Growth chamber studies plant tops and roots

A computer-controlled and monitored system for studying a whole plant (top and roots) at the same time has been built by scientists working for Clemson University and the U. S. Department of Agriculture's Science and Education Administration. The device should make it possible to develop better computer models to simulate crop growth.

The Soil-Plant-Atmosphere Research (SPAR) System will allow scientists for the first time to determine whole plant responses to microclimatic and soil environment changes. Among other uses, the SPAR system enables scientists to study air pollution effects on plants and to perform integrated pest management experiments.

The use of the SPAR system to provide the necessary data for crop simulators could have far-reaching impact in the areas of crop-yield prediction, crop management, and improvement of photosynthetic and yield efficiency. Rates of certain physiological processes (e.g. photosynthesis and growth as well as environmental inputs) are controlled independently in these SPAR units. The combination of these facilities with the computer simulation model of crop growth provides a new and powerful approach in the analysis of agronomic systems.

Each SPAR unit consists of a steel soil bin about 2 yards long, half a yard wide, and 1 yard deep. The soil bin is topped by plastic aerial chamber 1.5 yards tall. The soil bin is separated from the aerial chamber by a plastic sheet hermetically sealed around each plant to prevent gas exchange between soil and aerial chambers.

The units were designed to contain two or more rows of plants, half a yard long, perpendicular to its long dimension and oriented in a north-south direction.

Each unit is provided with a pressure-regulated water outlet, a flow meter, and a remotely controlled electrical solenoid valve for automatic irrigation control.

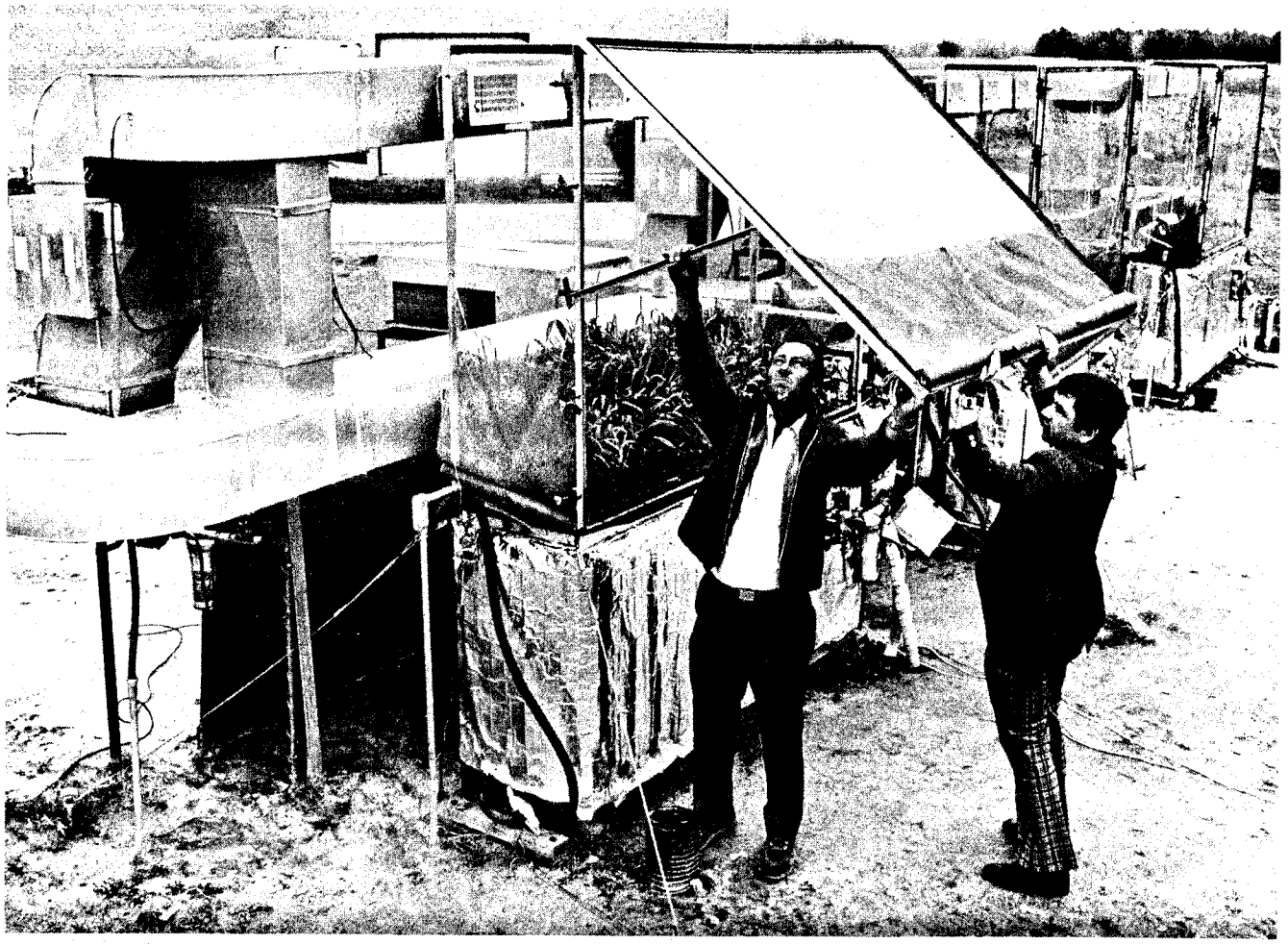
Temperature of the soil bin is thermostatically controlled by brine, which is heated or cooled by a heat pump. The brine flows through copper tubing placed around the bin.

Access to the soil can be gained either by removing an exterior steel-reinforced glass panel or by means of nine access ports on the opposite side of the soil bin which provide quick access at various soil depths. These ports can also be used to install sensors. Visual observation of the soil and root system can be made through the reinforced glass panel.

In the base of the soil bin is a series of porous ceramic rods attached to a manifold that can be used for drainage or water table control by subirrigation.

Temperature of the aerial chamber is regulated with an air conditioner and an electric heater under microcomputer control.

Access to the chamber is gained through a side panel which is hinged at the top. The door is sealed with a rubber gasket to make it airtight.



Top; Phene, right, and Jimmie Vought, hydrological technician, raise the clear side of a SPAR unit. Note the plastic shade on the side and two more units in the background. Left; Mary Fields, laboratory assistant, marks and dates root growth.

Photos: USDA

To simulate field conditions, each side panel on the aerial chamber is fitted with an adjustable plastic screen which is raised daily to the height of the plants to simulate within-row shading as the crop grows.

With an array of sensors and instrumentation, soil matric potential and micrometeorological variables such as solar radiation, net radiation, ambient leaf and soil temperatures, CO_2 assimilation, and relative humidy are both measured and controlled.

Scientists can use the SPAR units to establish crop management principles and use these results in models to obtain better estimates of crop yields and market stabilization.

The units are at the Coastal Plains Soil and Water Conservation Research Center, Florence, S.C. Conducting the research were Claude J. Phene, soil scientist; Donald N. Baker, agronomist; John E. Parsons, mathematician; and James M. McKinion, electrical engineer, all of SEA, and Jerry R. Lambert, agricultural engineer, and James L. Dunlap, electrical engineer from Clemson University.

Donald Baker and James McKinion are at Mississippi State University; and John Parsons and Claude Phene are at the Coastal Plains Soil and Water Conservation Research Center. *(Adapted from an article published in the USDA-SEA magazine, "Agricultural Research.")*