Landscape plant irrigation trials©

L.R. Oki[1,a], K. Reid[2] and J. Sisneroz[1]

[1]Department of Plant Sciences MS6, University of California, Davis, California 95616, USA; [2]University of California Cooperative Extension, San Joaquin County, 2101 E. Earhart Ave., Ste 200, Stockton, California 95206, USA.

Abstract

With its large population and Mediterranean climate, California's water supply is a valuable, but limited, resource that has been made even more apparent during the current multi-year drought. About half of the water consumed in residences is provided as irrigation to landscapes. In the past, plants used in landscapes were chosen only for their ornamental value, but recently more consideration is also given to their water needs. To contribute to information on plant water use, an ongoing study at the University of California, Davis developed irrigation requirements. Plants were installed in a field in the fall of the year and provided ample amounts of water during the first summer. During the second summer, from April to October, four irrigation treatments at 20, 40, 60 and 80% of reference evapotranspiration (ET_0) (CIMIS) were provided to the plants. Evaluations of plant size, appearance, and other quality parameters were measured each month. Recommended irrigation rates were developed from the evaluations and reported to funding sources and posted online.

INTRODUCTION

California is one of five Mediterranean climates zones in the world characterized by cool, wet winters and hot, dry summers. This means that most urban landscapes require irrigation during the summer. But since water is a precious and limited resource, a fact that has been made even more apparent during the current multi-year drought, there have been mandates limiting the amounts of water that can be applied to these landscapes. Even though the first State legislation requiring more attention to urban landscapes planning was passed in 1990 (Clute, 1990), further legislation was necessary to emphasize the need for conservation (Laird, 2004, 2006). The latest legislation (Laird, 2006) led to the Model Water Efficient Landscape Ordinance (MWELO) that requires an estimated annual water use for the new or renovated landscape. This calculation requires information on plant specific water use (species coefficients, K_S), similar to that used in crop water use estimations, to develop landscape water use coefficients (K_L) and refers directly to the Water Use Classifications of Landscape Species (WUCOLS) document (Costello, 2014).

This document includes information on only about 3,500 plants, which is the largest assembly of this type of information, but still leaves a void of data on many thousands of other plants that could be used. The method used to compile the information in WUCOLS was the convening of horticultural experts in six different climate zones in California. These committees evaluated plants on a list and agreed on a category describing their water use in those zones. These categories were aligned with a percentage of reference evapotranspiration (ET_0), which is essentially a species coefficient (K_S) (Table 1) that can be used to calculate water needs.

The project discussed here developed information based on a scientifically based replicated experimental field set up where plants were first established and then exposed to four irrigation treatments. Physical measurements and quality assessments were made every month and a group assessment was conducted at the end of the study period. Recommendations for irrigation of these plants were derived from these measurements (Reid and Oki, 2008).

[a]E-mail: lroki@ucdavis.edu

Table 1. Categories of landscape plant water needs. Plants were placed into one or several of these categories based on knowledge of the plants by local horticultural experts. Irrigation needs of the plants were rated relative to reference evapotranspiration (ET_0), that is the amount of water needed by a well irrigated cool season turf in that region.

Category	Percentage of ET_0
High	70-90
Moderate	40-60
Low	10-30
Very Low	<10

MATERIALS AND METHODS

Plants are selected for examination to be planted in either the field (Figure 1) or under 50% shade cloth on the UC Davis campus. Plants are arranged in rows 2 m apart and within the rows also 2 m apart. Rows are covered with 3-4 in. of mulch. Each row is provided four water lines so that any treatment can be delivered to each plant. Two 2 gph emitters are provided to each plant.

Plants selected for evaluation are planted in the field or shade house in October. Plants are allowed to establish during the first year after planting with regular irrigation during the summer. Establishment period irrigations of 8.3 gal per plant are applied at about weekly intervals, depending on weather. This volume of water replaces 50% of the water holding capacity (WHC) of a cylinder of the Yolo silty clay loam soil of 1 m diameter and 0.5 m deep.

Deficit irrigation treatments are 20, 40, 60, and 80% of ET_0 and are applied during the second growing season after planting from April through September. The recommended irrigation rate for cool season turf is 80% of ET_0 and 60% of ET_0 is the recommended irrigation rate for warm season turf, as a reference. Both treatments and planting arrangements are designed in randomized complete block designs.

Figure 1. Plants are randomly organized and spaced 2 m in rows 2 m apart. Irrigation lines provide one of the 20, 40, 60, 80% of ET_0 treatments to each plant during the second summer after planting.

ET_0 is measured continuously at a nearby CIMIS (California Irrigation Management Information System) weather station located on campus and is checked on a daily basis. ET_0 is multiplied by the treatment factor (0.2, 0.4, 0.6, or 0.8) and those values are accumulated separately for each treatment. When the accumulated value reaches the triggering level, irrigation is initiated. The level that triggers irrigation is equivalent to 50% of the soil water holding capacity of the root volume (assumed to be a cylinder 1 m in diameter with a depth of 1 m). The amount of water applied (16.6 gal plant^{-1}) is also equal to 50% of the soil water holding capacity. So, volumes are fixed and provide a deep irrigation, but the interval between irrigations varies depending on the treatment factor and the weather.

Each month, a plant growth index (PGI) is determined to quantify the comparative growth of plants using the formula [(l+w)/2+h]/2, where *l*, *w*, and *h* represent length, width, and height of the plant (Figure 2). Height is measured from the ground to the tallest leaf. Length and width are measured along the row (in a north-south direction) and across the row (in an east-west direction), respectively, using the outermost leaf in each direction. The means of plant growth indices for each treatment and species are calculated and graphed as both a change in the value of the PGI over time, and as a PGI relative to the starting PGI. Aesthetic ratings for foliage quality, flower quantity, vigor, health and overall appearance rating (OAR) on a 1-5 scale (1: very poor, 5: excellent) are assessed each month.

Near the end of the study, local horticulturists are invited to view and rate the performance of the plants (Figure 3) and that data is integrated with the monthly measurements to develop irrigation recommendations.

Figure 2. Project manager Jared Sisneroz and graduate student Zhou Yang measure and evaluate plants.

Figure 3. Each fall, local horticulturists are invited to evaluate the plants in the irrigation trials. The data is used to develop recommended irrigation rates for each plant species/cultivar in the trial. See the list at: http://ccuh.ucdavis.edu/academia/plant-trials.

RESULTS

All of the data is used to develop a recommended irrigation rate (K_S) and is reported to funding agencies, plant providers, and posted as the "Compendium of Results, Landscape Trials" on the UC Davis California Center for Urban Horticulture (CCUH) website. This list includes the following information for each of the plants tested:

- Botanical Name and the plant patent designation (if applicable).
- Common Name and any marketing names a plant may be listed for sale as in a nursery, i.e. *Lonicera periclymenum* 'Inov 86', will be marketed as *Lonicera periclymenum* 'Peaches and Cream'.
- OAR (overall appearance rating) is the mean of the monthly overall appearance ratings for the recommended irrigation treatment for each species during the deficit period.
- Recommended Treatment ET% corresponds to the treatment where a species performed the highest in our field trial.
- Suggested Irrigation Frequency provides watering guidelines for each species when planted as part of a landscape, when using these guidelines for irrigation scheduling it is important to water deeply, fully saturating the root zone and use a thick layer of mulch.
- Year Trialed is when a selected species was trialed.

For more information about a species please visit: ccuh.ucdavis/academia/plant-trials. This site includes the list described above, reports for funding sources, and descriptions of the work conducted.

CONCLUSIONS

To date, there have been 48 full-sun and 14 shade plants tested. Results are reported as a downloadable PDF file that contains a summary of results of all of the plants tested. More complete reports that include detailed information including: discussion of performance, data analyses, images of the plants, and other issues such as pests, diseases, or other notables are also posted at the CCUH website.

This information can be used by landscape architects and designers who will need to calculate an estimated annual water use by the landscape as required by California regulations. WUCOLS is named in the regulation as a source for landscape plant water use, but the list contains "only" about 3,500 plants. The project described here adds information on plants not in the WUCOLS list using science-based methods. The process is slow, taking two years, but is an effective way to continue adding to this needed information.

ACKNOWLEDGEMENTS

Funding supporting the work has been provided by the California Association of Nurseries and Garden Centers, The Elvinia J. Slosson Endowment, and The Saratoga Horticultural Research Endowment.

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