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HS784

General Aspects of Plant Growth—Florida Greenhouse Vegetable Production Handbook, Vol 3

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Profitable greenhouse vegetable production depends on a complex system of chemical processes that make up plant growth. With optimum greenhouse and cultural management systems, growers hope to maximize the efficiency of plant growth so that high yields of high quality vegetables result.

Photosynthesis is the plant process that uses radiant energy, carbon dioxide, and water to form sugar and oxygen. This basic process occurs in special leaf cell structures called chloroplasts. Chlorophyll (the green pigment) absorbs light energy initiating the process.

Photosynthesis is affected by light intensity, carbon dioxide content of the air, air temperature, and water supply. The rate of photosynthesis is roughly proportional to light intensity in the greenhouse up to about one-third to one-half of full sunlight. Full sunlight on a clear summer day in Florida is about 10,000 footcandles and 6,000 in winter. 1 footcandle = 10.76 lux. Photosynthesis will not be affected by variations in light intensity above about 4000 foot candles. In the summer, on clear days, growers can shade the houses 30% to 40% without sacrificing growth since the reduced sunlight is still above the light saturation point for photosynthesis. Shading is actually beneficial since it lowers the temperature in the plant canopy by reducing the amount of radiant energy reaching the plant. A shade system (overhead curtain) is the best method to achieve temperature control in the greenhouse during late summer and early fall and again in late spring and early summer.

Temperature is another factor that affects the growth process. Speed of enzymatic processes increases as temperature rises from near freezing to about 100°F. Photosynthesis nearly doubles with a temperature rise of 18°F in laboratory experiments.

The level of $C0_2$ in the air affects the rate of photosynthesis. Typical ambient outdoor air has about 400 ppm CO_2. Research has shown that plants can increase growth and yield by increasing the CO_2 concentration to 800 or 1000 ppm as long as light, temperature, etc., are optimum. CO_2 can be introduced into the greenhouse by injecting CO_2 gas from cylinders or by burning natural gas or propane in special burners. Growers in the northern states take advantage of this by injecting CO_2. To benefit from CO_2, the injection must be done during the light hours of the day, and the greenhouse ventilation system must be off. The latter requirement is difficult to meet in Florida, even in the winter, because some ventilation is needed even on cold but sunny days. Therefore, it is questionable whether CO_2 injection will benefit Florida greenhouse growers.

Water supply to the plant will have an impact on photosynthetic rate. Drought stress causes the stomates in the leaves to close. Since the stomates are entry pathways for the CO_2

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needed for photosynthesis, the growth rate will drop to near zero in wilted plants.

Nutrient deficiencies, diseases, and insects also can reduce photosynthesis. Nutrient deficiencies damage the healthy leaf and its ability to produce chlorophyll. Disease organisms and insects reduce the amount of healthy leaf area for conducting photosynthesis.

The major objective of the greenhouse manager is to maintain photosynthesis in the plant. Nearly everything that a greenhouse operator does is with regard to optimizing the greenhouse environment so that growth rate is not slowed.

The products of photosynthesis undergo many transformations in the plant to produce all of the necessary compounds for plant growth and fruit production. These compounds include sugars, amino acids, proteins, starch, enzymes, energy compounds, cellulose, lipids, and nucleic acids, among others.

Products from the building processes such as photosynthesis can be used in the degradation processes, such as respiration. The process of respiration "burns" organic molecules to produce energy for growth. This energy is used in cellular reactions that assimilate compounds into cell walls and many other cellular components.

The rate of respiration, like photosynthesis, is affected by several factors such as temperature, moisture, plant injury, age of plant tissue, CO_2 level, and the amount of food (photosynthate) available.

Respiration rates increase as temperature increases. Respiration takes place at night and during the day. Growers generally desire to manage the night temperature so as to minimize excess respiration. Wounding of the plant increases respiration in order to provide material to heal wounds. Therefore, growers need to minimize wounding from practices such as pruning, harvesting, and removing lower leaves.

Photosynthesis and respiration work together in making up the metabolism of the plant. They appear to be opposite in nature because one uses water and CO_2 and produces sugars and oxygen, while the other uses sugar and oxygen to produce water and CO_2. The challenge for the greenhouse grower is to manage the greenhouse environment and provide optimum cultural conditions that result in the proper balance of metabolism that results in high yields of high quality fruits. Volume 3 of this handbook serves to provide details and suggestions on greenhouse systems and crop management that optimize vegetable yields and quality.

More Information

For more information on greenhouse crop production, please visit our website at https://smallfarms.ifas.ufl.edu.

For the other chapters in the Greenhouse Vegetable Production Handbook, see the documents listed below:

Volume 1: Introduction • Financial Considerations • Pre-Construction Considerations • Crop Production • Considerations for Managing Greenhouse Pests • Summary

Volume 2: Physical Greenhouse Design Considerations • Production Systems • Other Design Information Resources

Volume 3: Preface • General Aspects of Plant Growth • Production Systems • Irrigation of Greenhouse Vegetables • Fertilizer Management for Greenhouse Vegetables • Production of Greenhouse Tomatoes • Greenhouse Cucumber Production • Greenhouse Nematode Management • Alternative Greenhouse Crops • Vegetable Insect Identification and Management