MICROLYSIMETERS TO MEASURE THE WATER USE OF SEEDLING COTTON

J.L. Duesterhaus
R.J. Lascano
J. Booker
T.S. Goebel
USDA-ARS Cropping Systems Research Laboratory
Lubbock, TX
J.D. Booker
Texas Tech University
Lubbock, TX

Abstract

Upland cotton is the leading crop grown in the High Plains of Texas, and is subject to challenging environmental conditions that are unique to this region. Research on how to manage an irrigation supply that is diminishing is a subject of many studies; however, information on cotton water use, especially from emergence to squaring, is limited. Part of the problem is that the measurement of water use is difficult given the small size of the plants and the lack of soil and plant based sensors available to measure crop water use. Thus the objective of this research was to design and evaluate a weighable lysimeter to measure the water use of cotton in the early stages of crop growth and under field conditions. For this purpose, cylindrical lysimeters (6"diameter × 14" deep) were built from PVC and weighed using load-cells and a bench top scale. This size (1.6 gal) was selected because it accommodated enough soil to grow two plants to first-square and small enough to be weighed by a single load cell. The study was divided into weekly intervals, over two separate field trials. Seventy-two lysimeters were placed in the field after planting, prior to cotton emergence. Beginning each week of the study, a set of 16 lysimeters (8 bare soil and 8 with cotton) were randomly chosen and extracted from the soil. The lysimeters were capped on the bottom and placed into 16 individual holes dug into the soil, which have been prepared to hold the lysimeters for the study. The lysimeters were weighed daily. Each subsequent week of the study, 16 new lysimeters were extracted from the soil until all lysimeters were used. Daily changes in lysimeter mass were converted to depth (inches) of water loss. Cotton seedling transpiration was calculated as the difference in water loss between the planted and bare soil lysimeters. Ancillary measurements included soil and lysimeter temperature, cotton leaf area, root length, soil water content and weather. Average evaporative demand for the first experiment was 0.3in d^{-1} (8mm) and 0.2in d^{-1} (5mm) for the second experiment. Lysimeter soil temperature did not vary greatly from field temperature, and did not appear to effect water loss from the lysimeters. Volumetric water content of the lysimeters containing cotton plants tended to be lower than the surrounding field samples taken from the plant row, while the lysimeters containing soil tended to be higher than the field samples. Volumetric water content of the bare soil lysimeters was approximately 30 % higher on average as compared to the lysimeters containing plants. Higher water contents in the soil lysimeters possibly contributed to higher evaporation rates, while transpiration may have been limited by plant available water in the planted lysimeters. Average root length began to exceed lysimeter depth approximately 20 days after emergence resulting in root binding. Root binding may have limited vegetative growth and caused a decrease in transpiration. Soil evaporation accounted for the majority of evapotranspiration until two weeks after emergence, at which time transpiration began to exceed evaporation. Cotton seedling transpiration accounted for 58% of measured evapotranspiration in the first experiment, and 53% in the second experiment. Measuring cotton seedling water use by microlysimeters of this design shows to be achievable, but considerations of plant physiological development must be taken into account. Further studies on water use by cotton seedlings in relation to growth and development are needed to evaluate effects on lint yield potential.