

# California Turfgrass Culture

Volume 47, Nos. 3 & 4, 1997

## Using $ET_0$ (Reference Evapotranspiration) for Turfgrass Irrigation Efficiency

William E. Richie, Robert L. Green, and Victor A. Gibeault<sup>1</sup>

Water is a valuable resource in the arid southwest where annual rainfall is often less than approximately 10 inches. Irrigation, therefore, is a necessary component of typical landscapes and is becoming commonplace in landscapes countrywide. Because of the importance of water to the West, it is in the best interest of turf and landscape managers to practice irrigation scheduling which results in wise water use. Fine-tuning irrigation scheduling can maintain acceptable aesthetic quality, eliminate luxury consumption of water by plant material, reduce disease susceptibility, and result in monetary savings.

### *How much water should be applied?*

The first questions asked about turfgrass irrigation often relate to irrigation quantity, i.e. "How much water needs to be applied to maintain acceptable aesthetic quality?" Ideally, the amount of water required by turfgrass can be quantified by the equation:  $ET_{crop}$  (or  $ET_{turf}$ ) =  $ET_0 \times K_c$ , where  $ET_{crop}$  is the actual turfgrass water use,  $ET_0$  is the reference water use, and  $K_c$  is the crop coefficient. The last step in determining irrigation quantity is to divide  $ET_{crop}$  by the irrigation system distribution uniformity (DU):

$$\text{Actual irrigation need} = \frac{ET_0 \times K_c}{DU} = \frac{ET_{crop}}{DU}$$

Basically, as the distribution uniformity (DU) decreases, more irrigation water will need to be applied, though the turfgrass water use has not changed. The following text will explain  $ET_0$ ,  $K_c$ ,  $ET_{crop}$ , and DU in more detail.

### *Reference water use ( $ET_0$ ) and soil moisture-based irrigation scheduling*

$ET_0$ , or reference evapotranspiration, is an estimate of

the amount of water used by a healthy 4 to 6 inch-tall stand of cool-season grass. Reference ET values can be obtained from different sources. The California Department of Water Resources maintains the CIMIS (California Irrigation Management Information Service) program to aid irrigation managers. This program uses hourly weather data and a modified Penman model to calculate (estimate)  $ET_0$  values, which are retrieved using a modem. Also, historical  $ET_0$  values for California can be found on the internet at: <http://www.dla.water.ca.gov> or <http://www.ceresgroup.com/col/weather/cimis/>. A similar program (AZMET) is available in Arizona. Managers of large turfgrass areas (golf courses, for example) may also employ controllers that use similar weather-monitoring Penman systems to provide on-site  $ET_0$ -based irrigation programming.

Besides using empirical equations, reference evapotranspiration can also be estimated from pan evaporation and atmometers. Doorenbos and Pruitt (1975) provide a thorough discussion of  $ET_0$ , and pan evaporation ( $E_p$ ) using a USDA Class A pan. Simonne et al. (1992) discuss using containers other than a standard Class A pan for measuring reference evaporation and scheduling irrigation. Qian et al. (1996) estimated turfgrass evapotranspiration using pan evaporation, atmometers (Bellani plate) and the empirical Penman-

<sup>1</sup>Staff Research Associate, Turfgrass Research Agronomist, and Extension Environmental Horticulturist, respectively, Department of Botany and Plant Sciences, University of California, Riverside.

Monteith equation and found that atmometers correlated most closely with measured turf ET in humid eastern Kansas. Atmometers can be wired to certain irrigation controllers to facilitate ET-based scheduling.

Though not commonly practiced, some irrigation managers also practice soil moisture-based scheduling. Moisture sensors, such as tensiometers, gypsum blocks, or granular matrix sensors interfaced with irrigation controllers, can effectively control irrigation by permitting or preventing irrigation when soil moisture is adequate for plant needs.

### *Crop coefficients ( $K_c$ ) and Crop water use ( $ET_{crop}$ )*

University research over the past two decades has yielded monthly crop coefficients ( $K_c$ : sometimes termed 'plant factors') to facilitate ET-based irrigation scheduling of warm- and cool-season turfgrasses (Note: These coefficients were developed under coastal California climatic conditions and may differ

slightly in other regions of the country.) When multiplied by  $ET_c$ , crop coefficients provide a relatively accurate estimate of  $ET_{crop}$  or  $ET_c$ , or the amount of water (in depth units) used or required by the turfgrass. However, this is not irrigation requirement. Monthly coefficients can be averaged to yield quarterly, semi-annual, or annual crop coefficients. Annual cool- and warm-season turfgrass coefficients are 0.8 and 0.6, respectively. Averaging crop coefficients reduces monthly precision and turfgrass may be under-irrigated during stressful summer months. Ideally, irrigation managers should employ monthly, or at least quarterly, crop coefficients in their calculations of turfgrass water requirements. See Table 1 for a list of monthly, quarterly, semi-annual, and annual cool- and warm-season crop coefficients.

### *Turfgrass water use versus irrigation water requirement*

Distribution uniformity (DU) of an irrigation system is

**Table 1. Cool- and warm-season turfgrass crop coefficients for use in the arid southwest' with quarterly, semi-annual, and annual irrigation programming.**

Cool-Season Turfgrass					Warm-Season Turfgrass								
Month	Monthly	Quarterly	Semi-annually	Annually	Monthly	Quarterly	Semi-annually	Annually	Month				
I	.61	.67	.68	.80	.55	.62	.55	.60	J				
F	.64									.54			F
											M		
A	1.04	.96	.90			.72	.73		.71	A			
M	.95									.79			M
M	.88									.68			J
J	.94									.71			J
A	.86	.85				.71	.68			A			
S	.74									.62			s
O	.75	.68	.68			.54	.56		.55	O			
N	.69									.58			N
D	.60									.55			cl

' These coefficients may differ slightly in other regions of the country.

a measure of how uniformly a system applies water to a crop surface. Rainfall, in most cases, would be considered to be 100% uniform because all areas of a particular site would receive an equivalent depth of precipitation. Many turfgrass sites have an irrigation DU ranging from 50 to 70% compared to irrigation research plots that normally have a DU of 80% or above. DU is important because it influences the amount of required irrigation, though turfgrass water use ( $ET_{crop}$ ) remains unchanged.  $ET_{crop}$  divided by DU determines the actual irrigation requirement. Table 2 illustrates the concept of turfgrass water requirements and turfgrass irrigation water requirements.

### *From recommendation to practice*

Once a recommended water quantity for a particular turfgrass is determined, a series of calculations are required to convert this quantity to an actual run time on an irrigation controller. The first step in this calculation is to determine how many inches of water need to be applied by multiplying  $ET_{crop}$  for the region of interest and for the time increment desired, such as a month or quarter (irrigation schedules are not usually altered more frequently than this) by the crop coefficient ( $K_c$ ) for the turfgrass of interest (Table 1). Crop  $ET$  is then equal to  $ET_{crop} \times K_c$ . The resulting number is then divided by the irrigation system distribution uniformity, or DU, which will be calculated below. This 'depth' of water is converted to an actual run time (minutes) for the period by dividing by the system precipitation rate (inches per hour) and then multiplying by 60. The final step is to calculate run time (minutes) per irrigation event by dividing run time for the period by the number of irrigation events for the period (month or quarter). Below is an example calculation for the city of Los Angeles for the month of July:

$$\frac{\text{Historical } ET, (6.2") \times 0.94 \text{ (} K_c \text{; July crop coefficient for cool-season grass)}}{\text{DU (assume 0.6 or 60\%: a typical uniformity for many systems)}}$$

$$= 9.7 \text{ inches water to apply}$$

Run time for July could then be calculated as follows:

$$\frac{9.7 \text{ inches water to apply}}{\text{System precipitation rate (assume 1.5 inches per hour - an average rate for rotor-type heads)}} \times 60$$

$$= 389 \text{ minutes run time for July}$$

Two variables are required for this calculation. These are DU, or *system distribution uniformity*, and *system precipitation rate* which are both calculated by performing a "catch can test." Six or more straight-sided cans (such as tuna cans) are placed in a grid within the irrigated area. The more cans that are used, the better the information yielded from the test. After arranging the cans, sprinklers are run for 15 minutes (one quarter of an hour so that hourly precipitation is easily calculated by multiplying by 4) and then the depth of water in each can is measured with a ruler. If 15 minutes is not long enough, run sprinklers long enough to collect a measurable depth of water and multiply by the factor needed to give hourly precipitation. System distribution uniformity (DU) is determined by calculating the average amount of water in 25% of the cans that accumulated the least amount of water during the test divided by the mean depth of water in all cans. DU is calculated as follows:

Distribution Uniformity (DU) =

$$\frac{\text{Mean of the low quarter (volume or depth)}}{\text{Overall mean (volume or depth)}}$$

Precipitation rate is the average depth of water collected in all of the cans multiplied by 4 (assuming a 15 minute run time). If the average measured depth is .25", then the system precipitation rate would be 1 inch per hour. Alternatively, precipitation rate can be calculated using the following equation:

$$\frac{\text{gpm(one head) } \times 96.25}{\text{head spacing on row (ft) } \times \text{row spacing (ft)}}$$

$$= \text{inches} \backslash \text{hour precipitation}$$

Here is an example. A catch can test is performed with

**Table 2. A comparison of turfgrass water requirement (ET<sub>crop</sub>) and irrigation water requirement.**

Turf	Kc	ET <sub>crop</sub>	DU	Irrigation Water Requirement
Average warm-season grass	.6	60% ET,	(÷) .6	100% ET,
Average cool-season grass	.8	80% ET,	(+) .6	133% ET,

20 cans, spaced 5 feet apart. Measuring the depth of water in each can, the average depth in the 5 lowest cans is found to be .22 inch. The average depth of all 20 cans is .35 inch. Precipitation rate for this system is  $.35 \times 4 = 1.4$  inch per hour. DU is  $.22/.35 = .63$ .

The next step in developing an efficient irrigation program is to calculate run time per irrigation event. This requires knowledge of the number of irrigation events per time period (month or quarter, for example). In the following example it will be assumed that the manager wants to irrigate twice per week (an assumption based on UCR research). Examination of a calendar shows 9 irrigation events for an average month, or 35 irrigation events for a quarter. Total run time needs to be divided by this many irrigation events. Continuing with the preceding example for Los Angeles:

$$\frac{\text{Run time per month (389 minutes)}}{\text{\# irrigation events per month (9)}}$$

**= 43 minutes per irrigation event (Monday and Thursday for example).**

This is the amount of time that will actually be programmed into the irrigation controller to apply a total irrigation amount equivalent to 94% ET,, the recommended replenishment for cool-season turf in July.

#### ***Optimizing irrigation application: Water penetration***

Regardless of how much irrigation water is applied, the water must reach the root zone to be available for plant uptake. If the precipitation rate is greater than the soil infiltration rate, runoff will occur. Proper management will ensure maximum water penetration into the soil. First determine how long sprinklers can run before water begins to pool and run off. Irrigation run times should be shorter than this amount of time.

Several sequential 'cycles' may be needed to apply enough water to meet plant needs. The 43 minute run time in the above example may need to be cycled into two 22 minute runs, three 14 -15 minute runs or four 10-11 minute runs (allowing soak-in time between runs) to ensure that all 43 minutes of water reaches the root zone. Some irrigation controllers offer cycle repeat features which simplify this operation and preclude the need for multiple start times.

The second step an irrigator can take to increase water penetration or infiltration is to reduce irrigation system precipitation rates. Reducing precipitation rates does not change soil infiltration rate, but provides a longer time period for the water to soak into the soil. This can be accomplished by designing systems with rotor-type heads instead of spray heads when possible. A spray head may demand the same gallonage as a rotor head, but only cover one-fourth the area of the rotor head. Thus, more water is applied per area using the spray head. Using smaller nozzle sizes on rotor heads which provide the same coverage radius also is a consideration. Micro spray systems can also be employed, some of which adapt to existing spray heads. Consult a professional irrigation supplier for availability.

Core cultivation or aerifying (punching holes in the soil surface) also can be performed to increase water infiltration.

#### ***Optimizing Irrigation Application: System Uniformity***

Maximizing irrigation system uniformity is one of the most important steps an irrigator can take to optimize his irrigation. Returning to the preceding example of applying 94% July ET, in Los Angeles, a comparison of two systems with different distribution uniformities is interesting:

In Table 3, notice how much more water must be applied with system 2 to achieve a similar result com-

**Table 3. A comparison of water applied by two irrigation systems with varying distribution uniformities.**

	<b>System 1</b>	<b>System 2</b>
System Uniformity (DU)	80%	50%
Inches water applied	7.3	11.7
Total minutes	292	468
Minutes per run event	32	52
Gallons applied <sup>z</sup>	14600	23400
Cubic feet applied <sup>z</sup>	1957	3136

<sup>z</sup> Assuming an irrigation system using 50 gallons per minute and a precipitation rate of **1.5** inches per hour.

pared to system 1 (11.7 inches vs. 7.3 inches). The less uniform a system is (the lower the DU), the longer the sprinklers will have to run to produce a uniform turf appearance over the entire irrigated area.

Irrigation system uniformity can be improved in many ways. The first is to ensure that system *operating* pressure is within the manufacturer's recommended range for the head being used. Sprinkler heads are often sold with a specification sheet which includes a recommended operating pressure. Manufacturer's catalogues also list optimum operating pressures for specific heads. High pressure causes atomization and loss of fine droplets to wind, not to mention unnecessary wear on system piping and equipment. Low pressures cause insufficient diffusion of sprinkler spray patterns, and dry 'donut' areas are the result. Operating pressure can be measured with a gauge affixed to a shradler-type valve on the solenoid valve (pressure regulating valves have these), or installed somewhere in the system. Pressure can also be measured on rotor or impact-type heads with a pitot tube held where water leaves the nozzle.

If system pressure is too high, it can be regulated down with an adjustable pressure regulator or a pressure regulating solenoid valve. Pressure regulators are often located after the backflow device and regulate pressure on all systems downstream (Note: before performing any alterations an irrigation designer should be consulted. Higher pressures may be re-

quired for certain systems downstream, e.g., systems at higher elevations). One can also use a pressure regulating master valve which is actuated by the irrigation controller to supply water to all systems. All systems will therefore be supplied with the same operating pressure (assuming no friction loss in supply piping) from the master valve. Pressure regulating valves can also be installed on each irrigation system. This provides the greatest flexibility by allowing adjustment of each system to an optimum operating pressure. Pressure regulation at the sprinkler head itself is also possible with products now available on the market. Spray head nozzles can be purchased with pressure compensating devices (PCD's) or pressure compensating screens (PCS's) which reduce operating pressure to an ideal range for a specific nozzle and thus eliminate fogging. One manufacturer has also recently marketed a pop-up spray head with a built-in stem pressure regulating feature.

System uniformity also can be adversely affected by low operating pressures. Although sometimes more difficult to remedy than high pressure, several steps can be taken to increase low operating pressure. The first is to ensure that supply piping is not restricted with corrosion and that frictional pressure loss is not excessive. A booster pump can be installed to increase system pressures. This can be a costly remedy and require considerable work. Another solution is to separate large systems into multiple smaller systems, reducing the gallonage demand, and increasing the operating pressure of the smaller individual systems. This procedure will require the installation of more valves and may be complicated by the need for more wiring and extra controller stations. An easier solution may be to install smaller nozzles on rotor heads. Smaller nozzles can often provide sufficient radius for head-to-head coverage, while reducing the gallonage demand of the system. Finally, irrigation should occur when supply pressure (city water) is at maximum, usually early morning.

Assuming system operating pressure is within the recommended range, system uniformity can often be improved further. Typically, rotor or impact-type heads provide superior uniformity to spray heads and should be used when possible. When using rotor heads, nozzles should be selected carefully to balance precipitation. For example, a rotor head with a 180" arc takes twice as long as a head with a 90" arc to cover its area. Therefore a nozzle supplying approximately twice the

gallage of water should be used in the 180" head. A nozzle supplying four times the gallage should be used in a 360" head. More specifically, if a corner head with an arc of 90" has a 1.5 gpm nozzle, an adjacent head operating with a 180" arc should have a 3.0 gpm nozzle. A full circle head on this system would then need to be equipped with a 6.0 gpm nozzle. It is also important to maintain consistency of sprinkler head brands within a system. Heads from various manufacturers may have different rotation and precipitation rates and matched precipitation may be lost. If a system is equipped with quality components, seek to replace damaged or worn heads with those of the same brand. Though tempting, the money saved in the purchase of a 'cheap' sprinkler head is not worth the time and maintenance headaches that may result later.

Heads should be checked for vertical alignment periodically to make sure they are as near to vertical as possible (assuming level ground). Head spacing and proper nozzle size should also be checked to ensure head-to-head coverage. System operating condition should be checked routinely to ensure that all heads are functioning properly and that there are no clogged nozzles or streams. Finally, irrigation should be performed at times when wind is at a minimum, such as evening or morning. Early morning is generally recommended to reduce disease occurrence.

#### ***Optimizing irrigation application: Final considerations***

A few more considerations can help optimize irrigation application. First, irrigation controllers should be rescheduled as frequently as possible. The above example assumes a monthly reschedule. Time permitting, run times could be changed weekly or biweekly. At the very least, irrigation controllers should be reprogrammed quarterly to coincide with seasonal climatic changes. Water budget or global adjust features on many controllers can simplify rescheduling by allowing the operator to 'dial in' an irrigation level as a percentage of a seasonal maximum. Remote control of irrigation, where programs can be changed via modem or radio, is becoming increasingly popular. Such features encourage frequent controller update because irrigation control can be changed and monitored from one's home or office.

An irrigation system should be designed with hydro-

zones in mind. Water requirements of trees and shrubs differ from turf because the former have deeper and more extensive rooting patterns and can be watered more infrequently. The trees, shrubs, and turf constitute different hydrozones and separate systems should be used for each if possible. Furthermore, shaded areas require less water than sunny areas, and so ideally, separately valved systems should be in operation for these two zones. Irrigation on slopes may need to be cycled more frequently than other systems and therefore may constitute a unique hydrozone.

The use of rain switches can also prevent irrigation during rain events. Many new controllers have terminals into which a rain switch can easily be installed. Soil moisture sensors, such as Watermark sensors (Irrrometer Co., Riverside, CA), also can be used to prevent irrigation when soil moisture is adequate for plant needs. Such sensors operate by opening valve circuits (preventing irrigation) when soil moisture is higher than a required level.

#### ***Conclusions***

Applying an amount of water which replenishes turf and landscape water use (ET) is a realizable goal which can result in significant water and monetary savings. ET-based irrigation scheduling seeks to prevent over-irrigation which leads to runoff or leaching into potable water sources. The goal is to irrigate plant materials at a recommended percentage of ET, as infrequently as possible. University research has shown that applying an annual average of 80% ET, to tall fescue less frequently (twice per week) can result in improved turfgrass visual color and quality. The irrigator should keep in mind that with longer run times associated with less frequent irrigation, water infiltration becomes a consideration and multiple cycles or lower precipitation rates may need to be used. Acceptable turf quality can best be maintained when irrigation system uniformity is optimum. Recommendations for improving system uniformity include checking and adjusting operating pressures, selecting appropriate heads and nozzles, checking head alignment and operation, and irrigating at times when wind is minimal. Finally, nothing is more important than visual observation. The turf manager should visually inspect turf areas and irrigation systems on a regular basis. If dry areas are apparent in spite of proper system operation, controller programs should be ad-

justed accordingly. With a proficient irrigation system and frequent controller program updates, landscape managers should begin to see improved plant quality with water and monetary savings.

### References

- Beard, J. B. 1973. Turfgrass: science and culture. Prentice-Hall, Englewood Cliffs, NJ.
- Doorenbos, J. and W. O. Pruitt. 1975. Guidelines for predicting crop water requirements. FAO irrigation and drainage paper 24.
- Grau, F. V. and M. H. Ferguson. 1948. Pointers on making good lawns. pp. 302-307 In A. Stefferud (ed.) Grass, The Yearbook of Agriculture, USDA.
- Hagan, R. M. 1955. Watering lawns and turf and otherwise caring for them. pp. 462-467 In A. Stefferud (ed.), Water, The Yearbook of Agriculture. USDA.
- Qian, Y. L., J. D. Fry, S. C. Wiest, and W. S. Upham. 1996. Estimating turfgrass evapotranspiration using atmometers and the Penman-Monteith model. Crop Sci. 36: 699-704.
- Simonne, E., H. A. Mills, and D. A. Smittle. 1992. A simple method to measure on-farm pan evaporation for scheduling irrigation. HortTechnology. 2(3): 392-393.
- Youngner, V. B. 1985. Physiology of water use and water stress. p. 37-43 In V. A. Gibeault and S. T. Cockerham (ed.) Turfgrass water conservation. Univ. of California Publ., Oakland.
- DU -Irrigation system distribution uniformity; a measure of how evenly or uniformly an irrigation system applies water to a crop area.
- $E_{pan}$  -A measurement of water evaporation (often in units of mm per day) from a USDA Class A pan of standard dimensions. Pan evaporation can be correlated to reference evapotranspiration ( $ET_o$ ) by pan coefficients ( $K_p$ ) which are available from published tables.
- $ET_o$  -Reference or potential evapotranspiration; An estimation of water-use and soil evaporation from a short, green reference crop, assuming soil moisture is not limiting.  $ET_o$  is calculated from measures of solar radiation, air temperature, humidity, and wind.
- $K_c$  -Crop coefficient; An adjustment factor which, when multiplied by  $ET_o$ , provides an estimate of actual crop evapotranspiration.  $K_c$  is calculated as a dimensionless ratio of actual crop water use to reference evapotranspiration ( $ET_{crop}/ET_o$ ).
- $K_p$  -Pan coefficient; An adjustment factor used to convert values of  $E_{pan}$  to  $ET_o$  under specific environmental conditions.
- Historical  $ET_o$ , vs. Real Time  $ET_o$ ; Historical  $ET_o$  is the average reference evapotranspiration for the number of years of available data for a location. Real Time  $ET_o$  is that reference evapotranspiration determined at the time of interest for a location, from automated weather stations such as the California Irrigation Management Information System (CIMIS), an on-site atmometer, or evaporation pan.

### Terms Defined

Arc -A degree measure (0 to 360) of a sprinkler head's application pattern. For example, a sprinkler head with a 360 degree arc will distribute water over a full circle area. A head with a 180 degree arc will distribute water over a half-circle area, and a head with a 90 degree arc will apply water to a quarter-circle area.

### Acknowledgment

Partial funding for the turfgrass water conservation project has been provided by the Metropolitan Water District of Southern California. Sincere appreciation is extended to John Addink (President, A-G Sod Farms, Inc.), Jurgen Gramckow (General Manager, Southland Sod Farms), Scott Silva (Metropolitan Water District of Southern California), and Dave Skinner (Irrigation Design Specialist, Oasis Irrigation and Landscape Supply) for their helpful review of this article.

## WARNING ON THE USE OF CHEMICALS

Pesticides are poisonous, Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in their original labeled containers in a locked cabinet or shed, away from food or feeds and out of the reach of children, unauthorized persons, pets, and livestock.

Recommendations are based on the best information currently available, and treatments based on them should not leave residues exceeding the tolerance established for any particular chemical. Confine chemicals to the area being treated. **THE GROWER IS LEGALLY RESPONSIBLE** for residues on his crops as well as for problems caused by drift from his property to other properties or crops.

Consult your County Agricultural Commissioner for correct methods of disposing of leftover spray material and empty containers. **Never burn pesticide containers.**

**PHYTOTOXICITY:** Certain Chemicals may cause plant injury if used at the wrong stage of plant development or when temperatures are too high. Injury may also result from excessive amounts of the wrong formulation or from mixing incompatible materials. Inert ingredients, such as wetters, spreaders, emulsifiers, diluents and solvents, can cause plant injury. Since formulations are often changed by manufacturers, it is possible that plant injury may occur, even though no injury was noted in previous seasons.

**NOTE:** Progress reports give experimental data that should not be considered as recommendations for use. Until the products and the uses given appear on a registered pesticide label or other legal, supplementary direction for use, it is illegal to use the chemicals as described.

## CALIFORNIA TURFGRASS CULTURE

## EDITORIAL COMMITTEE

Stephen T. Cockerham, Superintendent  
Agricultural Operations  
University of California, Riverside

Victor A. Gibeault  
Extension Environmental Horticulturist  
Department of Botany and Plant Sciences  
University of California, Riverside

Ali Harivandi  
Environmental Horticulture Advisor  
University of California Cooperative Extension  
Alameda, Contra Costa and Santa Clara  
Counties

Lin Wu, Professor  
Department of Environmental Horticulture,  
University of California, Davis

Correspondence concerning  
*California Turfgrass Culture*  
should be sent to:

Victor A. Gibeault  
Bachelor Hall Extension  
University of California  
Riverside, CA 9252 1-O 124

---

**The University of California, in accordance with applicable Federal and State law and University policy, does not discriminate on the basis of race, color, national origin, religion, sex, disability, age, medical condition (cancer-related), ancestry, marital status, citizenship, sexual orientation, or status as a Vietnam-era veteran or special disabled veteran. Inquiries regarding the University's nondiscrimination policies may be directed to the Affirmative Action Director, University of California, Agriculture and Natural Resources, 300 Lakeside Drive, 6th Floor, Oakland, CA 94612-3560, (510) 987-0096.**