Report to the USDA NCR-101 Committee
on Controlled Environment Technology and Use

John Innes Centre

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Penn State University Report

Departments of Agricultural & Biological Engineering, Biology, and Horticulture

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A. New Facilities:

Three commercial scale (17' x 96') high tunnels have been added to the High Tunnel Research and Education Facility at the Horticulture Research Farm, Russell E. Larson Research Center, Rock Springs, PA. To demonstrate the impact of wider structures, one 21' x 36' and one 30' x 36' tunnels have also been constructed. Data loggers and environmental monitoring instrumentation were installed to collect environmental data so that models of the high tunnel environment can be developed. Potato, pepper, tomato, broccoli, cut flowers, strawberries, blackberries, raspberries, and cherry trees have been grown in the tunnels. Current projects include evaluation of colored plastic mulch, TPU greenhouse films, and PEP composite materials. (Contact: Mike Orzolek, mdo1@psu.edu. Center for Plasticulture website – http://hortweb.cas.psu.edu/plastic/)

Constructed wetlands housed in a controlled environment (greenhouse) were evaluated for odor removal performance. Anecdotal evidence pointed to reduced odor as a side benefit of the waste treatment functions of constructed wetlands used for livestock wastes. Housing the wetlands in a greenhouse offers year-round effective treatment of the waste by microbes and wetland plants, which are temperature dependent. Swine facility wastewater (feces, urine, and flush water) treated in 8 bathtub-sized constructed wetland tanks had large percentages of two highly malodorous compounds removed: Dimethyl disulfide (DMDS) and *p*-cresol. Planted wetlands removed 80 percent of dimethyl disulfide (DMDS) and 83 percent of *p*-cresol from swine facility wastewater. Fifty-two percent of DMDS and 64 percent of *p*-cresol were removed from swine wastewater in unplanted wetlands. This recently completed two-year study is currently being taken to scaled-up facilities for commercial application in a second two-year study. (Contacts: ABE and Animal Science: Eileen Wheeler efw2@psu.edu, Robert Graves, Jennifer Zajazckowski)

B. Instrumentation, Controls, Sensors

The PSU Germinator growth chamber is currently scheduled to lift off on November 29th, 2001 on shuttle flight ST 108. Integration of the payload is scheduled for early September at Kennedy Space Center. This small plant growth chamber will be contained as a primary experiment in Penn State's Get Away Special (GAS) Payload G-064 which we have named MAGIC (Magnetometer, Accelerometer, and Germinator In a Can). It consists of the following: a digital syringe pump, CO_2 and O_2 sensors, a Minco heater-stat with a strip heater, a relative humidity and temperature sensor, a miniature centrifuge to supply variable g forces controlled by a miniature 586 computer. Time elapse images are collected *via* a Kodak digital camera and stored on flash RAM. The test plant, *Arabidopsis thaliana*, will be grown from seed for 7 days under variable gravity and microgravity conditions after launch. The goal of this experiment is to observe gravity effects on germination and early development of seedlings and to determine gravitational sensing thresholds in plants. This project is designed, constructed, and run by students. (ABE, EE, and Biology Departments - Students:

Gioia Massa <gdm4@psu.edu> and Gregg O'Marr <glo101@psu.edu>; Faculty: Simon Gilroy and Russell Philbrick.)

C. Plant Responses

We have characterized the cellular signaling systems associated with gravity perception in plant roots and defined the rapid (within seconds) spatial and temporal changes in cytoplasmic pH that appear essential for this process to occur (Fasano et al., 2001). We have therefore generated transgenic plants expressing a pH sensitive form of green fluorescent protein (GFP). Using confocal imaging of the GFP signal it is now possible to non-invasively monitor whether plants have initiated gravity perception events well before any detectably oriented growth response has occurred. This technology should facilitate studying the fundamental cellular processes that allow plants to respond to the gravity vector. In addition, the GFP imaging approach should help design plant growth facilities or treatments that elicit 'gravity perception' events in microgravity, thus potentially entraining space grown plant material to a developmental program more similar to those exhibited on earth. (Biology Department - Students: Jeremiah Fasano, Victoria Kramer, Gioia Massa; Faculty: Simon Gilroy, sxg12@psu.edu)

In 2000, eight tomato varieties were evaluated at the High Tunnel Research and Education Facility at the Russell E. Larson Research Center, Rock Springs, PA. Four rows were planted per high tunnel with 20 plants per row (1.5 ft. between plants and 3.5 ft. between rows). The tomato plants were drip irrigated a total of approximately 33 hours through the season. They were generally disease free, although powdery mildew did appear. A small outbreak of whitefly and aphids was quickly controlled following multiple releases of two parasitic wasps, *Aphidus colemani* (aphid control) and *Encarsia formosa* (whitefly control). All varieties grew well and achieved relatively good yields. It was observed that the mildew started in the middle rows and then quickly spread to the outer rows. Lack of sufficient air movement throughout the house may have contributed to the rapid spread of the mildew. Attempts were made to promote as much air movement through the tunnel by letting the sides up as much as possible. Harvest of the crop commenced on August 20, 2000. A total of 15 harvests were made, occurring twice a week and ending on October 10, 2000. However, most of the varieties continued to flower and still had fruit on them until the first hard frost (October 29, 2000). (Contact: Mike Orzolek, mdo1@psu.edu).

D. Meeting Announcement

February 23-26, 200@ - PLASTICULTURE 2002 – 30th American Agricultural Plastics Congress, Mission Valley, San Diego, California. Contact the American Society for Plasticulture at (717)238-9762 or FAX (717)238-9985 or e-mail the Executive Director, Pat Heuser, at pheuser@calabreseheuser.org

E. Publications

J.M. Fasano, S.J. Swanson, E.B. Blancaflor, P. Dowd, T-h. Kao, and S. Gilroy. 2001. Changes in cytoplasmic and cell wall pH are associated with the gravity response of the *Arabidopsis* root. *Plant Cell* 13: 907-921.

Wood, S. L., E. F. Wheeler, and R. D. Berghage. 2000. Removal of dimethyl disulfide and p-cresol from swine facility wastewater using constructed wetlands. *Transactions of ASAE* 43(4):973-979.

Wood, S. L. and E. F. Wheeler. 2000. Malodor reduction in liquid swine manure treated in subsurface flow constructed wetlands. *Proceedings of Second International Conference on Air Pollution from Agricultural Operations*. ASAE, St. Joseph, MI. pp. 59-66.

Wood, S. L., E. F. Wheeler, and K. B. Kephart. 2000. Reliability of subjective odor quantification using the refined cloth swatch olfactometric technique. ASAE Paper No. 00-4022. American Society of Agricultural Engineers. St. Joseph, MI. 18 pp.