature seedlings.

While the chlorosis shown in the accompanying photo is real, we caution growers not to overreact by not considering using DIF for height control. The plants pictured were exposed to a DT 18 degrees F cooler than the NT. This is a very large negative DIF.

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To prevent chlorosis, one- to three-week-old seedlings need small negative DIFs.  

are changed from a positive DIF to a zero DIF than from a zero DIF to a negative DIF. Therefore, growers can get significant height control by changing from positive DIF to zero DIF temperatures without a delay in plant development due to chlorosis.

Positive to negative DIF switches slow growth
The second caution relates to the potential of slower growth when a grower changes from being a “positive DIF grower” to a “negative DIF grower.” The slower growth has nothing to do with the chlorosis described above.

Instead, if NTs are not increased when the DT is lowered, the 24-hour average temperature will be lower. Since growth of vegetative plants, including plugs, is primarily controlled by 24-hour average temperature, a reduction in average temperature will slow growth.

Growers of all crops should be aware of this potential problem when chang-

Exposing plants to a negative DIF reduces both plant height and leaf chlorophyll content. For seedlings, negative DIFs greater than 5 to 10 degrees F cause severe chlorosis. Salvia grown with a negative DIF of minus 18 degrees F are obviously chlorotic compared to plugs grown with a positive DIF. Growth temperatures are 15 degrees C (69 degrees F) and 25 degrees C (77 degrees F).
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Plug growers have successfully used cool days/warm nights to control plug height.

Growth retardants plus DIF give best control

A third caution relates to possible problems that may occur if DIF is the only height control method used. Once applied, a growth retardant continues to exert its influence until it wears off. Unfortunately, it may not wear off until some time after the plug has been transplanted. Consequently, a grower loses some control of the crop.

In contrast to a growth retardant, growers can increase or decrease stem elongation rate as quickly or as often as they wish by using DIF. This definitely is an advantage of using DIF to control plant height. The problem comes if outside weather conditions prevent DT control. Without any growth regulator, the loss of a negative DIF can result in rapid stem growth. We suggest using low levels of growth retardants in combination with a negative or zero DIF for height control. Then, if DIF control is lost, excessively rapid elongation won't occur.

We believe that manipulation of DT and NT can be a very useful tool in the production of plug transplants. We will continue our research this spring to further expand our understanding of height control in plants grown in plugs using the DIF concept.

Information presented in this article is a result of projects funded in part by the American Floral Endowment, the Fred O. Glocckner Foundation and commercial greenhouse growers.

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