By Erik Runkle

Maximizing Photosynthesis to Improve Growth

In the past several years, growers have tightly sealed their greenhouses to reduce heat losses and save on fuel costs, but the consequence can be slower plant growth. If crops develop roots slowly, if shoot growth is retarded, or if plants don't use much water, then these are signs that one or more ingredients of photosynthesis is in short supply. In that case, you would be wise to identify the limitation(s) and then take corrective action so that photosynthesis can proceed unimpeded.

Photosynthesis is the process by which plants convert three inputs into three outputs. The three inputs are light, carbon dioxide (CO_2), and water, and the outputs are carbohydrates, oxygen, and water. Carbohydrates are used by the plant to build biomass, such as shoots, roots, and flowers, as well as for plant maintenance. When any of the three inputs is limiting, the outputs are also limiting. Therefore, plant growth is suppressed when light, CO_2, and/or water are not sufficiently available.

Why is this so important for commercial growers? All it takes is one of these photosynthesis "ingredients" to be in short supply to slow down growth. Sometimes it is obvious when one of these factors is limiting, such as low light on a dark winter day, but other times deficiencies are not obvious, such as low CO_2. Let's look a little closer at these three inputs.

Light. Light levels are a common limitation during the winter, especially in northern latitudes such as the Pacific Northwest, Midwest, and Northeastern United States, as well as in Canada. When in short supply, light can be maximized by ensuring the greenhouse glazing is clean and by minimizing overhead obstructions such as hanging baskets. Sometimes that isn't sufficient though, so growers provide high-intensity lighting to increase plant growth. The benefits can be dramatic, with increased shoot growth as well as rooting of seedlings and cuttings, but only if the other inputs are not limiting.

Water. There are several ways in which water can be a limiting ingredient of photosynthesis:

• Insufficient water in the root zone. This is the most obvious way in which water can be limiting to photosynthesis. When water is not available, plants respond by closing their stomata to reduce water loss by leaves. As a consequence, plants wilt and photosynthesis essentially comes to a halt. Although providing a limited amount of water is a successful way of limiting stem elongation, it also limits photosynthesis and thus root and shoot growth.

• Water present but not readily used. Photosynthesis is limited when a plant can't effectively use water that is available in the root zone. A common cause is poor root growth, which can occur when media is kept too moist or a pathogen has attacked the roots. If the concentration of soluble salts in the media is high, water is less available to plants.

• High humidity. The amount of water that a plant uses depends on a variety of factors, including environmental parameters such as light and relative humidity. When the humidity is high (for example, above 85 percent), there is little transpiration (water loss by leaves), so there is little demand for water. Therefore, although water is present and available, it may be used very little by plants and thus, photosynthesis is impaired.

Carbon dioxide. A short supply of CO_2 is probably more common than we realize, especially on cold, sunny days when a full greenhouse is tightly sealed. Photosynthesis is highly regulated by this gas that we can't see, usually don't measure, and often don't even think about. Plants use a tremendous amount of CO_2, and when it is limiting, photosynthesis decreases dramatically.

High humidity and low CO_2 can be overcome by bringing in fresh outdoor air. This can be expensive since the cold air has to be heated, but having a high humidity and low CO_2 can also be expensive in terms of delayed rooting and poor shoot growth. CO_2 can be supplemented in a greenhouse, but that isn't done very often in North America except in the production of high-wire greenhouse vegetable crops. More research is needed to better understand the merits and costs of supplying supplemental CO_2 to ornamental crops.

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