2007 Report from Georgia for NCERA-101

Ian Flitcroft and Marc van Iersel, University of Georgia,

New Facilities and Equipment in Athens

The Life Sciences division of the College of Arts and Sciences installed a new growth chamber facility, consisting of 18 Conviron growth chambers. Different types of chambers include Arabidopsis chambers, reach-in chambers and walk-in chambers. Six of these chambers are installed in the Life Sciences Building, while 12 of them are installed in the headhouse of the Plant Biology greenhouse. This new facility was funded by an NSF grant.

A set of three propagation units (Nurseryman) from Southern Sun Biosystems (http://www.sosun.com/) is currently being renovated. When finished, these units will have independent control of temperature, relative humidity, and CO_2 in each of the units. These units are sun-lit, so light levels can be controlled with shading or the use of supplemental lighting.

Six high tunnels were installed at the Horticulture farm and will be used for organic agriculture research and teaching. Current research in these tunnels is aimed early production of organic blueberries (Funded by a USDA Integrated Organic Program Grant).

Update on facilities at the Envirotron in Griffin

Rainout Shelters. The rainout shelters are scheduled to be demolished or moved in 2008 to make way for a new road on the UGA Griffin Campus. Repairs and renovations were therefore restricted to the minimum repairs needed to keep the rainout shelters functioning during the 2006 growing season. The 12V drive motors for each shelter were replaced in the winter of 2005-2006. In addition some drain pipes were installed next to each shelter to improve the removal of water from the shelter roofs during rain events. A peanut modeling experiment was carried out through the 2006 growing season (see below).

Envirotron Growth Chambers. A retrofit of the growth chamber dehumidifier systems was purchased from Conviron. Presently the humidity in each of the CG72 chambers is controlled by a CargoCaire 150 chemical dryer unit, controlled by a humidistat mounted on the wall of the machine room at the back of each chamber. A dial on the humidistat sets the relative humidity at the desired humidity and the chemical dryer cycles on and off to reduce excess humidity above the set level. The retrofit will provide control of the humidity using the chamber controller program, so that programmed humidity changes can be accomplished.

Envirotron Greenhouses. In 2004 and 2005 the eight greenhouses at the Envirotron were retrofitted with Wadsworth step 50 controllers. Of these eight controllers, three have required replacement of the aspirator, owing to a failure of the aspirator circuit board. There are no major improvements scheduled for the greenhouses. Two greenhouses were used to house a collection of tropical legumes through the winter of 2006-2007.

Envirotron Research Projects

<u>Leaf Level Response of Maize to Temperature and Moisture</u>

Gerrit Hoogenboom, Department of Biological and Agricultural Engineering, and Jiftah Ben-

Asher, The Jacob Blaustein Institute for Desert Research, Ben-Gurion University

Four CG72 chambers and three PGW chambers at the Georgia Envirotron were used to grow maize and study the effects of temperature and humidity on leaf transpiration and photosynthesis. A new device developed in Israel - a Phytosynthesis and Transpiration Monitor (PTM)- was installed in chambers sequentially and it's performance was tested. The PTM sensors attach to plants and clamp onto selected leaves. The sensors close around a leaf for one minute every thirty minutes to measure transpiration and photosynthetic rates. Further development of the PTM device is planned for Fall 2007.

Determining Irrigation Scheduling for Peanut using a Cropping System Model

Cecilia M. Tojo Soler and Gerrit Hoogenboom, Department of Biological and Agricultural Engineering

Irrigation scheduling is an important management practice for farmers who grow irrigated crops. Effective irrigation is possible by regular monitoring of soil water and crop development conditions in the field. However, this methodology requires frequent field visits and, consequently, it is time consuming. Computer simulation models can be an important aid for irrigation scheduling, as they integrate the soil-plant-atmosphere complex. The main objectives of this study were to determine the impact of different irrigation scheduling regimes on peanut growth and development and to evaluate the application of a crop simulation model as a tool for irrigation scheduling. A peanut experiment was conducted in four rainout shelters, located at the Griffin Campus of the University of Georgia, during the summer of 2006. The CSM-CROPGRO-Peanut model was used to define the irrigation treatments by estimating the timing of irrigation and the amount of water to apply. The irrigation event was triggered when the actual soil water content in the effective root zone dropped below a specific threshold of the available water content (AWC) and then irrigation was applied until the soil water reached 100% of AWC. The irrigation treatments corresponded to 30%, 40%, 60% and 90% of the irrigation threshold (IT). The model requires daily weather data, including maximum and minimum temperature, solar radiation and precipitation as input. Actual weather data were used until the current date and the daily weather data for the past 10 years were used to project until the end of the growing season. The peanut cultivar Georgia Green was planted on May 22, 2006. The soil water content was monitored with Time-Domain-Reflectometry (TDR) and with a soil profile probe (PR2/6, Delta-T Devices, Ltd.). Low values of aboveground biomass at harvest and yield were found for the 30 and 40% IT treatments. The study showed that the dynamic crop growth model CSM-CROPGRO-Peanut can be used for irrigation scheduling, but a variable irrigation management depth needs to be incorporated in the model and a correct characterization of the soil properties is needed.

Evaluation of Turfgrass Establishment Methods for Erosion and Sediment Control at Construction Sites

Rose Mary Seymour, Department of Biological and Agricultural Engineering

Research is needed to examine various vegetation establishment methods and products to better understand mechanisms of various methods and products that prevent erosion. . The evidence of Georgia's stream water quality in developing, suburban and urban areas would

suggest that the present erosion and sediment control methods are not effective. An experiment was carried out to measure and compare different vegetation establishment methods and products for erosion control. The erosion and sedimentation characteristics were measured, including volume of sediment as a measure of actual erosion that occurs, and runoff volumes as a measure of the erosive energy developed on the slope. In addition vegetation cover over the test period was also measured. The cultivar used for all of the treatments was Princess 77 seed or sod. The turfgrass establishment began with planting and laying the sod on June 22, 2006 in large lysimeters. For the first 30 days of establishment, the turfgrass was kept in the Envirotron greenhouses and watered regularly. Then after 32 days, on July 24, the lysimeters were moved out of the greenhouses and exposed to regular weather conditions. The lysimeters were placed under a rainfall simulator. There were 3 separate rainfall simulator tests in July, September and October to take measurements of runoff and sediment movement from the lysimeters. Observationally, the sod had a much stronger grass stand than the other methods. The sod stand was dense enough to prevent any weed growth, while the other treatments had much of the surface cover from weeds. All of the treatments had good cover. All of the treatments reduced the sediment movement dramatically and reduced runoff from the lysimeters. The study will provide scientifically determined results of significant differences that various turfgrass establishment methods have on erosion control of disturbed land.

Unique Plant Responses

During studies on increasing irrigation efficiency in greenhouses, physiological responses to different substrate water contents were studied. Surprisingly, we found that there was little or no effect on leaf photosynthesis, even though plant growth was severely reduced at low water contents. There was no correlation between plant growth and leaf photosynthesis. So what reduces plant growth at low substrate water content? It turns out that leaf elongation is very sensitive to water availability in the substrate. When plants are exposed to drought, leaf elongation is inhibited, thus reducing the total area of leaves that are photosynthesizing.

High salt levels in irrigation water are an increasing problem worldwide. We studied the effects of high salinity levels (either from NaCl or by using high fertilizer concentrations) on the physiology and morphology of tomato. High salinity levels reduced plant height, dry weight, and leaf elongation. High levels of NaCl (but not high fertilizer concentrations) reduced leaf chlorophyll and photosynthesis and the maximum quantum yield of photosystem II. Increasing the Ca^{2+} concentrations of the nutrient solution prevented these effects of high NaCl on leaf photosynthetic parameters, but did not restore growth. High Ca^{2+} did not prevent the effects of salinity on leaf elongation. Growth was highly correlated with leaf elongation, but was not correlated with leaf photosynthesis.

Impact Statements

The availability of water for agricultural use is under pressure, and more efficient use of the available water is increasingly important. Research at the University of Georgia has shown that efficiency can be increased by applying water based on the actual needs of the crops. This can be done using automated irrigation controllers that maintain substrate water content at a grower-determined level. Research indicates that a substrate water content of 20-25%

(v/v) is adequate for most crops. Using automated controllers to maintain this substrate water level may reduce water use by 40% to 70%.

Organic agriculture is a rapidly expanding component of agriculture. The University of Georgia is looking at the production of blueberries in high tunnels, with the goal to achieve an early harvest, which presumably would result in premium prices. In 2007, ripening of blueberries in high tunnels started in early to mid-April, approximately six weeks before the normal harvest season. Propane heaters were needed to protect the crop from freezes, making high tunnel production of blueberries expensive. However this also allowed us to protect the blueberries from a later freeze, which complete decimated unprotected crops. The economics of high tunnel production of organic blueberries will be evaluated to determine whether this would be profitable for growers in the Southeast.

Published Written Works

Montesano, F., and M.W. van Iersel. 2007. Calcium can prevent toxic effects of Na^+ on tomato leaf photosynthesis, but does not restore growth. *Journal of the American Society for Horticultural Science* 132: In press.

Frantz, J.M., N.N. Cometti, M.W. van Iersel, and B. Bugbee. 2007. Rethinking acclimation of growth and maintenance respiration of tomato in elevated CO_2: effects of a sudden change in light at different temperatures. *Journal of Plant Ecology*. In press.

Nemali, K.S., F. Montesano, S.K. Dove, M.W. van Iersel. 2007. Calibration and performance of moisture sensors in soilless substrates: ECH_2O and Theta probes. *Scientia Horticulturae* 112:227-334.

Nemali, K.S. and M.W. van Iersel. 2006. An automated system for controlling drought stress and irrigation in potted plants. *Scientia Horticulturae* 110:292–297.

van Iersel, M.W. 2006. Respiratory Q_{10} of marigold (*Tagetes patula* L.) in response to long-term temperature differences and its relation to growth and maintenance respiration. *Physiologia Plantarum* 128:289-301.

Scoggins, H.L. and M.W. van Iersel. 2006. *In situ* probes for measurement of EC of soilless substrates: effects of temperature and substrate moisture content. *HortScience* 41:210-214.

Burnett, S.E., M.W. van Iersel, and P.A. Thomas. 2006. Medium-incorporated PEG-8000 affects elongation, growth, and whole-canopy carbon dioxide exchange of *Tagetes patula*. *HortScience* 41:124-130.

Scientific and Outreach Oral Presentations

van Iersel, M.W. 2006. Whole-plant photosynthesis measurements: What, how and why? 2006 Annual meeting of the American Society for Horticultural Science, New Orleans, LO.

Montesano, F., and M.W. van Iersel. 2006. NaCl stress in hydroponic tomatoes can be alleviated by calcium. 2006 Annual meeting of the American Society for Horticultural Science, New Orleans, LO.

van Iersel, M.W. 2006. Beyond routine measurements: Using dataloggers for control and complicated measurements. 2006 Annual meeting of the American Society for Horticultural Science, New Orleans, LO.