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Introduction

Between 2012 and 2017, California experienced the most severe drought in its recorded history, resulting in major losses of groundwater and surface water, widespread ecosystem damage, and the death of more than 100 million trees. The state's most recent drought, from 2020 to 2022, became the driest 3-year period since records began in 1896. In 2018, California passed major water conservation laws to promote a long-term shift toward making water conservation a normal part of daily life. These policies went into effect in 2025, with the first potential enforcement milestones scheduled for 2027.

In California, landscape watering accounts for about 50 percent of household water use each year (Mount et al. 2023). During the summer months in Southern California, when plant water needs are at their highest, outdoor water use can rise sharply. For example, high-resolution meter data from single-family homes in Orange County showed that in 2020 more than 70 percent of total residential water use during peak summer months was for outdoor purposes (Flume Inc. and WaterDM 2021). As a result, meeting California's water-saving goals will require reducing irrigation in cities, even if it means putting some stress on landscape plants.

Extreme heat is a serious public health issue and can lead to illness or even death (SCAG 2020). Green spaces and vegetation are increasingly valued for helping to cool cities by reducing the urban heat island effect, cutting

down on building energy use, and making outdoor spaces more comfortable (Kunasingam et al. 2024). Irrigated landscapes help reduce heat buildup during the day and improve nighttime cooling, creating a more comfortable urban climate (Shashua-Bar et al. 2009).

Plants help cool cities by releasing moisture through evapotranspiration (ET), providing shade, and reflecting more sunlight due to their surface characteristics. Trees can absorb 70 to 90 percent of incoming sunlight, with the shade they produce being a highly effective tool for cooling urban environments (Wong et al. 2021). Ground-level greenery can lower surface temperatures by 2 to 9°C (Wong et al. 2021).

The type of plants used and how they are watered affect both how nice a landscape looks and how much it can help cool the area. Different plants use and access water in different ways during drought depending on physical traits such as root systems and how they respond to water stress. Plants that are drought-tolerant, avoid water loss, or can survive with little water are especially suited for the hot, dry climate of inland Southern California. To water landscapes efficiently, we need scientific data on how much water each plant species needs.

This publication shares irrigation recommendations based on nearly 10 years of field trials in inland Southern California's dry climate, along with findings about how much different plants can help with cooling.

ET-based irrigation scheduling of urban landscape

ET refers to the combined loss of water from plants through transpiration and from the soil surface through evaporation. ET-based irrigation scheduling is a commonly used method for managing water in both agricultural and urban landscapes.

Reference ET (ET_o) is the amount of water used by a healthy, well-watered reference crop under standard conditions. The reference crop used at most California Irrigation Management Information System (CIMIS) weather stations is a well-watered, actively growing, closely clipped turfgrass that fully covers and shades the soil. Smart irrigation controllers that rely on ET—also called weather-based controllers—use ET_o to schedule irrigation. These controllers either calculate ET_o using weather sensors at the site (which is preferred) or receive ET_o data from nearby weather stations.

To work properly, smart controllers also need information about each plant species water needs, called the plant factor or landscape coefficient (Singh et al. 2020). The smart controller then multiplies the ET_o by the plant factor to estimate how much water each landscape species should receive.

Plant factor values are typically determined through research using field trials for specific landscape species. In the dry climate of inland Southern California,

water-efficient landscape irrigation focuses on using the minimum amount of water needed to keep plants healthy and looking attractive, without wasting water. The plant factor represents the minimum fraction of ET_o needed to keep a plant looking nice and in overall good health.

Science-based plant factor values for inland Southern California

A total of eighteen landscape species (fig. 1) were studied over about 10 years in multiple field trials at the UC Riverside Agricultural Experiment Station (Iradukunda and Verdi 2024; Singh et al. 2024; Verdi et al. 2024; Haghverdi et al. 2023; Sapkota et al. 2023a, b; Haghverdi et al. 2021a, b, c; Amiri et al. 2026; Amiri and Verdi 2025). These include fourteen drought-tolerant groundcovers and four turfgrass species. The research team closely studied how each species responded to different irrigation amounts and schedules, testing them during summer for at least 2 years per species. Plants were selected in collaboration with local nurseries and included a mix of native plants, widely used non-natives, and new introductions suited for the hot, dry conditions of inland Southern California.

Table 1 shows the plant factor values for each species and ranks them by how much water they use. Table 2 ranks the same species by their cooling potential under low-water conditions. For each species, researchers recorded both canopy temperature and air temperature

Table 1. Plant factor values for eighteen landscape species for the semiarid region of inland Southern California

Plants with low to average water requirements (PF<0.4)	Plants with average to high water requirements (PF=0.4–0.8)	Plants with high water requirements (PF>0.8)
Creeping Australian Saltbush, PF=0.2–0.25	African Daisy, PF=0.5	Buffalograss, PF=0.8–0.9
Coyote Bush, PF=0.25–0.30	Gold Emu Bush, PF=0.4–0.5	Tall fescue, PF=1–1.1
Buckwheat, PF=0.2	Jasmine, PF=0.5–0.6	
Prostrate Acacia, PF=0.2	Kurapia, PF=0.6	
Vaalbietou, PF=0.3	Lantana, PF=0.6	
Ice Plant, PF=0.4	Honeysuckle, PF=0.6	
Rosemary, PF=0.4	St. Augustinegrass, PF=0.6–0.7	
Saltillo Evening Primrose, PF=0.4	Hybrid Bermudagrass, PF=0.75	

Table 2. Ranking plant species based on their relative cooling potential under limited irrigation application for the semiarid environment of inland Southern California

Plants with high cooling potential	Plants with average cooling potential	Plants with low cooling potential
Creeping Australian Saltbush	Gold Emu Bush	Ice Plant
Coyote Bush	Honeysuckle	Jasmine
Buckwheat	Rosemary	Lantana
African Daisy		Kurapia
Prostrate Acacia		Saltillo Evening Primrose
		Tall fescue
		Vaalbietou
		St. Augustinegrass
		Hybrid Bermudagrass
		Buffalograss

Figure 1. Landscape species studied in inland Southern California.

Creeping Australian Saltbush
(*Rhagodia spinescens*)
Origin: Australia



Coyote Bush
(*Baccharis* 'Starn')
Origin: USA



Gold Emu Bush
(*Eremophila glabra* 'Mingenew Gold')
Origin: Australia



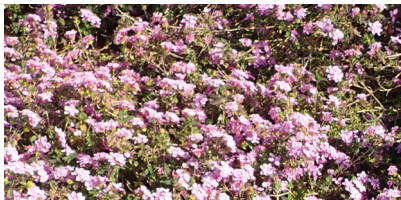
Honeysuckle
(*Lonicera japonica*)
Origin: Asia



Ice Plant
(*Ruschia lineolata* 'Nana')
Origin: South Africa



Jasmine
(*Trachelospermum jasminoides*)
Origin: China



Lantana
(*Lantana montevidensis*)
Origin: South America



Rosemary
(*Rosmarinus officinalis* 'Roman Beauty')
Origin: Mediterranean



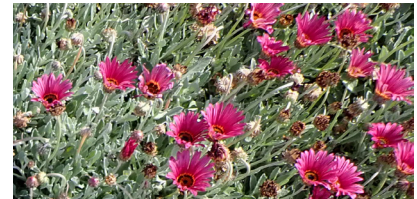
Saltillo Evening Primrose
(*Oenothera stubbei*)
Origin: Mexico



Buckwheat
(*Eriogonum fasciculatum* 'Warriner Lytle')
Origin: USA



Prostrate Acacia
(*Acacia redolens* 'Low Boy')
Origin: Australia



African Daisy
(*Arctotis acaulis* 'Big Magenta')
Origin: South Africa



Vaalbietou
(*Chrysanthemoides incana*)
Origin: South Africa



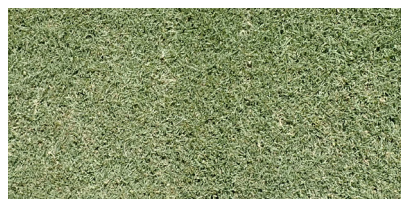
Kurapia
(*Lippia nodiflora*)
Origin: Japan



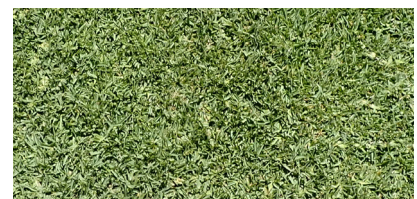
Hybrid Bermudagrass
(*Cynodon dactylon* x *C. transvaalensis* 'Tifgreen')
Origin: USA (cultivar)



Tall Fescue
(*Festuca arundinacea* 'Westcoaster')
Origin: USA (cultivar)



Buffalograss
(*Buchloë dactyloides* 'UC Verde')
Origin: USA (cultivar)



St. Augustinegrass
(*Stenotaphrum secundatum* 'A-G')
Origin: USA (cultivar)

and used the difference between them as an indicator of cooling potential. Plants that kept their canopies cooler than the surrounding air were considered to have high cooling potential and could help reduce urban heat.

Top-performing species like Prostrate Acacia, Buckwheat, and Creeping Australian Saltbush—both native and non-native—retained a healthy appearance and cooling ability even under very low irrigation.

Using plant factors to program ET-based controllers

Smart ET-based controllers allow users to manage multiple irrigation zones, with each zone typically controlled by its own solenoid valve. The best practice is to group plants with similar water needs in the same zone and avoid mixing species with very different water requirements. Smart controllers, like the Weathermatic SmartLine, which allow users to enter a separate plant factor for each irrigation zone, are recommended. It's also important to select the correct type of irrigation system for each zone when programming smart ET-based controllers, because different systems apply water at different rates—and the controller uses this information to calculate how long each zone should run.

For example, a water-efficient California-friendly irrigation zone might include Prostrate Acacia, Buckwheat, and Creeping Australian Saltbush, all programmed with a plant factor of 0.2. These plants need only 20 percent of the water required by a typical cool season turfgrass species to stay healthy and visually appealing. They also help cool the environment by keeping their canopies at lower temperatures, even when watered minimally—an important benefit during hot summer months.

Summary and conclusion remarks

The plant factor values provided in this publication are based on conditions during summer and in full sun. If plants are located in partial shade or during cooler seasons, lower plant factors may be used to save water. These values are also based on irrigation using pop-up sprinkler heads. For more efficient systems, such as drip irrigation which reduces evaporation from the soil surface, the plant factor can be lowered. We recommend starting with the plant factors listed here and then observing plant health and appearance. If signs of overwatering are seen, gradually reduce the plant factor to find the right setting for your specific site and microclimate.

Our research showed that several of the best-performing species—those that required minimal water and offered strong environmental cooling under limited irrigation—were non-native. Therefore, appropriate non-native species that are well adapted to the semiarid climate of inland Southern California should be considered ideal

choices for new landscapes. These species can help meet regional water conservation goals while supporting sustainable and resilient urban green spaces.

When trees are planted in the same irrigation zone as other landscape species, their water needs should be calculated separately and added to the water applied to the groundcovers and turfgrass species listed in this publication.

More information about landscape irrigation recommendations for inland Southern California—including updates on new species currently under study—can be found on Dr. Verdi's research website: <https://www.ucrwater.com/landscape-irrigation.html>.

Two other publications in this series provide guidance on soil-moisture-based and ET-based irrigation controllers for residential areas. These resources also highlight rebate programs available in California that can help reduce the cost of upgrading to more efficient irrigation technologies.

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