Report to Annual Meeting, NCR-101, Controlled Environment Technology and Use
April, 2006, Wooster, Ohio

Louis D. Albright, Professor
Department of Biological and Environmental Engineering, Cornell University

New Facilities: None

New or Different Control Systems: The light integral supplemental light and movable shade control algorithm has been programmed in LabView and used in the Cornell CEA lettuce facility for more than six months with very acceptable results.

Sensors and Instruments: None

Hardware and Control Software: None

Unique Plant Responses:

1. Laboratory experiments were conducted to compare the persistence of three chelators, EDTA, DTPA, and EDDS, and the resulting effects on plant nutrition. The EDDS concentration in hydroponic solutions growing lettuce decreased rapidly and remained low, while EDTA and DTPA concentrations remained steady over the course of the growth period. The steady chelator concentration for EDTA and DTPA, even though chelator is added in the “make-up” solution over the course of the experiment, indicates some loss of the chelator from the solution. One potential loss is photodegradation of the Fe-chelate complex, as indicated by greenhouse studies of nutrient solution exposed to natural sunlight, resulting in half-lives of EDTA and DTPA of 28.3 and 22.7 min respectively. Another potential loss is uptake of chelator into plant tissue. Low concentrations of EDTA and DTPA were found in both root and shoot tissues. Although the measured concentrations do not account for the amount of chelator lost from the system, photodegradation of the Fe-chelate complex inside the tissue may have occurred over the course of the experiment. In one experiment comparing EDTA and DTPA, metal concentrations were measured daily over the growth period. Fe concentrations remained steady, Zn and Cu steadily increased, likely due to greenhouse contamination, and Mn concentrations decreased steadily. The rockwool cubes used for crop support contained high levels of Mn at the end of the experiment and may have acted as a sink for Mn.

2. A study compared three sterile, soil-less media (Agrifoam and Oasis, growth foams, and Grodan, an expanded rockwool substrate) to determine which media characteristics favor seedling development and establishment. These media were studied during days 7-10 of the seed gemination stage. One problem with foam media is"pop-outs", a disorder in which actively growing roots do not penetrate and spiral on the media surface, causing the root tip to die. Pop-outs were more frequently observed in Agrifoam compared to the other media. High soluble salts, particularly high magnesium in the root zone, produced roots that were "burned" and did not grow. This, in combination with low pH and a

decrease in number of cation exchange sites, lead to toxicity in the roots. Magnesium salts added to Grodan (control substrate), in concentrations equivalent to that found in Agrifoam, increased the number of pop-outs and produced roots resembling those grown in Agrifoarn. Root hairs did not form as readily in Oasis and Agrifoam as in Grodan possibly contributed to poor anchorage and increased pop-outs. More frequent watering increased the severity of pop-outs. Foams that are too wet have more pop-outs and spiraling roots. A flooded root zone might also allow more cations in the foam to go into solution and to be taken up by the roots.

3. A lettuce growth model is being developed based on accurate and detailed morphological and physiological characteristics of each leaf's growth. Unfolding of each lettuce leaf was described by using a series of flap patterns, each composed of a triangle and an ellipse. This method enables an accurate presentation of the morphological changes within each leaf and tracks plant growth by sequential measurements of each leaf length, width, and distance between the leaf base and the location of the maximal leaf width. Quantification of the leaves' morphological changes can also be used for drawing information about the initiation and maturity states of each leaf life cycle.

4. An economically viable means to employ pond (or deep-flow) hydroponics in continuous production of salad spinach has been identified. In such a system the nutrient solution will be kept in use (replenished but not changed out) for many crop cycles. At warm temperature, disease was chronic but at cool temperature it was prevented, or died out if already established. Both UV and filtration mitigated immediate effects of inoculation compared to inoculation with no treatment, but a severe chronic disease process eventually became established in each case.

Cooperative/Interdisciplinary Projects: None

Workshops, etc.: None

Publications:

Ferentinos, K.P. and L.D. Albright. 2005. Optimal design of plant lighting systems by genetic algorithms. Artificial Intelligence 18(2005):473-484.

Dayan, E., E. Presnov and L.D. Albright. 2005. Methods to estimate and calculate lettuce growth. Acta Horticulturae 674:305-312.

Linker, R., J. Mathieu and L.D. Albright. 2005. A user-friendly, Internet-based, version of the NICOLET simulation model for lettuce. Acta Horticulturae 675:337-342.

Montgomery, J. 2005. Evaluation of solid artificial media for lettuce seedling growth and anchorage. M. S. Thesis, Cornell University Libraries, Ithaca, NY. 77 pp.

Seginer, I., L.D. Albright and I. Ioslovich. 2005. Improved strategies for a constant daily light integral in greenhouses. Biosystems Engineering 93(1):69-80

Internet site: www.cornellcea.com