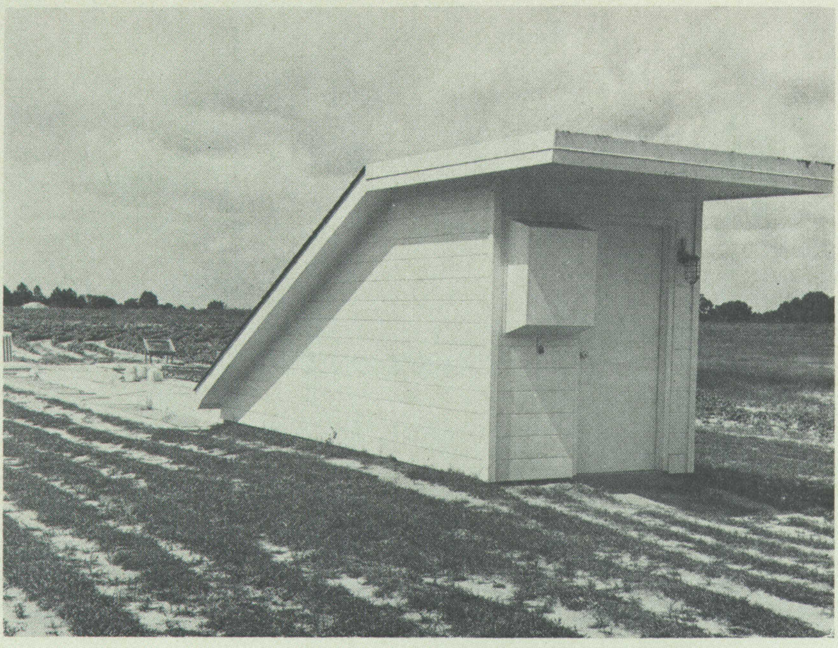

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The RHIZOTRON at AUBURN, ALABAMA — A PLANT ROOT OBSERVATION LABORATORY

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The RHIZOTRON at AUBURN, ALABAMA – A PLANT ROOT OBSERVATION LABORATORY[1]

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THE RHIZOTRON[3] at Auburn is an underground walkway fitted on either side with windows to observe plant root growth in soil. It is designed to study growth and development of root systems in relation to the aerial parts of different plant species under controlled-rooting environments. The aerial parts of the plants are exposed to field environmental conditions.

The rhizotron is located 2.3 miles southwest of Auburn on U.S. Highway 29.

The Auburn rhizotron is one of four major root observation laboratories in the world. It is the only one devoted primarily to the study of annual plant root systems. The root observation laboratory at East Malling, England is used to study root systems of perennial fruit and berry plants. One located at Guelph, Ontario, Canada is used to study the root systems of fruit and ornamental trees. A fourth located at Mount Edgecombe, Republic of South Africa, is used to study effects of soil conditions on growth rate and yield of sugarcane.

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[1] Contribution from the Soil and Water Conservation Research Division, Agricultural Research Service, USDA, and the Agronomy and Soils Department, Auburn University Agricultural Experiment Station, Auburn, Alabama.

[2] Research Soil Scientist, USDA, Auburn, Alabama.

[3] The word "rhizotron" is coined from the Greek word for root (*rhizo*) and the suffix for instrument (*tron*).

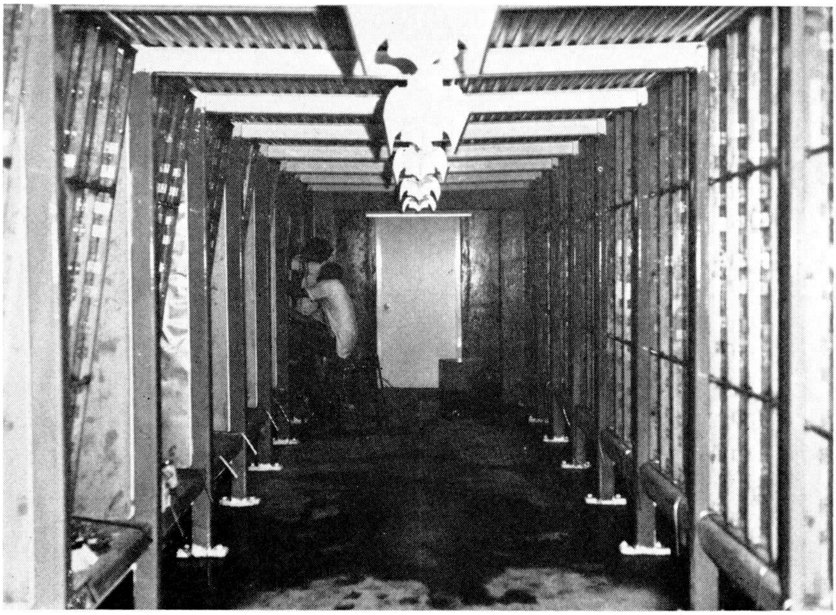


FIG. 1. Interior view of the rhizotron. Compartments 1 through 10 are located on the right side and 11 through 20 are on the left side. Two technicians are measuring root lengths through the sloping glass panels of compartment 19.

The Auburn rhizotron is based on a prototype constructed in 1960 at the East Malling Research Station, East Malling, Kent, England, Rogers and Head, 1963[4]. However, the Auburn facility represents a substantial modification of the East Malling installation and provides a more precise control of soil environment. The rhizotron was constructed by the Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department on Agriculture, on land furnished by Auburn University. Personnel of both USDA and Auburn University Agricultural Experiment Station use it for conducting studies.

CONSTRUCTION DETAILS

The rhizotron is 72 ft long, 8 ft. deep, and 13 ft. 4 inches wide. The outer walls are reinforced concrete with steel support columns and beams for the 2½-inch thick concrete slab roof. The roof is trough-shaped and drains at the end away from the en-

[4] Rogers, W. S. and G. C. Head. 1963. *Pomology.* A new root-observation laboratory. *In* Annual Report of the East Malling Research Station for 1962.

trance to the rhizotron. Roof slopes are sufficient to ensure that rainfall will not concentrate and flow into any of the soil compartments.

There are 20 soil compartments, 10 on each side of the tunnel. Each compartment has a glass side facing the walkway within the tunnel. The rear side of each compartment is the outer retainer wall of concrete. The bottom of each compartment is a concrete slab shelf 4 inches thick. Utility lines and water drains are located under the slab. All concrete surfaces are treated with epoxy paint to reduce soil contamination by the concrete material. Compartments are separated from each other by side panels of steel or aluminum plate between two stainless steel sheets. Silicone caulking seals all joints and cracks within each compartment.

Each compartment is about 74 inches high and 48 inches wide. Compartments 1 through 10 are 24 inches from front to rear, both top and bottom. Compartments 11 through 20 are inclined 10 degrees from the vertical so that taproots will stay in the soil along the glass windows. The compartments are 24 inches at the top from front to rear, but 12 inches at the bottom from front to rear. Two 6 x 6 x ½-in rectangular porous plates with drainage tubes are located in the bottom of each compartment. In compartments 1 through 10, diatomaceous earth (about 2 inches thick) is placed over the porous plate drains.

Except for compartments 7 through 10, each compartment has a window that contains 32 panes of glass, each about 10 inches wide and ¼-inch thick. A ½-inch square grid wire mesh is embedded in each pane of glass. This wire provides a convenient measuring grid and also reduces shattering if the glass breaks. Vertical stainless steel bars, ½ x 2 inches, provide support for the window panes. Each pane is caulked to the support bar with silicone caulking compound and is supported by a stainless steel clip at each corner.

Acrylic plastic sheets, each about 10 inches wide and 74 inches long, and from ¼ to ½-inch thick, form the viewing area of compartments 7 through 10. Various measuring instruments are inserted into these compartments through holes drilled in the plastic sheets.

A tunnel anteroom, located at the end opposite the entrance, provides space for recording instruments and equipment storage. The anteroom space is dehumidified for instrument longevity.

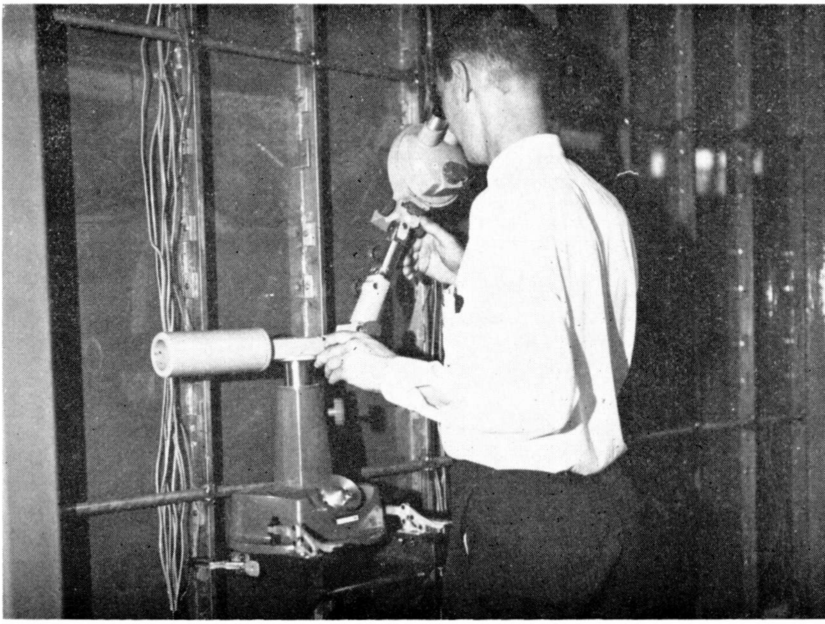


FIG. 2. A research scientist examining cotton roots through a binocular microscope. The microscope support stand can be moved to examine roots behind any part of the transparent panel.

EQUIPMENT

Roots – their initiation, growth, development, and death –can be studied and measured through the windows by direct observation, by viewing through microscopes, or by serial photography. The rhizotron is also equipped to monitor or continuously record oxygen and carbon dioxide contents in aeration studies, soil and air temperatures, and soil-water status at various points within a compartment. Time-lapse cinematography equipment is also available. Continuous records of stem and root diameters can be made in plant water experiments using linear variable differential transformer equipment. Other measuring equipment is added as required for particular experiments.

SOILS

Initially, four Alabama soils were used to fill various compartments. These soils were the A_p horizon of Decatur clay loam collected near Huntsville, the B_2 horizon of Dothan fine sandy loam collected near Headland, the A_p horizon of Cahaba fine

FIG. 3. An exterior view of the rhizotron. The research scientist is adjusting an instrument that measures plant stem shrinkage during periods of high evapotranspiration.

sandy loam from Tallassee, and the A_p horizon of Norfolk loamy sand from Auburn. As other experiments require additional soil series or soil conditions, some of the present soils will be removed. To unload a compartment, the lower panes of glass will be removed, then the soil will be loaded on a moving belt elevator located by the side of the entrance steps. This elevator dumps outside the entrance building into a truck.

PHILOSOPHY LEADING TO THE CONSTRUCTION OF THE RHIZOTRON

For plants to grow, the leaves and other green parts provide the energy through photosynthesis. The tops also provide growth regulators. In turn, the roots use these photosynthetic compounds and growth regulators to extend through new soil volumes and provide the tops with water and essential minerals. Thus, root and top growth occur in dynamic balance with each other. If either partner receives insufficient material for adequate growth, growth of the other partner also soon slows down or stops.

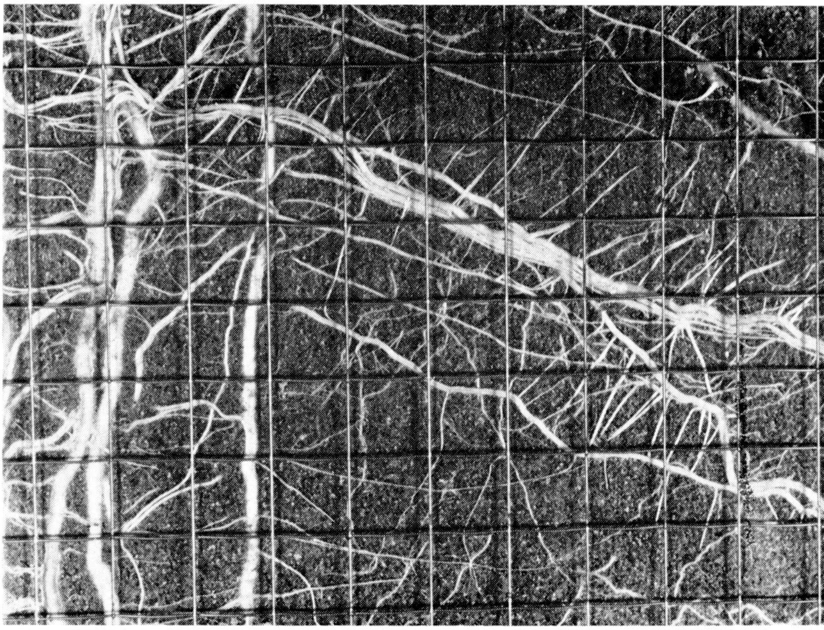


FIG. 4. A close-up view of corn roots 12 inches below the soil surface. Estimates of rooting length and intensity are made by measuring the number of roots that intersect horizontal grid lines at 6-inch increments to 72 inches, or by measuring root lengths within sample squares.

Studies of root growth are much more difficult than those of top growth under field conditions. As a result, research workers often have concentrated on studies of top growth and neglected root growth studies. This neglect means that much soil fertilization, soil liming and soil cultivation is on a hit-or-miss basis because too little is known about the effects of particular practices on root growth.

For many years, personnel of the Auburn University Agricultural Experiment Station and USDA research workers located in Alabama have conducted field experiments where plant roots were dug, washed, and weighed. Thus, the rooting pattern usually could be observed only one or two times during a growing season. Since the early 1960's, many short-term growth chamber experiments have been conducted when root elongation could be observed for a few days through small glass-fronted boxes. However, these plants soon outgrew the available containers.

The rhizotron bridges the gulf between the short-term intensive study of roots in growth chamber experiments and the field experiments where root size, shape, and frequency are observed once or twice in a growing season.

The rhizotron provides a facility to study interaction between roots of plants and their tops. This interaction can be seen, and a measure of how this interaction is affected by changes in plant root environment can be made. The root environment can be changed by manipulating the soil, water content, lime or fertilizer quantities, amount of compaction, or other ways. Supplemental aerial environmental control can be installed, and investigation of effects of shoot environment on root growth can be made. Because of its flexibility, the rhizotron will allow a better evaluation of soil management effects on root and top growth of plants.

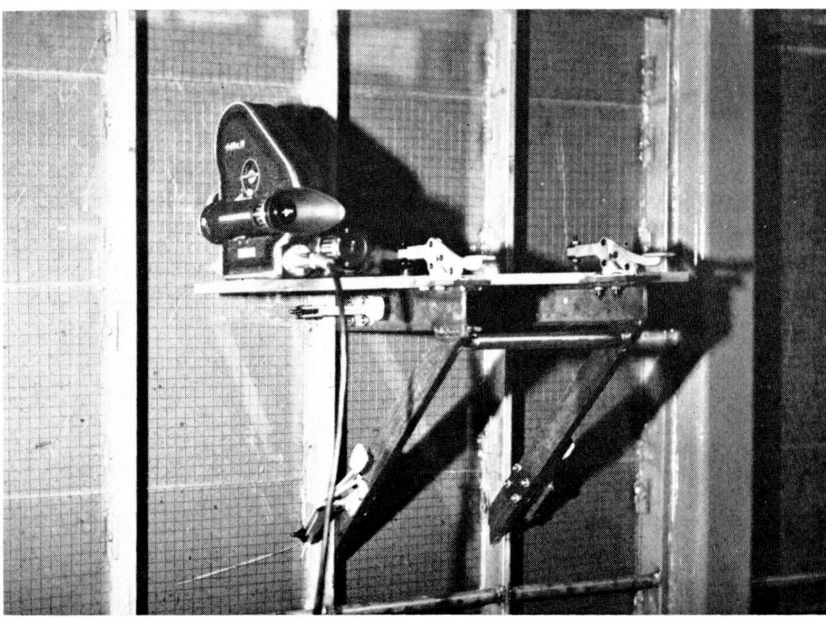
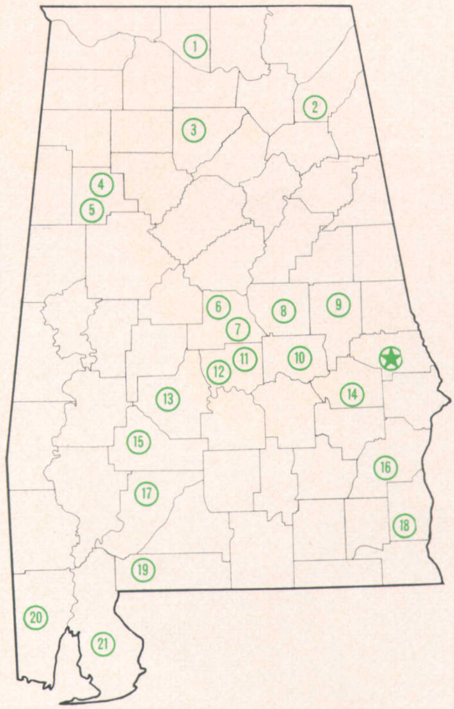


FIG. 5. Time-lapse photography is used to closely examine root behavior behind the glass panels. The camera support can be moved to allow photography of any part of the visible root system.

AGRICULTURAL EXPERIMENT STATION SYSTEM OF ALABAMA'S LAND-GRANT UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. Tuskegee Experiment Field, Tuskegee.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.