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GREENHOUSE AND INDOOR PRODUCTION OF HORTICULTURAL CROPS

Slowing Growth of Ornamentals

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The COVID-19 pandemic has affected every business in the U.S., including floriculture. Although greenhouses are open in Indiana, sales have decreased significantly. When stay-at-home orders are in place, shopping for plants is the last thing in the minds of customers! Wholesale sales of plants for landscaping purposes have also slowed due to company closures and onsite work restrictions for employees. With limited success, some growers are conducting online business and curbside delivery to customers, while others are developing drive-thru methods for plant sales. Some growers are planning to hold plants longer in greenhouses and hoping that the COVID-19 issue will resolve by summer.

Many greenhouses in Indiana start their operations during winter to get thousands of plants ready for spring planting in homes and landscape. This year, the situation has drastically changed. Market demand for ornamental plants has decreased due to the COVID-19 pandemic. When sales are down, plants accumulate in greenhouses – where they continue to grow rapidly due to warmer temperatures and higher light levels during April. Under such circumstances, it's extremely important to ensure that plants in greenhouse do not become excessively large and lose quality. Large plants occupy space, consume more resources and pose challenges during shipping. Poor-quality plants bring low prices. It is extremely important to slow plant growth rate and maintain their quality in greenhouses when sales are low.

There are many ways to slow plant growth. Growers are familiar with PGRs (Plant Growth Regulators), which reduce extensive growth. However, PGR applications add additional costs and may not be attractive to growers, especially when sales are low. Moreover, there are no registered PGRs for vegetable transplants. However, non-chemical methods to control plant growth in greenhouses are available. And this article provides several examples. It is important to understand that many factors affect plant growth, including irrigation, fertilizers, temperature, light intensity, light spectrum, and carbon dioxide levels. Growers can adjust the levels of these factors to either reduce or promote plant growth.

Irrigation

Irrigation can significantly affect plant growth rate. Water pressure inside plant cells is critical for their expansion, which results in growth. In addition, fertilizers are mixed with irrigation water in greenhouse production. Frequent irrigation results in increased water and nutrient availability to plants and enhances plant growth. Growers can reduce plant growth by decreasing either irrigation frequency or volume. In figure 1, chrysanthemum plants were irrigated using the same fertilizer solution and similar volume of water but either twice a week (left) or every day (right). There is a 14% reduction in height and 12% reduction in width of chrysanthemum plants when irrigated twice a week compared to daily irrigations. Irrigation frequency/volume recommendations that can control growth are difficult to make, as it can vary by location and weather. However, growers can try to reduce irrigation frequency or volume by 20-30% of their current practice. It is important to ensure that plants are exposed to "mild" stress when reducing irrigation frequency or volume.

Figure 1. Effect of irrigation frequency on chrysanthemum growth. Left: twice a week. Right: every day.

Fertilizer Concentration

Fertilizer concentration supplied to plants can be effectively used to reduce plant growth without reducing irrigation frequency or volume. This method can be done more precisely than reducing irrigation. However, growers must be able to measure fertilizer concentration supplied to plants. This can be achieved using calibrated electrical conductivity (EC) sensors. In figure 2, the effect of EC of fertilizer on petunia growth is shown. Optimal growth of petunia in the figure below is observed at approximately an EC level of 2.0 dS/m (or 2000 µS). For many ornamentals, a fertilizer solution concentration of 1.5 to 2.5 dS/m (100 to 200 ppm N) as constant feed is optimal. Note that plant size was significantly reduced by lowering EC to 1.2 dS/m without a reduction in quality. Also note that plant size is smaller at the highest EC level too. This is due to too much fertilizer in the growing medium that causes osmotic stress. Growers can reduce fertilizer concentration by approximately 30% and achieve slower growth.

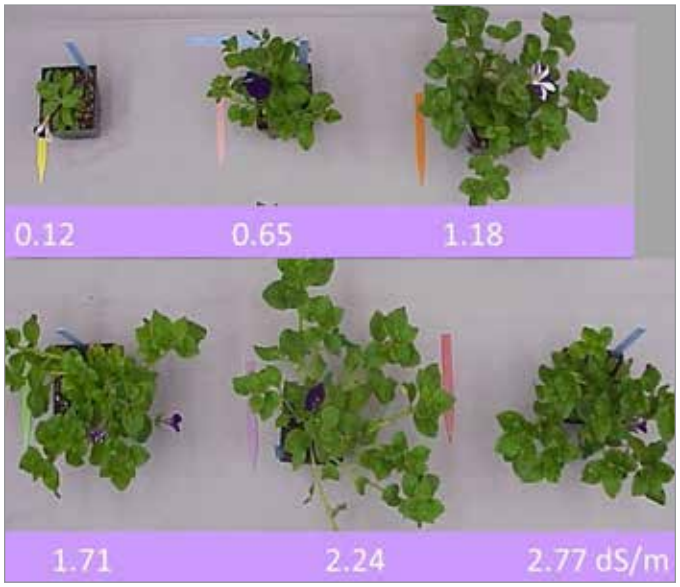

Figure 2. Effect of fertilizer concentration on petunia growth.

Nitrogen Form

Form of nitrogen in the fertilizer can influence plant growth. Generally, nitrogen is supplied either as ammonium or nitrate form. This information can be found on the fertilizer bag. The ammonium form of nitrogen can result in large foliage and lush plant growth. Fertilizers containing less ammonium and more nitrate nitrogen may be used instead. Nitrate is also known to increase stress tolerance in plants.

However, growers should pay attention to pH increase in the substrate that may result due to using nitrate form. In Indiana, alkalinity of irrigation water is high, which can further increase pH of the substrate. In addition to nitrogen, amount of phosphorus supplied to plants can influence their growth. Phosphorus concentration can be quite important for bedding plant plug production. Higher levels of phosphorus, especially when temperatures are higher, can significantly enhance elongation growth in seedlings.

Temperature

Temperature influences both growth and flowering in floriculture crops. For most of the species, a temperature range of 65 to 75°F is considered optimum for growth and flowering. Lower temperature in the range of 55 to 65°F can reduce growth. However, lower temperature decreases flowering or increases days to flowering in many floricultural crops. In the figure 3, the effect of temperature on salvia plants can be seen (research conducted at Michigan State University.). Plants grown at 63°F are much smaller without flowers than those grown at 68 or 73°F. If flowering is not a concern, lower greenhouse temperature can be effectively used to reduce crop growth. It is important to note that plant growth in several species stops at temperatures below 50°F. Such low temperature is not recommended as it can cause cold injury. Therefore, growers can maintain a daily average temperature in the range of 55 to 65°F to reduce growth. Photosynthesis, which produces sugars for plant growth, is usually higher in the morning between 8 and 11 a.m. A slightly lower temperature during this period can have a bigger impact on growth reduction.

Figure 3. Effect of temperature on the growth of salvia (Courtesy: Pramuk and Runkle).

Supplemental Light Composition

Light spectrum is another factor that can affect plant growth. Some growers use supplemental lighting in greenhouses. It is important to know the composition of supplemental light used in production. For example, high-pressure sodium lights contain a higher proportion of green, yellow and red than blue light. In figure 4, marigold plants were grown under blue (455 nm) or red (620 nm) light. Note the difference in plant growth between the two colors. Supplemental lighting with higher proportion of blue light can produce small plants, while a higher proportion of red light increases growth. The proportion of blue in sunlight is generally low during winter. In addition, if supplemental lighting contains less blue light than red light, it can significantly increase elongation growth.

Figure 4. Effect of blue (top) or red (bottom) light on the growth of marigold.

Carbon Dioxide

Carbon dioxide levels inside a greenhouse can affect plant growth. The effect of CO2 on growth is usually higher with increasing light levels. Many growers may not add CO2 inside greenhouses. However, CO2 levels can increase inside a greenhouse over time if ventilation is absent. In the figure 5, petunia seedlings were grown at CO2 levels of 450 and 900 ppm, but at low light levels that are seen during winter. There is a visible increase in the size of plants grown at 900 ppm. An easy way to reduce CO2 levels inside a greenhouse is to allow outside air into the greenhouse. The CO2 concentration of outside air is 410 ppm. This should be possible, especially with warmer outside temperature.

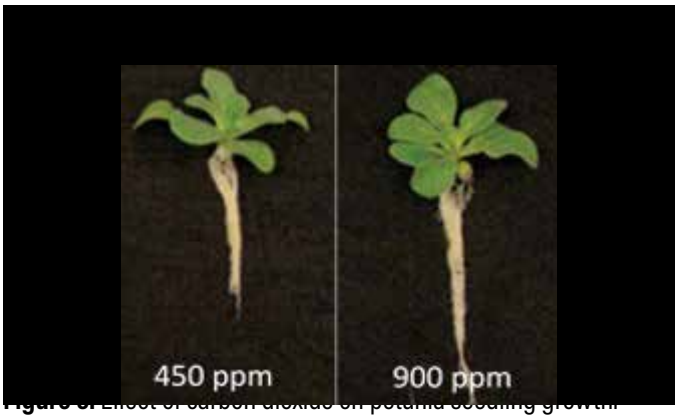

Figure 5. Effect of carbon dioxide on petunia seedling growth.
(Courtesy: Craver and Lopez)

In summary, growers can slow down plant growth by decreasing irrigation frequency or volume and fertilizer concentration, using ammonium form of nitrogen, lowering greenhouse temperature, increasing blue light fraction (if supplemental lights are used), and lowering CO2 concentration inside greenhouses.

Disclaimer: Growers should exercise caution while implementing the above recommendations and make necessary changes that are specific to their location, facility and situation.