DESIGN AND CONSTRUCTION OF A RHIZOTRON-LYSIMETER FACILITY AT THE OHIO STATE UNIVERSITY[1]

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ABSTRACT

A rhizotron-lysimeter was constructed at the Ohio State University in 1979. This entirely below ground-level facility consists of three main rooms: (1) An instrument room equipped with climatological and data acquisition instrumentation, (2) a water reservoir room used in the lysimeter portion of the facility, and (3) an observation area consisting of two rows of 15 observation-lysimeter cells (60 x 60 x 90 cm high.)

The lysimeter portion of the facility operates on a Mariotte supply system which allows evapotranspiration rates to be determined concurrently with root observations. When the Mariotte supply system is not in use, leachates can be drawn under vacuum from each cell. The rhizotron-lysimeter is initially being used to monitor the seasonal rooting responses and water use rates of several cool season turfgrasses.

Additional index words: **Root measurement, Leachate removal, Evapotranspiration, Water use.**

RHIZOTRONS provide an in situ method of continuous observation and recording of roots behind transparent panels. One of the original rhizotrons and the prototype for most present day facilities was constructed in 1963 at East Mailing, Kent, England (5). Since the completion of the East Mailing facility several rhizotrons in various parts of the world have been constructed (1, 2, 3, 6, 7, 8).[3]

In recent years, two rhizotrons have been constructed which have lysimeter capabilities. The rhizotron-lysimeter facility at Muscle Shoals, Ala. (6) allows researchers to collect leachate automatically while monitoring root behavior. A rhizotron-lysimeter at Temple, Tex. (1) makes use of weighable steel chambers. This technique allows precise measurement of evapotransporation.

A rhizotron-lysimeter facility was completed in July 1979, at The Ohio State University, Columbus, Ohio. This facility, although similar to several previously

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[3] DiPaola, J. M., and J. B. Beard. 1976. Development of a turfgrass rhizotron at Texas A & M. p. 114-117. *In* Proc. of the 31st Annual Texas Turfgrass Conf.

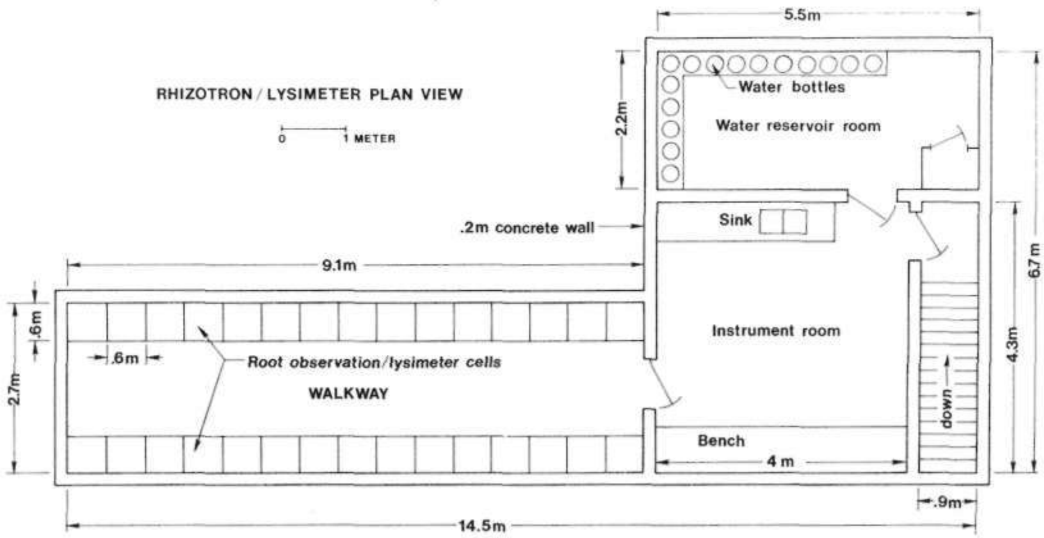

Fig. 1. Plan view, rhizotron-lysimeter facility.

Fig. 2. Top view of rhizotron-lysimeter.

reported rhizotrons, does possess several unique features. This note discusses the basic design and construction of the OSU rhizotron with emphasis placed on the unique design features.

The facility consists of three separate rooms which are entirely below ground-level (Fig. 1 and 2). It includes an observation area or walkway, instrument room, and water reservoir room which is used in the lysimeter component of the facility. Exterior wall construction is of 20 cm thick, steel-rod reinforced, concrete block. The observation area consists of two rows of 15 observation cells which are separated by a 1.5 m wide x 12.7 cm thick, concrete walkway (Fig. 3). Each observation cell is 60 x 60 x 90 cm high and is constructed of 1.9 cm thick exterior grade plywood. To ensure water tightness and wood preservation, all wood surfaces in contact with the soil were fiberglass coated. This procedure involved tacking 113 g/0.84 m^2 glass cloth to the inside surface of each cell and then brushing on three coats of a general purpose polyester laminating resin. This was followed with several layers of an air dry plastic coating[4]. The viewing panels of

[4] Manufactured by PDI Inc., 1458 West County Road C, St. Paul, MN 55113.

Fig. 3. Interior view of rhizotron-lysimeter observation area.

Fig. 4. Interior view of rhizotron-lysimeter water reservoir room.

each cell consist of a single pane of 9.5 mm thick plate glass set at a 20 degree angle from the vertical. Silicone caulking was used to adhere and seal the panels to 2.5 x 2.5 x 90 cm long hardwood stops. The roof covering the observation area is 2.1 m above the concrete walkway and is constructed of 18 gauge corrugated galvanized steel positioned on a 1 degree slope away from the instrument room. The observation cells and walkway roof are supported by 5.1 x 3.1 x 0.6 cm thick angle iron and 2.5 x 2.5 x 0.6 cm thick structural tubing. The walkway roof was covered with 10 mil polyethylene plastic and then 7.5 cm of soil to bring the grade to that of the surrounding field soil and tops of the observation-lysimeter cells.

The instrument room is partitioned from the observation area by a 4.5 cm thick wooden door. The inside dimensions of the instrument room are 4 x 4.3 x 2.0 m high, while the water reservoir room measures 2.2 x 5.5 x 2.1 m high. The roofs of both the instrument and water reservoir room are of 18 gauge corrugated galvanized steel covered with iron-rod reinforced concrete 12.7 cm thick. Both rooms are fully insulated, heated, and dehumidified. The instrument room contains a sink and adequate bench and storage space for various pieces of climatological instrumentation. Access to the facility is through a wooden door located at the top of a concrete staircase leading to the instrument room. To avoid any microclimate disturbance, the access door is positioned flush with the surface of the surrounding field soil.

An important feature of the facility is the capability to use the observation cells as lysimeter units from which soil leachates can be collected or precise evapotranspiration measurements can be made. The lysimeters when used for evapotranspiration measurements, make use of a Mariotte supply system as described by Krans and Johnson (4). The system consists of each observation-lysimeter cell being connected by hydraulic tubing to a water bottle located on a support stand in the water reservoir room (Fig. 4). The principle involves the continuous supply of water from the water bottle to the observation-lysimeter cell to maintain a constant water table depth (Fig. 5). By adjusting the height of the bottles and depth of the air vent tube, water tables can be maintained from the surface to the bottom in each cell. Waterlogging of the soil can be avoided and adequate air exchange allowed by maintaining the water table several centimeters below the root system and allowing soil capillarity to move the water upward. By calibrating the water bottles in 1 mm increments, precise evapotranspiration measurements can be made. Each 18 liter water bottle is connected to an observation-lysimeter cell by 6.3 mm diam hydraulic tubing ranging in length from 12 to 17 m depending on the position of the cell in the observation area. Each bottle has a 35 mm diam rubber stopper with three holes which accommodate the following: (1) A 6.3 mm diam hydraulic filler tube with shut off valve, (2) a 4.8 mm diam, 40.6 cm long glass air vent tube, and (3) a 6.3 mm diam hydraulic observation-lysimeter cell supply line. The hydraulic supply line enters the bottom of each observation-lysimeter cell through a 25 mm diam rubber stopper. A 300-mesh stainless steel screen filter was positioned over the supply line inside each cell to prevent movement of the rooting medium into the line.

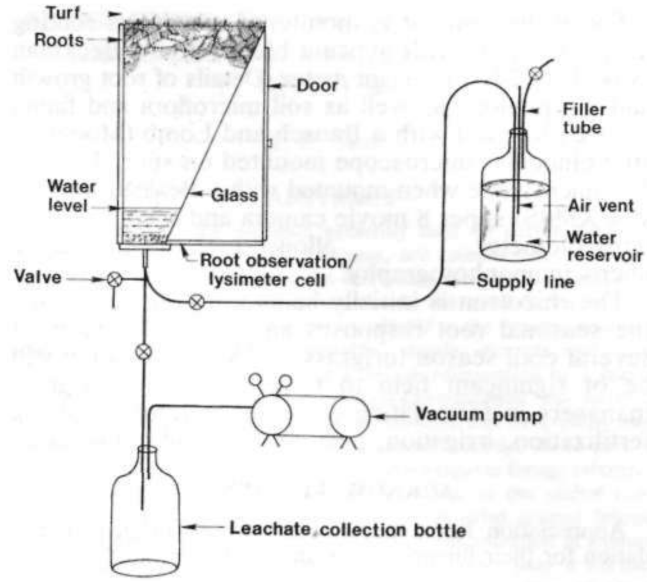

Fig. 5. **Diagram of Mariotte supply and leachate collection system used in the lysimeter component of the facility.**

In studies requiring the removal of leachates, the water supply line is shut off by a gate valve located beneath the cell. Conversely, another gate valve is opened which allows the percolate to drain into an 18-liter glass carboy by means of 6.3 mm diam hydraulic tubing, under a constant vacuum of 25 cm Hg. Passive drainage occurs by shutting off the gate valve to the carboy and opening another gate valve which allows the percolates to by-pass the carboy and enter a 9.3 cm diam drainage tile covered by gravel beneath each row of observation cells. This drainage water is removed from the facility by a 1/2 horsepower sump pump.

A Climatronics Meterological System[5] is used for monitoring daily weather conditions. The system consists of sensors and translators necessary for monitoring the following parameters: air temperature, dewpoint, wind direction and speed, precipitation, barometric pressure and net visible radiation (400 to 700 nm). In addition to the above an International Light (Model IL-700) net radiometer monitors net radiation in the range of 400 to 1,000 nm. All sensors are located approximately 24 m from the rhizotron inside a 18.5 m^2 chain link enclosure. Inside the enclosure is an evaporation pan made to the National Weather Service Specification No. D060SP001. A series of copper-constantan thermocouples were placed at 0.5, 2.5, 10, 25, and 50 cm depths in the rooting medium of three observation-lysimeter cells as well as in the adjacent native soil. Voltage outputs of the thermocouples are monitored by an Instrulab (Model 2000) data logger. The outputs from the sensors located within the chain link enclosure are monitored by a Monitor Labs (Model 9300) data logger. This data logger is then interfaced with a Radio Shack TRS 80, (Model I), 32K ROM microcomputer to reduce handling of the large volume of climatological data collected.

Climatronics Corp., 140 Wilbur Place, Bohemia, NY 11716.

Soil water content is monitored at various rooting medium depths with gypsum blocks and a Beckman (Model BN2-B1) resistant meter. Details of root growth and morphology as well as soil microflora and fauna can be observed with a Bausch and Lomb (Model V-105) binocular microscope mounted on special stand. The microscope when mounted with a Bealeau (Model-4008XM4S) super 8 movie camera and accompanying intervolometer, allows time-lapse microcinemaphotography.

The rhizotron is initially being used for monitoring the seasonal root responses and water use rates of several cool season turfgrasses. This information will be of significant help to researchers and turfgrass managers in formulating cultural programs involving fertilization, irrigation, pest control, and cultivation.

ACKNOWLEDGMENT

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