NCR-101 Annual Report 2001 from Georgia
Research Activities at the Georgia Envirotron
College of Agricultural and Environmental Sciences, Griffin Campus

The Impact of Global Climate Change on Soybean Production

A.B. Heinemann[1], G. Hoogenboom[1], K. Ingram[2], R. Kuchenbuch[2] and I. Flitcroft[2], [1]Dept. of Biological and Agricultural Engineering, [2]Dept. of Crop and Soil Sciences.

Soybean [*Glycine max* (L.) Merr.] is an important source for protein and other food products. Soybean growth and development are affected by elevated levels of carbon dioxide (CO_2), and also by elevated temperatures, both of which are likely scenarios of future climate change. Simulation models have been used to predict the impact of climatic change on agricultural production. The CROPGRO simulation model has been used by many researchers to determine the potential impacts of climatic change on soybean growth, development and yield. However, experiments are necessary to determine how well these models mimic the responses of crop growth and development under field conditions. The objective of this study was to evaluate the CROPGRO simulation model at different temperatures and CO_2 levels with data collected from an experiment conducted in the Conviron growth chambers.

Soybean [*Glycine max* (L.) Merril] 'Stonewall', maturity group VII are being grown in the six CG72 growth chambers, in two CO_2 and three different temperature treatments. The chambers were set for a twelve-hour day, and so all plants shared a common photothermal regime. Plants were grown at two different CO_2 levels, 400 and 700 ppm, and three different temperatures, 30/25 ºC, 25/20 ºC and 20/15 ºC (day/night). Each treatment contained 20 pots, each with a capacity of 20 liters (2 plants per pot) and filled with 18.3 kg of fine sand. A drip irrigation system was used to irrigate the pots and to apply a half strength Hoagland's solution.

Interactions Between Temperature and Fertilizer Concentration Affect Growth of Petunias

Jong-Goo Kang[1] and Marc van Iersel[2], [1] Department of Horticulture, Sunchon National University, South Korea, [2] Department of Horticulture.

The objective of this research was to determine whether optimal fertilizer concentrations for petunia (*Petunia* x*hybrida*) depend on environmental conditions such as air temperature. Petunias were grown in three CG72 chambers at temperatures of 15/7, 25/17 or 35/27 °C (day/night), with a 14-hour daylength. The plants were grown in 10 cm square pots filled with a soilless growing medium and were subirrigated with one of five fertilizer solutions containing 0, 135, 290, 440 and 590 $mg \cdot L^{-1}$ N.

The fertilizer electrical conductivity (EC) resulting in maximum dry weight depended on the growing temperature (3.5 $dS \cdot m^{-1}$ at 15/7 °C; 2.6 $dS \cdot m^{-1}$ at 25/17 °C; and 1.6 $dS \cdot m^{-1}$ at 35/27 °C) (Fig. 1). Maximum growth rate was better correlated with the EC of the growing medium than with the EC of the fertilizer solution. Irrespective of growing temperature, plant growth was best when the final EC of the growing medium was 3-4 $dS \cdot m^{-1}$. These results show that fertilization guidelines for growers should be based on maintaining the EC of the growing medium within an optimal range, instead of the more traditional recommendations based on the concentration of the fertilizer solution.

Quantification of root growth of maize seedlings at a transparent surface as influenced by soil bulk density

R. O. Kuchenbuch and K. T. Ingram. Department of Crop and Soil Sciences

We developed a system presented in which maize (*Zea mays* L.) seedlings were grown in acrylic containers - cuvettes - in a soil layer 6-mm thick. These thin-layer soil cuvettes facilitate homogeneous soil preparation and nondestructive observation of root growth. Cuvettes were placed on a rack slanted to a 45º angle throughout the experiment to promote growth of roots along the transparent acrylic sheet. At 2- to 3-day intervals, cuvettes were placed on a flatbed scanner to collect digital images from which root length and root diameters were measured using available software.

Soil was compacted to bulk densities (SBD) ranging from 1.3 to 1.7 $g \cdot cm^{-3}$. Root growth was monitored nondestructively during plant growth and destructively 15 days after planting. Analyses of roots washed from soil showed that increasing bulk density reduced root length by 40% in root diameter classes < 0.6 mm. Neither length of seminal roots nor shoot growth were influenced by SBD. Nondestructive quantification of root growth did not show these differences between treatments. This leads to the conclusion that measurements of root growth at transparent surfaces may not always be related to quantitative changes of roots growing in soil.

Establishing the minimum cardinal temperature for **Neotyphodium coenophialum** *growth in its mutualistic host, tall fescue*

H.J. Ju[1], N.S. Hill[1], K.T. Ingram[2], and H.J. Earl[1], [1] Department of Crop and Soil Sciences, University of Georgia, Athens, GA, [2] Department of Crop and Soil Sciences, Griffin, GA.

The endophyte (*Neotyphodium coenophialum*) imparts drought and herbivory protection to its tall fescue (*Festuca arundinacea*, Shreb) host. Plant breeders have learned to manipulate the association between plant and endophyte for the benefit of turf and pastures, it is therefore important to be able to detect the presence of endophyte in pastures or turf. Previously we documented that endophyte presence varies due to season, with lowest infection frequencies occurring during winter or early spring months. This is a season when tall fescue may be actively growing, thus it is reasonable to assume that temperature requirements for endophyte growth are greater than that of the host plant.

The objective of this experiment was to test the hypothesis that endophyte has a higher minimum cardinal temperature than the host, tall fescue. Three environmental chambers were set to constant temperatures of 10, 15, and 20 ^{o}C and two-week-old seedling tall fescue plants placed into the chambers. Fifty plants were sampled prior to placing the plants into the chambers and at weekly intervals for 6 weeks. The plants were tested for endophyte presence using immunoblot procedures, and for endophyte mass using ELISA. Endophyte mass data were regressed against temperature within each week and intercepts and regression coefficients compared for a) weekly variation (replication), and b) temperature variation (treatment variable) using analysis of variance.

Regression equations describing growth of tall fescue and endophyte were quadratic, with linear and quadratic coefficients not different from one another. However, the minimum temperature requirement for plant and endophyte (as determined from the intercept of the regression lines) were lower for tall fescue (4.9 ^{o}C) than for endophyte (11.7 ^{o}C). Thus, the cardinal minimum for endophyte growth is approximately 7 ^{o}C higher than for the plant and explains, in part, why seasonal variation for endophyte detection exists. Once the cardinal minimum is met, the increase in mass of plant and endophyte approximate one another.