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What We Know About Landscape Water Requirements

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Reliable research-based data on landscape plants' water needs is extremely limited. Few information sources offer quantitative estimates of landscape plants' water requirements, and most of those that do, including the widely-referenced publication, *Water Use Classification of Landscape Plants* (or *WUCOLS*), are *not* based on scientific field research. Field research on non-turf landscape plants' minimum water requirements is limited to several commonly used groundcover, tree, and shrub species. There is very little research-based water requirement data for California native plants when they are used in planned landscapes.

Background

Why is so little scientific information available on landscape water needs? Primarily because there are hundreds of plant species to evaluate and the scientific process requires a great deal of resources to identify water requirements of an individual species. A brief look at how plant water requirements are scientifically determined helps explain.

First, a reference point or standard for comparison is established, which is known as *reference evapotranspiration*, *reference ET*, or most simply ET_o. It is the amount of water used via transpiration and evaporation by a large planting of a cool-season grass growing 3 to 6 inches tall and given unlimited water. It is *not* the amount of water a tall fescue lawn requires for good growth. Most landscape species, including turfgrass, require an amount of water that is less than ET_o during most of the year.

Reference ET provides an estimate of the local climate's impact on plant water use. Local climatic factors - sunlight energy, temperature, wind speed, relative humidity, and other variables - are entered in a complex mathematical equation to derive an ET_o value for a given period of time, usually a day. Generally, as sunlight, temperature, and wind increase and as relative humidity decreases, the value of ET_o increases. In California, local or regional ET_o data is provided by the California Irrigation Management Information System (CIMIS), which calculates daily ET_o values using a modified Penman equation.

Although ET_o varies from one climate zone to another, the percentage of it used for a given species (or the crop coefficient) does not change. To establish an estimate of the water requirement of a given species or crop, it is supplied with known quantities of irrigation and its performance is evaluated in terms of yield, growth, appearance or other parameters. The minimum amount of water

Table 1. Crop coefficients (K_c) for cool-season and warm-season turfgrasses, in California [z].

Month	Cool-season[y]	Warm-season[x]
January	0.61	0.55
February	0.64	0.54
March	0.75	0.76
April	1.04	0.72
May	0.95	0.79
June	0.88	0.68
July	0.94	0.71
August	0.86	0.71
September	0.74	0.62
October	0.75	0.54
November	0.69	0.58
December	0.60	0.55
Annual Average	***0.80***	***0.60***

[z] Meyer et al. 1985. Irrigation of turfgrass below replacement of evapotranspiration as a means of water conservation: determining crop coefficient of turfgrasses, pp. 357-364 in: F. Lemaire (ed.) Proc. 5th Intl. Turfgrass Res. Conf., Avignon, France, July 1985. INRA Publications, Versailles, France.

[y] Species include tall fescue, ryegrass, bentgrass, and Kentucky bluegrass.

[x] Species include bermudagrass, zoysiagrass, and St. Augustinegrass.

at which the desired level of performance is achieved is then compared to ET_o during the same period and expressed as a percentage of ET_o using a term known as a *crop coefficient* or K_c. Crop coefficients are dimensionless numbers usually ranging from 0.1 to 1.2. A simple equation is used to express a crop's water requirement as $ET_{crop} = ET_o \times K_c$.

The concept of using the ET_o standard to estimate a crop's water needs through a crop coefficient was initially derived by agricultural crop scientists to estimate the water requirements of large tracts of field and orchard crops. Thus, the scientific application of ET_o to calculate crop coefficients assumes the plant material of interest is:

- well-watered with soil moisture unlimited at all times.
- growing vigorously.
- forming a uniform, nearly continuous canopy that functions as a single big leaf.
- grown with the goal of optimum growth and development.
- using water in direct proportion to the rate of ET_o.

Applying Assumptions of ETo to Landscape Plantings

Lawns and other turfgrass plantings closely match the ET_o assumptions, so crop coefficients have been scientifically determined that represent the water needed by common turfgrass species to perform optimally (see Table 1). The annual averages are more commonly used, but monthly values generate irrigation schedules that more precisely match turfgrass needs.

Many landscape plantings, however, violate the above assumptions of the relatiuonship between ET_o and a plant's K_c. Mixed plantings of groundcover, shrub and tree species create variations in the plant canopy and shading that prevent the overall planting from functioning as a single big leaf, soil water content is not always at optimum levels, and the plants are not usually grown with optimum growth and development as the goal. Expectations of landscape plant performance are simply acceptable appearance and function, which are much less stringent than optimum growth and development. Also, research in plant physiology has revealed that water use of some woody landscape plants does not increase proportionally as ET_o increases throughout the day especially when site conditions are harsh, such as when trees are planted within paved parking lots. Some species actually use less water in harsh situations because their stomatclose. Altogether, these factors severely limit the ability of the ET_o equation to accurately reflect a landscape's water requirement and make it impossible to determine a precise crop coefficient for each landscape plant species.

Since landscape plants do not conform to the scientifically accepted assumptions of calculating crop coefficients, the ET_o standard has been used to determine ranges in percentage of ET_o for several species in which they will provide minimally acceptable performance and function, not necessarily optimum growth. The findings show that many universally used species maintain their aesthetic and functional value when irrigated within a range of 18% to 80% of ET_o (see Table 2).

For the many landscape species with unknown water requirements, it is currently recommended to set initial irrigation schedules at 50% ET_o for established non-turf landscape plantings. Plant performance must be evaluated and irrigation increased or decreased in increments of about 10% ET_o until the desired level of performance is attained with the least amount of water. Intervals between irrigation of woody landscape plant materials can usually be greatly extended from fall through winter.

Table 2. Irrigation amount required for selected landscape groundcovers and shrubs to provide acceptable landscape performance after establishment.[z]

Scientific Name	Common Name	% ET
Arbutus unedo 'Compacta'	compact strawberry tree	18 - 36
Arctostaphylos uva-ursi 'Pacific Mist'	bearberry	18 - 36
Artemisia 'Powis Castle'	workwood	0 - 36 [y, w]
Baccharis pilularis 'Twin peaks'	Twin Peaks coyote bush	20
Calliandra haematocephala	pink powder puff	18 - 36
Cassia artemisioides	feathery cassia	0 - 36 [y, x]
Cistus x purpureus	orchid spot rock rose	0 - 36 [y]
Correa alba 'Ivory Bells'	white Australian correa	18 - 36
Drosanthemum hispidum	pink iceplant	20
Echium fastuosum	pride of Madeira	0 - 36 [y]
Escallonia x exoniensis 'Fradessii'	Frades escallonia	18 - 36
Galvezia speciosa	bush snapdragon	0 - 36 [y, x]
Gazania rigens v. leucolaena 'Yellow Cascade'	trailing gazania	50 - 80
Grevillea 'Noelii'		0 - 36 [y]
Hedera helix 'Needlepoint'	Needlepoint English ivy	20 - 30
Heteromeles arbutifolia	toyon	0 - 36 [y]
Hibiscus rosa-sinensis	rose of China	40 - 60
Lantana montevidensis	trailing lantana	18 - 36
Leptospermum scoparium	New Zealand tea tree	18 - 36
Leucophyllum frutescens 'Green Cloud'	Texas ranger	0 - 36 [y, x]
Ligustrum japonicum 'Texanum'	Texas privet	40 - 60
Myoporum 'Pacificum'	prostrate myoporum	0 - 36 [y]
Otatea acuminata	Mexican bamboo	18 - 36
Phormium tenax	New Zealand flax	18 - 36
Pittosporum tobira	mock orange	18 - 36
Potentilla tabernaemontanii	spring cinquefoil	70 - 80
Prunus caroliniana	carolina laurel cherry	0 - 36 [y]
Pyracantha koidzumii 'Santa Cruz'	firethorn	0 - 36 [y]
Rhaphiolepis indica	indian hawthorne	18 - 36
Teucrium chamaedrys	germander	18 - 36
Vinca major	periwinkle; myrtle	30 - 40
Westringia rosamarinaformis	rosemary bush	18 - 36
Xylosma congestum	shiny xylosma	18 - 36

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[y] Acceptable landscape performance with no summer irrigation shown only at the immediate coast. Inland plantings may require summer irrigation up to the maximum amount listed.

[x] Species typically provides unacceptable landscape performance in summer and fall months irrespective of irrigation amount.

[w] Requires renovation every 3 years to maintain acceptable performance.

New Research Project

Since scientific quantitative information on landscape plant water use is so scarce, the Landscape Workgroup of University of California's Division of Agriculture and Natural Resources (DANR), with financial support from the California Landscape Contractors' Association and U.C. DANR, is establishing a statewide set of field research plots aimed at expanding and refining the database on minimum water requirements of landscape plants.

Specific goals of this research are:

1. Refine the minimum quantity of irrigation required for commonly used landscape plant species to maintain their aesthetic and functional value.
2. Develop scientific, reference evapotranspiration based irrigation information that can be used to develop effective landscape water conservation techniques and BMPs.
3. Determine the effect of reduced irrigation on the growth of selected shrubs.

Study plots are currently scheduled to be established at the following locations:

- *South Coast* at the U.C. South Coast Research & Extension Center in Irvine.
- *Low Desert* at the U.C. Riverside Coachella Valley Agricultural Research Station near Indio.
- *Central Valley* at the U.C. Kearney Agricultural Center in Parlier.
- *North Coast* at the U.C. Hopland Research & Extension Center in Hopland.

At each site there will be a large research plot (up to 1/2 acre) consisting of up to 15 plant species receiving 4 irrigation treatments. A core group of 6 plant species will be used at all of the sites with additional species selected forom a common list and planted at sites as resources permit. Plant species will represent commonly used shrubs, groundcovers, and herbaceous perennials.

This project is expected to fill gaps in the knowledge about the lower limit thresholds for water application to plant species widely used in landscapes across the state and supply sound research findings to support the implementation of effective landscape irrigation best management practices (BMPs) by landscape contractors, water agencies, and allied professionals.

Blueberries on Mars! Is Southern California Next?

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Blueberry (*Vaccinium sp.*) is a member of the Ericaceae family. This family includes other ornamentals such as azalea and rhododendron (*Rhododendron*), heath (*Erica*), and mountain laurel (*Kalmia*). Initially, most people think it is unlikely that blueberries can be grown in California. However, blueberries are quite adaptable to their environment. In fact, NASA has even found blueberries on Mars. In all seriousness, growing blueberries in Southern California is not so far-fetched when one realizes that other ericaceous plants are found through out California such as the madrone tree (*Arbutus menziesii*), the many species of manzinita (*Arctostaphylos spp.*), huckleberry (*V. ovatum*) and *Comarostaphylis*, species of which are endemic all the way into Mexico. What has kept blueberries from being grown in Southern California in the past is the high amount of chilling most cultivars needed to break dormancy (>800 hours). However, during the past 30 years, great accomplishments have been made by breeders in Florida and Georgia to develop blueberry cultivars that require very little chilling. These low chill varieties are classified as Rabbiteye and Southern Highbush Blueberries.

Vaccinium species diversity and geographical distribution. There are many species of *Vaccinium*. The lowbush blueberry (*V. angustifolium*) and cranberry (*V. macrocarpon*), two of the more common species, are native to cold temperate climates of the northeastern United States and Canada. However, some less commonly know species such as *V. pahalae*, the 'ohelo' berry and *V. acrobracteatum* are native to the volcanic cinder cones of the Hawaiian Islands (Figures 1 and 2) and New Guinea, respectively. Even though these exotic species are very

Figure 1. Vaccinium pahalae growing in volcanic cinder on a Hawaiin volcano.

Figure 2. Vaccinium pahalae growing in volcanic cinder on a Hawaiin volcano.

beautiful (most have evergreen leaves, and new stems and leaves that are bright red) and definitely worth studying for there ornamental qualities, this article will only focus on the species and their cultivars which are used for commercial fruit production, and also have attractive foliage and growth characteristics that would earn them the title of 'ornamental'.

General ornamental traits. There are several outstanding characteristics that will accelerate the desire for blueberries in the ornamental industry.

1. Diversity – There are many different cultivars to choose from, with varying growth characteristics in height, canopy shape, and leaf color to meet the tastes of most customers.
2. Growth Habit - Average plant height is 4-6 feet, which is suitable for the smaller gardens found in Southern California. However, there are also smaller-growing cultivars (2-3 feet) that can be grown as container plants on patios.
3. Leaf Characteristics – While most cultivars are deciduous in the eastern U.S. (even in Florida), these same selections can be evergreen in California.
4. Fruiting Characteristics – Many cultivars being introduced into California will produce a small fruit crop, even without other cultivars nearby.
5. Bird Attractant – Most birds find blueberries irresistible (a trait that commercial growers hate, but bird enthusiasts will love).
6. Disease resistance – Currently, blueberry is not afflicted with major pathogens or insects, so care is minimal.
7. Cultural Recommendations – Cultural needs are similar to azaleas. The soil should be acidic (pH 4.0-6.0) and well-drained. Plant performance is also improved with the incorporation of organic matter into the soil and mulching over the roots.
8. Plant Availability - Plants are easily propagated from cuttings and tissue culture. Therefore, plant production should not be a limiting factor to plant availability. Rooted cuttings require approximately two years to become 1-gallon sized plants.

Specific Descriptions of Species and Cultivars

Cranberry. The common cranberry is *V. macrocarpon*, a low-growing groundcover, which is native to the northeastern United States and Canada. Even though this could be a very attractive groundcover, cranberries as ornamentals are not being tested in Southern California, as this species requires more hours of chilling than most growing regions in Southern California receive.

Ligonberry. *Vaccinium vitis-idaea* (*minus*) is the ligonberry, a species that is native to Europe. Ligonberries, also called lignonberries, produce small, tart, red berries. In some cultivars these berries may stay on the plant through the winter. Berries are usually used in baking and jams. Plant growth is similar to cranberries, being evergreen groundcovers. If adaptable to Southern California, this species could be used as a small groundcover. Trials with several cultivars of this species are being conducted in Ventura and Tulare counties.

Note: Don't confuse ligonberry with loganberry (a raspberry-blackberry type fruit)

Highbush Blueberry. *Vaccinium corymbosum* is native to the eastern region of the United States. Many blueberries available are from selections of this species. However, most cultivars with this species and other northern species such as the lowbush blueberry (*V. angustifolium*) require too many chilling hours (> 600) for the plants to grow reliably in Southern California.

***Rabbiteye Blueberry.** Cultivars classified as true rabbiteye are derived wholly from the selections of the blueberry species *ashei* (no highbush – *corymbosum* is in the parentage). The common name of 'rabbiteye' was established because the flower scar tends to look like a rabbit's eye. Collection and cultivation of this species began in the late 1800's but had ceased by the 1920's. Collection of *V. ashei* started again in the 1930's, but was discontinued in the 1940's when most of the U.S. resources were directed to the efforts of World War II (Sharpe, 1954). In 1951, Ralph Sharpe from the University of Florida, resumed the collection program for *V. ashei* along with other species native primarily to Florida, Georgia and Alabama (Lyrene, 1998). Later, Paul Lyrene and Wayne Sherman joined him in the University of Florida breeding program. As a result of their efforts, many rabbiteye cultivars are now available. Some traits specific for rabbiteye blueberry are listed below.

Growth characteristics – Plants can be easily maintained at between 5-6 feet tall.

Leaf characteristics – Most cultivars are deciduous (even into Florida). However, in the California climate, some are evergreen or semi evergreen. Leaf color ranges from green to glaucous blue.

Fruiting – It is recommended that most cultivars be planted with other cultivars for cross-pollination.

Disease resistance – On the east coast, rabbiteye are usually more resistant to *Phytophthora* than highbush and lowbush cultivars. Plants are also claimed to have more resistance to drought, by east coast standards (east coast standards drought = 'a week without rain'. How drought tolerant this is in California, remains to be seen).

Southern Highbush Blueberry. In an effort to breed low-chill cultivars, the research group (P. Lyrene, W. Sherman, and R. Sharp) crossed the highbush blueberry (*V. corymbosum*) with the rabbiteye (*V. ashei*) and several other southern species such as *V. darrowi, V. elliottii, V. myrsinites, and V. fuscatum* (Lyrene and Sherman, 1980). The resulting hybrids have the excellent fruit flavor of *V. corymbosum* and the low-chill (<150 hours) requirements of the southern species.

Growth characteristics – Plants can be maintained between 4-6 feet. However, some selections like 'Sunshine Blue' are dwarf, growing only to 3 feet.

Leaf characteristics – Many cultivars are evergreen or semi-evergreen in California. There are a variety of leaf characteristics. 'Misty' has heavy-textured, dark green leaves, much like some varieties of *Ceanothus*. In colder regions, Misty can turn a spectacular red color, before dropping its' leaves. However, in most areas of Southern California, it is evergreen. 'Sharpblue' leaves are not as heavy as 'Misty's, but are more glaucous.

Fruiting – Most cultivars are self-fruitful. This trait has made southern highbush currently more popular than rabbiteyes.

Disease resistance – Since southern highbush has *ashei*, *darrowi*, and other southern species in its parentage, it is considered more resistant to *Phytophthora* than the northern cultivars.

In closing, blueberries in California, for both commercial and ornamental purposes, are becoming very popular. Like other plants, blueberry performance (i.e. the evergreen characteristics), is much different in California than the blueberries grown in other states, so cultural requirements for California may be slightly different as well. In addition, the cultivar selection is going to expand as other subtropical and Mediterranean regions such as New Zealand, Australia, and South America pursue blueberry breeding and production programs. So stay tuned as the Mediterranean blueberry establishes itself in our commercial fields and residential landscapes.

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Ericaceously yours,

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Zoysiagrass for California

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Zoysiagrasses are warm-season grasses that originated in east Asia and were first introduced into the United States early in the 20th century. In California, there has been only limited use of the grasses for turfgrass sites and as ground covers in landscapes where summers are warm and winters mild. The grasses range from the very fine-leaved Korean velvetgrass (*Zoysia tenuifolia*), used to a limited extent as an unmowed, meadow-like ground cover, to Japanese lawngrass (*Z. japonica*), a relatively coarse bladed turfgrass used in lawns. Other kinds of zoysiagrass include the fine-bladed Manillagrass or Korean lawngrass(*Z. matrella*) that is used for low-input lawns in Asia, and the minor use, highly salt tolerant *Z. sinica* and *Z. machrostaycha*. "Species" of zoysiagrass can be hybridized so the grasses may be considered to be a "family" of related grasses (Brede, 2000). As an example, 'Emerald' zoysiagrass is a hybrid between Korean velvetgrass and Japanese lawngrass.

Interest in zoysiagrass increases

Interest in zoysiagrass improvement programs has increased because they are considered to be resource efficient (low input) or mimimun maintenance turfgrasses. As examples, zoysiagrasses are heat tolerant and thrive under high summer temperatures; they have few disease or insect problems, especially under California climatic conditions, and the dense turf is very competitive against weed encroachment; they have a slow growth rate so mowing and edging frequency is reduced; they have high traffic tolerance; they make a satisfactory turf surface with less nitrogen fertilizer than other commonly used turfgrasses; they are quite salt tolerant; and they grow in light to moderate shade (Youngner, 1980). Some zoysiagrass are highly shade tolerant.

Previous California studies have shown that warm-season turfgrasses, including zoysiagrass, require less water supplied as irrigation than the commonly used cool-season turfgrasses (Youngner, 1981 and Meyer, Gibeault, 1986). Concerns with zoysiagrass would include their slow establishment rate; thatch accumulation because of the stoloniferous and rhizomatous growth habit; and slow growth/dormancy during winter months.

'El Toro' zoysiagrass used widely

In the mid-1980's 'El Toro' zoysiagrass, a *Z. japonica*, was released from a long term University of California plant improvement program directed by the late Dr. Victor B. Youngner and implemented by Mr. Stanley Spaulding (Gibeault and Cockerham, 1988). 'El Toro' zoysiagrass was shown to have a much faster establishment rate, better late-season color and more rapid spring greenup than other *Z. japonica* grasses, and less thatch production.

'El Toro' zoysiagrass has been used nationally and internationally for various turfgrass purposes since its introduction but to a limited amount in California. A reason 'El Toro' zoysiagrass or other warm-season turfgrasses have not been used more extensively in California, even though they have been shown to be more resource efficient, relates to the dormancy of the grasses during winter months.

Chilling injury to warm-season grasses

Chilling temperatures interacting with high light intensity result in a loss of chlorophyll and dormancy of warm-season turfgrasses. The appearance of anthocyanin may be observed as chlorophyll degradation exceeds synthesis; ultimately, the warm-season turfgrasses lose all green color until tempertures increase in late winter or early spring. Normally, the winter temperatures in Southern California are very close to threshold tempertures that cause chlorophyll degradation so plant selection and improvement can influence the presence and degree of dormancy. A continued breeding program at the University of California, Riverside emphasized, among other turfgrass establishment and quality parameters, the ability of experimental lines to retain green color during the winter months. Two new zoysiagrass cultivars, 'De Anza' and 'Victoria', resulted from the work.

'De Anza' and 'Victoria' zoysiagrass developed

'De Anza' and 'Victoria' zoysiagrasses were produced by hybridizing 'El Toro' zoysiagrass as the female parent with a zoysia selection that, itself, was a hybrid (*Z. matrella* x (*Z. japonica x Z. tenuifolia*)). Hand pollination was performed and seed was germinated. Seedlings were individually cultured under controlled conditions before being transplanted to the field for evaluation and selection. Several years of field screening demonstrated their superior ability to retain color through the winter months, under conditions in Riverside, California, when compared to other experimental and commercially available zoysia lines. They were also selected because of their competitive turfgrass establishment rate and quality which included color, texture, density, uniformity, and pest resistance. Being siblings, 'De Anza' and 'Victoria' zoysiagrass are similar in overall performance although 'De Anza' has a darker green genetic color and holds color slightly better than the lighter green 'Victoria' under Riverside conditions.

The cultivars must be vegetatively propagated from sod, stolons or plugs. They are appropriate for applications such as home lawns, parks, golf courses and general purpose lawns. Cultivar performance results from recently completed National Turfgrass Evaluation Program (NTEP) studies show that the two cultivars have been released that perform better in regions that have high summer temperatures with moderate winter temperatures. They do not give good performance in regions where low winter temperatures are common.

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