THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

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1. New Facilities

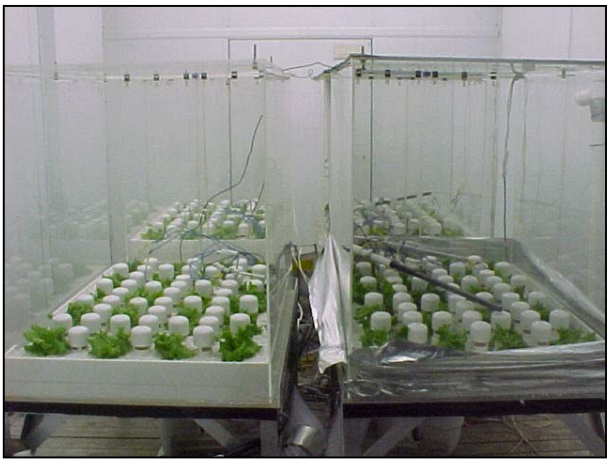
Open-roof greenhouse

Our open-roof greenhouse (Van Wingerden Greenhouse Company, MX-II, four gutter-connected bays, 17.7 by 18.3 m floor area) renovation is nearing completion. A floor heating system and an ebb and flood floor irrigation system were installed. Two independent growing areas allow for different floor heating and irrigation treatments. The sidewalls were outfitted with acrylic panels. Roof segments are clad with double poly film. In addition to the roof vents, two motorized side vents were installed along the east and west sidewalls. A gas-fired, hot-water boiler was installed to supply warm water to the greenhouse floor, and to a combined perimeter and overhead heating loop.

New greenhouse film material (F-Clean)

Two layers of a new greenhouse film material (F-Clean, AGA Chemicals, Inc., Japan, 0.064 mm thick) were installed on one of two identical greenhouses (11 by 15.3 m). The other greenhouse was covered with two layers of polyethylene film (Tufflite IV, Tyco Plastics, USA, 0.15 mm thick). The new film material has a higher light transmission and has a life expectancy of 10 years (approximately 2.5 to 3 time the life of polyethylene film). The light transmission and the long-term light reduction through the two film materials will be studied. The new film material is currently too expensive for most commercial greenhouse applications.

2. Sensors and Instruments



Plant photosynthesis and transpiration measurements by whole canopy gas analysis for a lettuce crop

In order to provide non-destructive growth data useful for crop modeling, four small plant growth boxes (located inside an environmentally controlled walk-in plant growth chamber and each measuring 91 by 64 by 76 cm, L x W x H) are being used to monitor canopy net photosynthesis and dark cycle respiration rates of lettuce (Lactuca sativa L., cv. Flandria). An ADC 2250 Gas Analyzer (ADC BioScientific Ltd., Hoddesdon, England) and a gas-handling unit (for sequential measurements of the four boxes) are used to conduct the analyses.

3. Cooperative/Interdisciplinary Projects

Crop Modeling for Environmental Control

Previous work with mathematical plant growth and development models has shown, theoretically, that they can be integrated with a model-based predictive control algorithm for optimization of plant production scheduling in controlled environments. The control algorithm was designed to select the best set of environmental set points based on model predictions of plant growth and development. The technique needs to be evaluated experimentally, however, before it can be implemented in practice. Research is being conducted to verify / validate the ability of explanatory crop models to accurately predict plant production in response to environmental disturbances in light intensity. On-going experiments are being conducted in the plant growth boxes (above) for evaluation of the effects of disturbances in light intensity on lettuce growth. Future work is planned to incorporate non-destructive measurements of plant nitrate uptake for use as feedback in the control design.

Top-level Modeling of Advanced Life Support Systems and Component Systems

As part of Luis F. Rodriguez PhD dissertation research, efforts were undertaken towards the development of acceptable, flexible, and dynamic mathematical computer modeling tools capable of system level analysis. Object oriented techniques were adopted to develop a top-level model of an advanced life support system such as a space station or a planetary base. An advantage of this approach is that object oriented abstractions of systems are inherently modular in architecture. Thus, models can initially be somewhat simplistic, while allowing for incorporation of adjustments and improvements. In addition, by coding the model in Java, the model can be implemented across the Web, greatly facilitating the use of the model. The sub-models of the overall advanced life support system model include Crew, Biomass Production, Waste Processing and Resource Recovery, and Food Processing and Nutrition. Currently each of the sub-models has been unified into one overall top-level model. Data collection is currently underway to populate the supporting database of information. Testing and simulation will be performed in the near future in an effort to demonstrate the usefulness of the modeling tool.

Supplemental Lighting for Plug Production

A collaborative research project under the leadership of Dr. Paul Fisher (University of New Hampshire) was continued for a second year. The project investigates the economic feasibility of supplemental lighting (HPS) for plug production and specifically studies the effects of supplemental lighting on growing time and on plant quality during the growing-out phase. Part of the research is conducted at a commercial greenhouse operation in Allentown, New Jersey (Kube Pak Corporation, Bill Swanekamp).

4. Committees and sub-committees served

NE-164 Regional Committee on Decision Support for Design and Control of Plant Growth Systems: A.J. Both, Chair (2001)

CEA Advisory Board, Cornell University: A.J. Both, member

SE-303 Committee on Environment of Plant Structures, ASAE: David Fleisher, Chair (2001)

SE-303 Committee on Environment of Plant Structures, ASAE: A.J. Both, Secretary (2002)

5. Recent Publications

Both, A.J., D.E. Ciolkosz, L.D. Albright. 2001. Evaluation of light uniformity underneath supplemental lighting systems. Accepted for publication in Acta Horticulturae.

Both, A.J., E. Reiss, D.R. Mears, and W.J. Roberts. 2001. Open-roof greenhouse design with heated ebb and flood floor. ASAE paper No. 01-4058. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. NJAES Paper No. P-03232-15-01. 13 pp.

Cavazzoni, J., F. Tubiello, T. Volk, and O. Monje. 2001 (in review). Modeling the effect of diffuse light on canopy photosynthesis in controlled environments. Submitted to Acta Horticulturae.

Ciolkosz, D.E., A.J. Both, and L.D. Albright. 2001. Selection and placement of greenhouse luminaires for uniformity. Applied Engineering in Agriculture 17(6):106-113.

Fleisher, D.H., S. Kang, K.C. Ting. 2001. Software for multiple crop production in advanced life support systems. ASAE paper No. 01-4084. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. NJAES Paper No. P-70501-08-01.
Fleisher, D.H., H. Baruh, K.C. Ting. 2001. Model-based predictive control for biomass production in advanced life support. Presented at the IFAC-CIGR Workshop on Intelligent Control for Agricultural Applications, August 22-24, Bali, Indonesia. NJAES Paper No. D-70501-10-1.
Fleisher, D.H. 2001. Modeling for multiple crop production and control in advanced life support systems. Ph.D. Dissertation. Rutgers University Libraries. NJAES Paper No. T-70501-16-01.
Fleisher, D.H., J. Cavazzoni, G.A. Giacomelli, K.C. Ting. 2001. Adaptation of SUBSTOR for hydroponic production of white potato in controlled environments. Submitted to Transactions of the ASAE. NJAES Paper No. D-70501-19-01.
Fleisher, D.H. and H. Baruh. 2001. An optimal control strategy for crop growth in advanced life support systems. Life Support & Biosphere Science 8:43-53. NJAES Paper No. D-70501-13-01.
Fleisher, D.H. and K.C. Ting. 2001. Modeling and control of plant production in advanced life support systems. Accepted for publication in Acta Horticulturae. NJAES Paper No. D-70501-07-01.
Hsiang, H. 2002. Top-level modeling of a food processing and nutrition (FPN) component of an advanced life support system (ALSS). M.S. Thesis. Rutgers University Libraries. NJAES Paper No. T-70501-02-02.
Hsiang, H., S. Kang, A.J. Both, and K.C. Ting. 2001. Analysis tool for food processing and nutrition (FPN) subsystem in an advanced life support system (ALSS). ASAE paper No. 01-3020. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. NJAES Paper No. P-70501-12-01. 16 pp.
Kang, S., K.C. Ting, and A.J. Both. 2001. Systems studies and modeling of advanced life support systems. Agricultural and Biosystems Engineering 2(2):41-49. NJAES Paper No. P-70501-17-01.
Kang, S. and A.J. Both. 2001. A management information system for food nutritional analysis and biomass production in an advanced life support system. ASAE paper No. 01-3021. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. NJAES Paper No. P-70501-11-01. 10 pp.
Kang, S. and J.A. Hogan. 2001. Optimization of feedstock composition and pre-processing for composting in advanced life support systems. Presented at the 31st International Conference on Environmental Systems, July 9-12, Orlando, Florida. SAE Technical Paper No. 2001-01-2297. NJAES Paper No. H-70501-05-01.
Mears, D.R. and A.J. Both. 2001. Insect screening and positive pressure ventilation for tropical and subtropical greenhouse facilities. Keynote presentation and Proceedings of The International Symposium on Design and Environmental Control of Tropical and Subtropical Greenhouses, Taichung, Taiwan. April 15-18, 2001. Submitted to Acta Horticulturae. NJAES Paper No. P-03130-06-01.
Reiss, E., W.J. Roberts, and A.J. Both. 2001. Design and construction of an open-roof greenhouse with heated ebb and flood floor irrigation system. Presented at the CSAE/SCGR-NABEC Meeting in Guelph, Ontario, July 8-11, 2001. NABEC Paper No. 01-916. NJAES Paper No. P-03232-14-01. 13 pp.
Roberts, W.J. 2001. Let the sunshine in. Resource magazine. July issue. Pp. 7-8. NJAES Paper No. E-03130-04-01.
Rodriguez, L.F., C. Finn, S. Kang, J. Hogan. 2001. Modeling of a composting system within BIO-Plex. Presented at the 31st International Conference on Environmental Systems, July 9-12, Orlando, Florida. SAE Technical Paper No. 2001-01-2323. NJAES Paper No. H-70501-09-01.

Translation:
Spaargaren, J.J. 2001. Supplemental Lighting for Greenhouse Crops. Published by P.L. Light Systems, Inc., Beamsville, Ontario, Canada. 178 pp.

Fact sheets:
E.F. Wheeler and A.J. Both. 2002. Evaluating mechanical ventilation systems for commercial plant production facilities. Penn State fact sheet No. I-40, Rutgers University Fact sheet No. E275.
E.F. Wheeler and A.J. Both. 2002. Instruments for measuring the aerial environment in commercial plant production facilities. Penn State fact sheet No. I-41, Rutgers University Fact sheet No. E276.

6. Internet Sites

http://aesop.rutgers.edu/~horteng
http://aesop.rutgers.edu/~fleisher