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USGA Semi Annual Research Report

Assessing Tree to Grass Water Use Ratios: Significance to the Golf Course Industry

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Since receiving funding from the USGA in support of our study entitled “Assessing Tree to Grass Water Use Ratios: Significance to the Golf Course Industry” we have made significant progress in initiating the research and addressing the research objectives stated in the proposal. First and foremost we selected a qualified student (Ms. Tamara Wynn) to undertake this project as part of her M.S degree in Biology at UNLV. We were fortunate to have a well- established tree research experimental orchard (10 species all planted approximately 20 years ago) that we could incorporate into the study and 12 non weighing lysimeters to use in estimating evapotranspiration of four turfgrass species.

Site Development

Although we had an established orchard of landscape trees we had to trench to a depth of 120 cm in both a N-S and E-W direction to isolate each tree to make sure no roots from a given tree were accessing water from an area below a neighboring tree. Many roots were cut but very few were found below a depth of 30 cm. After the trenches were cut, a tractor was used to refill the trenches and smooth out the surface around the trees. Basins were then built up around each tree that could hold the weekly irrigation volumes. We cored into the soil of each basin and installed a theta probe access tube which would allow us the ability to lower a theta probe to a depth of 100 cm. In one of the three replicates of each species we also installed a deep time domain reflectometry probe at 150 cm to assess deep soil moisture that might reflect a drainage component. All trees received a single yearly application of mixed fertilizers during early spring and they will continue to receive this yearly amount throughout the duration of the study.

Sensor Installation

Each of the 30 trees selected for the study were equipped with 10 mm Granier probes to assess transpiration velocity within the xylem. Bark was gently removed with sand paper and holes were drilled for the combo sensors. All probes were then sealed with putty, surrounded with foam and insulated with a foil wrap. Cables from the 30 trees were run through flexible plastic tubing to protect the cables from rodents. All of the cables were routed to a data logger where they were wired into a multi-plexer. A program was written to collect and parse the data into a meaningful table. To convert the velocity measurements into a flux we conducted a dye experiment in which we drilled a ¼ inch hole to the center of selected trees, mounted a stopper funnel system that allowed red dye (sanfranin) to slowly move into the horizontal hole. We added additional dye on a daily basis and continued the dye application for a one week period. At the end of one week, we removed the stopper funnel system and cored a parallel hole 2 cm above where the dye entered. Intact cores were dried mounted on wood and sanded to assess dye movement. We will measure the distance the dye penetrated and use this length to estimate the conductive tissue area in each tree, which will allow us to convert velocity to flux measurements.

Lysimeters

We have 44 non weighing lysimeters installed at our center for use in quantifying evapotranspiration. The lysimeters are 60 cm in diameter and 120 cm in depth with a theta probe access tube inserted at the center position. We selected 12 of these for use in quantifying evapotranspiration of turfgrass. In a large tall fescue plot we selected three lysimeters to remain as tall fescue. Three of the lsyimeters in this area were converted to perennial ryegrass. In another research plot planted to bermudagrass we selected three lsyimeters to remain as bermudagrass and three were converted to bentgrass. All grasses receive 0.5 pounds of Nitrogen per 1000 square feet on a monthly basis

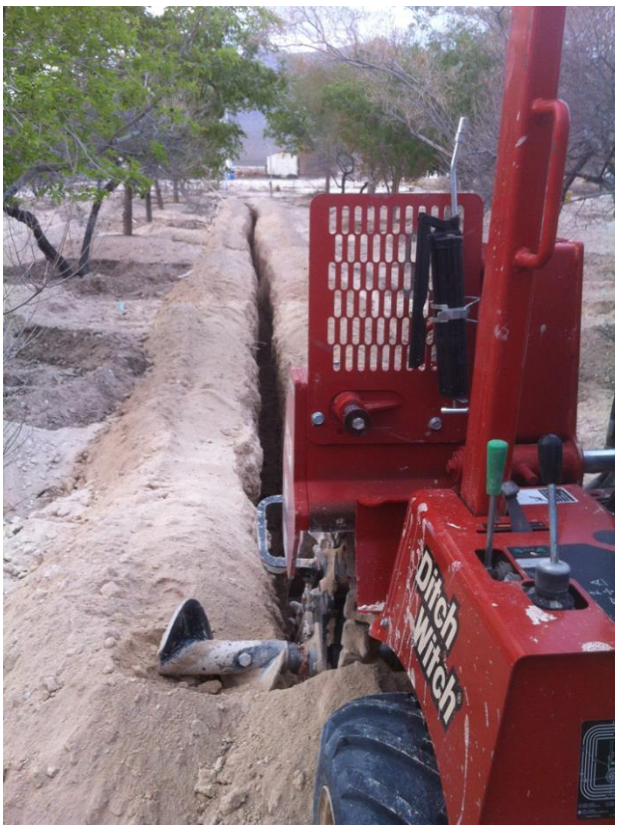
Irrigations and water balance

We initiated the study in May of 2016 and began applying irrigations to the tree basins and lysimeters planted to turfgrass. The goal has been to irrigate in a way that does not contribute to a drainage component that would have to be included in the hydrologic balance. As such we irrigate based on the previous weeks evapotranspiration rate, where ET = Input-Output-Change in Storage. In the tree basins we make weekly soil volumetric water content estimates at 10, 20,30,40,60 and 100 cm, enabling a weekly soil water in storage estimate. We also take soil volumetric water content estimates at 150 cm to monitor any deep soil water movement (no movement has been observed as of this report). Irrigation water is applied to the tree basins from an irrigation hose that is equipped with an accurate flow meter to estimate irrigation volume in liters. Lysimeters containing turfgrass are hand watered by measuring irrigation volumes with a graduate cylinder and then transferring that water to a watering can where the water is applied in a uniform fashion to each lysimeter. In the case of the ryegrass and bentgrass we had difficulty establishing and maintaining 100 % cover in all of the lysimeters, especially during the heat of July in which temperatures remained above 115 F for a one week period. Because of these problem we had to abandon the standard water balance approach and give additional water to help maintain the two grass species. This led to over irrigation and drainage build up. We are currently evacuating drainage via a drainage system that is based on ceramic extraction cups placed at 110 cm depth that are hooked to a vacuum extraction system. We are hopeful with cooler temperatures in fall that we can get good establishment of the ryegrass and bentgrass and get the drainage volumes back to very low values.

Evapotranspiration

We now have 19 weeks of ET estimates for the 30 trees based on the hydrologic balance approach. There is currently a significant amount of variability in the ET estimates when comparing replicates. This variability was expected since no two trees are identical. We will begin to normalize the ET estimates based on canopy volumes, basal canopy areas, trunk diameters, tree heights and leaf area index measurements to see if we can minimize this variability. Most of the trees show an increase in ET from late spring to summer with higher values holding throughout the summer period. We are looking forward to the fall measurements to see how the tree ET adjusts back down under lower environmental demand and how this will relate to the response observed with the turfgrass. Turfgrass ET has also revealed a similar temporal response. Once we normalize the tree ET values we will begin to compare the ET between the trees and turfgrass. The raw data suggest a 20 fold difference in the weekly ET when comparing the trees (higher) with the turfgrass (lower). The basal canopy area of the trees is not 20 fold larger than the turfgrass area which would suggest tree to grass water use ratios that would clearly favor the trees. We will finalize the normalization process during the next few months, enabling us to report on actual tree to grass water use ratios for each tree grass combination. We will also finalize our estimates of conductive xylem tissue area to convert the transpiration velocities into flux estimates. This process will also allow us to compare the sap flow approach with the hydrologic balance approach.

Surveying 100 Tree Site

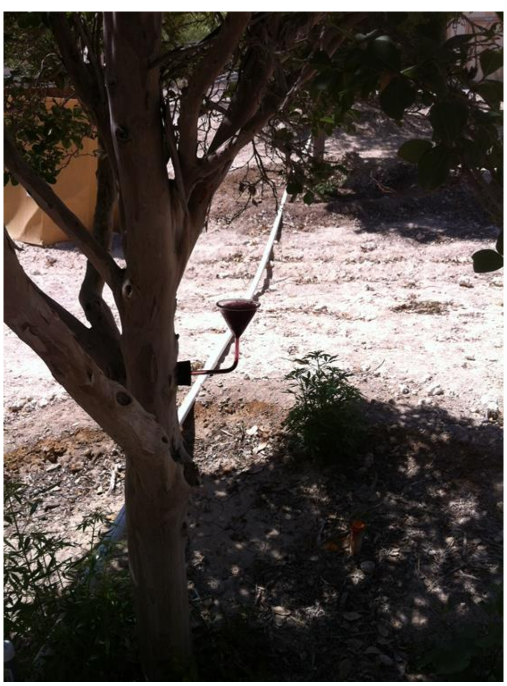


Trench dug to 120 cm to cut roots, isolating each tree

Roots observed between plots, almost entirely in the upper 30 cm

Basins built around each tree to hold irrigation water

Granier probes installed and covered with protective insulation.



Dye (sanfranin) injected into the xylem to assess the area of conductive tissue.

All irrigations applied with an accurate recording meter

Data logger with cables from 30 granier probes installed in the 10 species (3 replicates).

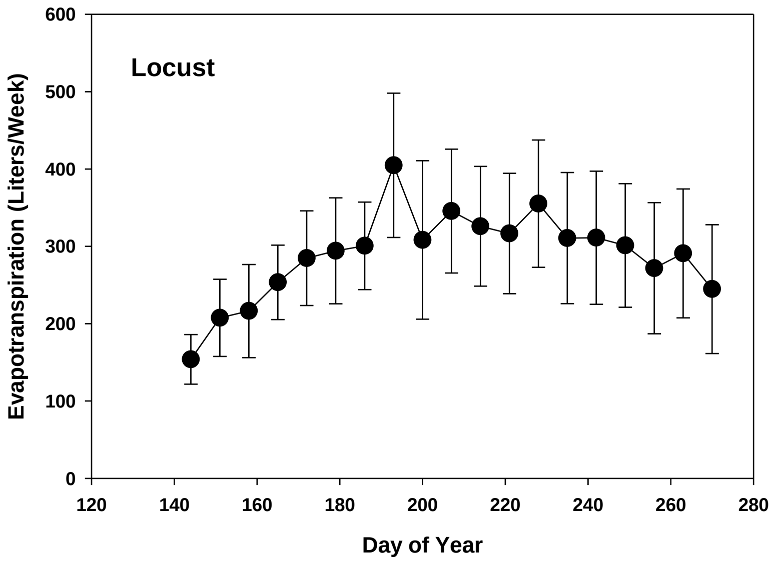
Cores taken above the point of dye injection to assess the area of conductive tissue.

Leaves of each species harvested for leaf area.

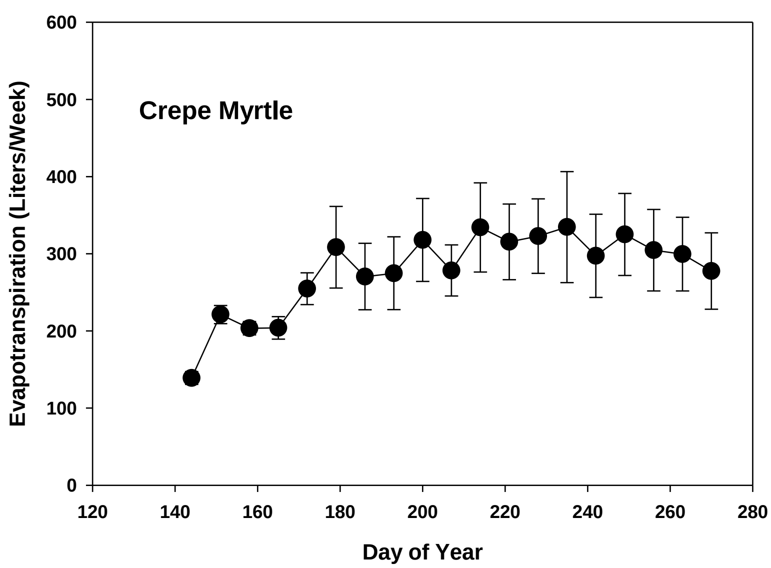
Tree heights, canopy volumes, basal canopy areas measured on each tree.

Tall Fescue

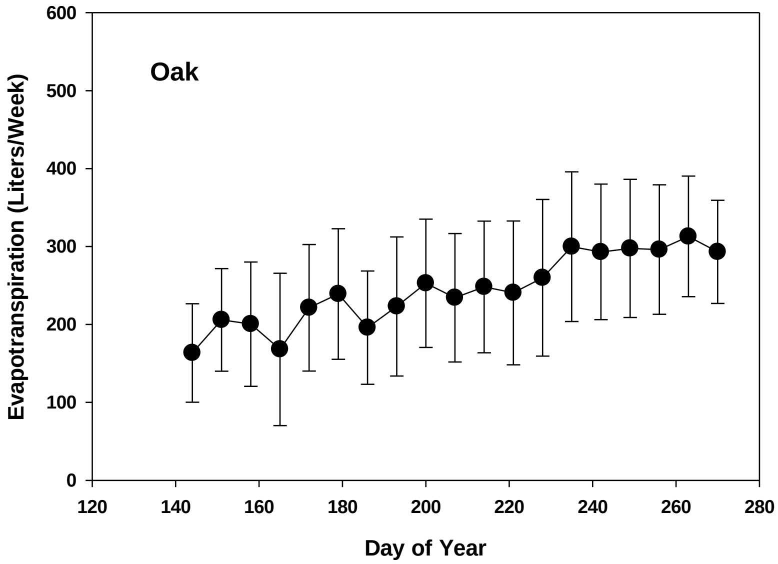
Ryegrass



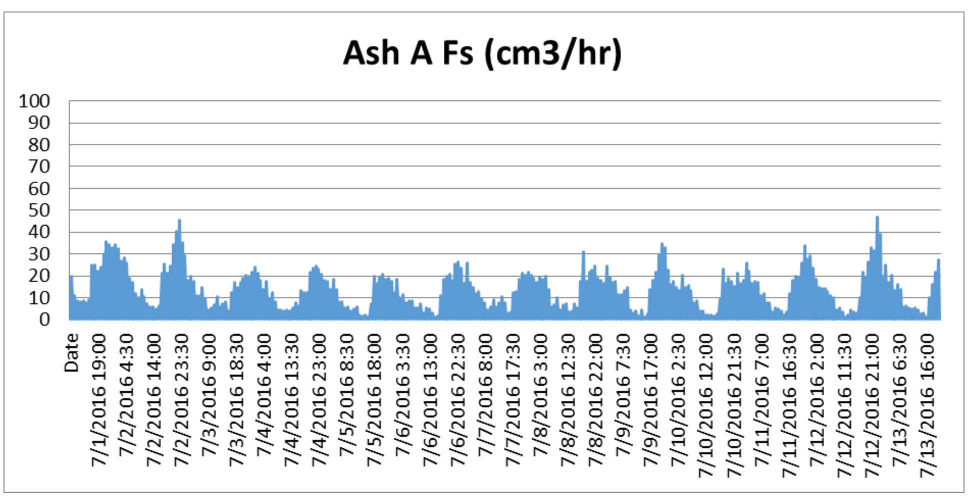
Evapotranspiration of Locust measured on a weekly basis with the hydrologic balance approach.



Evapotranspiration of Crepe Myrtle measured on a weekly basis with the hydrologic balance approach.



Evapotranspiration of Oak measured on a weekly basis with the hydrologic balance approach.



cm^3/hr

Sap flow (Granier probe) of Ash on a daily basis in mid-July of 2016.