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KERN
Crop Information

COOPERATIVE EXTENSION March 1991 UNIVERSITY OF CALIFORNIA

IRRIGATION MANAGEMENT WITH LIMITED WATER SUPPLIES

The University of California has been extensively involved in research and implementation of water conservation/management strategies throughout the state. A lot is known about when and how to most effectively use limited water supplies.

This newsletter is a synopsis and overview of strategies compiled by the Kern County Farm Advisors staff. We hope this information is useful to you in this critically dry year. We look forward to working with you to get through this critical period.

Please feel free to call our office for more detail on the enclosed information.

J. Hodge Black

J. Hodge Black, County Director

UPCOMING MEETINGS OF IMPORTANCE

1. **Water: The Lifeblood of Farms and Cities**
   March 14 at Beale Library

2. **Drought Irrigation Management for Trees and Vines**
   March 15 at Kearney Ag Center, Parlier, CA

3. **Kern County Almond Symposium**
   March 20 at Hodel's, Bakersfield
   (Pre-registration Requested)

4. **Kern County Citrus Meeting**
   March 28 Ag Conference Room
   1031 S. Mt. Vernon Avenue, Bakersfield

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SAVING WATER IN LANDSCAPE IRRIGATION

In residential areas, up to 45% of the water is used for landscape irrigation. It is possible to significantly reduce water consumption without major changes to a landscape or irrigation system through better management. Extensive changes may result in further savings. However, it is not necessary to convert a landscape to cactus and gravel to save water!

The simplest way to save water is to turn it off. With an automatic irrigation system, clock adjustments should be made at least quarterly during the year. Water use by plants changes dramatically from winter to summer throughout Kern County. If the clock settings are not changed, water is typically wasted during most of the year. Fall and spring are transition times when careful managers may want to adjust clock settings every two weeks. Some clocks have a water budget feature which allows a percentage change for all circuits. While adjustment of duration is helpful, adjustment of irrigation frequency is also important. Deep and infrequent irrigation is a rule-of-thumb. Ideally, soil within the root zone should be brought to field capacity at each irrigation. If runoff occurs, multiple short cycles may be necessary to apply the needed amount of water. Early morning is the best time of day to irrigate the landscape.

Regardless of irrigation schedule, soil and plants must be monitored. Plants indicate moisture stress by color change, or in more advanced condition, by wilting. Soils should be checked with a soil probe (preferable) or screwdriver to gauge the depth of water penetration. Periodically, irrigation should be run when the operator can watch and adjustments made, or any missing heads, breaks, leaks, etc. repaired.

A non-uniform system, especially on turf, can waste large amounts of water. It is common for homeowners to irrigate until the driest spot is wet. This may result in twice as much water as needed on other areas. In general, head-to-head coverage is necessary for uniformity. Sprinkler heads should be matched for precipitation rate. That is, full circle heads should give the same amount of water per unit time, half circle heads half as much, and so forth. Newer heads are often available with these specifications. On turf, a high degree of uniformity can be obtained with single-stream heads, stream rotors, or impact sprinklers. Fan-sprays are more difficult to work with to achieve high coefficients of uniformity. Simple geometric shapes are easier to irrigate uniformly than undulating curves of turf bordered by flexible edging. Some types of turf heads, such as stream rotors, offer low precipitation rates for soils with low infiltration rates. For shrubs, groundcovers and trees, drip irrigation is often practical, with a variety of emitters available.

Plants with similar water requirements should be in the same irrigation zone. This does not mean all plants have to be watered on the same circuit, but rather all plants on the same line should need similar amounts and frequency of irrigation. For example, in a residential landscape, turf would be irrigated from one or more lines, shrubs and groundcovers on another, fruit trees on another, and a vegetable garden by itself. Inexpensive clocks are available which allow two separate schedules, and more expensive commercial clocks allow each valve to be independently scheduled. Even with a manual system, zoning allows more efficient control with less possibility of overwatering.

In a landscape, the manager may have little idea of what the initial time settings ought to be. A water audit can establish baseline information from which future schedules can be calculated. Sprinklers are run for a set duration, with the water caught in cans. The water is measured to give a precipitation rate in inches per minute. If done on a grid pattern, the uniformity can also be calculated. Results may be surprising! If the precipitation rate is known, it can be compared with pan or reference evapotranspiration. Evapotranspiration, ET, is the amount of water evaporated and transpired by plants and soil.

Cultural practices influence need for water by plants. Nitrogen fertilization should be reduced, especially

on cool season turf. Turfgrass should be mowed at the optimum cutting height for that species. The height should be raised for cool season turf during the warmest part of the summer.

What about the use of greywater, water that has been used for washing clothes or dishes? From a horticultural standpoint, greywater is generally not harmful to plants. Water with high amounts of chlorine from bleach or with boron (borax) added can be deleterious to plants if used in large quantities. Also, swimming pool water has an elevated sodium content after it is repeatedly treated. Some plants, such as bermudagrass, are quite tolerant of high salts, others are not.

Plants differ in their suitability for use in arid environments. Warm season grasses, such as bermudagrass, are generally much better adapted to drought conditions than cool season grasses such as bluegrass. Bermudagrass, for example, can be irrigated at 50% of the amount of bluegrass and still be acceptable in appearance. Other plants have features which reduce water loss. These may include a waxy cuticle to retard evaporation from the leaf, sunken stomata further protected by a tangle of leaf hairs, reduced leaf area, and gray coloration. A number of plants available in the nursery trade have origins in dry regions and are considered to be water conserving.

Maximum water savings in the landscape can be obtained from appropriate landscape design followed by good management. These principles go together in Xeriscape, appropriate horticulture with emphasis on water conservation. Some of the common elements are:

- Grouping of plants according to common cultural needs, e.g. rockrose with rosemary
- zoning of irrigation to match plant requirements, e.g. shrubs on the same line
- Using turf for function not just appearance
- Using warm season turfs instead of cool season incorporating hardscapes such as patios into the landscape
- Utilizing islands of plantings rather than vast expanses of green
- Selecting plants for climatic conditions according to their adaptation
- confining high water use plants or water features to protected microclimates

Xeriscape can reduce net energy consumption by providing shade in summer and allowing the sun's rays to warm dwellings in winter. Properly executed, a xeriscape should reduce the need for pest control because selecting adapted plants is a key in reducing overall pest incidence. Weed control should be less necessary because irrigation is directed and schedules adjusted. Appropriate plant materials are available at no greater cost than others less suited. And, a good xeriscape is beautiful.

VINEYARD MANAGEMENT IN A DROUGHT YEAR

Kern County grape growers have some tough decisions to make regarding water use and crop production. Decisions will range all the way from abandoning vineyards to having enough water to produce a normal crop. In any event, water management will be a key factor in efficiently using the limited, and in many cases, expensive supplies available. The following are some of the options available to grape growers.

Abandonment of Vineyards. Not a pleasant thought, but will occur in some special cases. Wine grapes are in this category since prices are low and contracts for the 1991 crop are hard to come by. This might be the opportunity to make some needed adjustments in cropping. The long-term picture for wine grapes appears to be a continued decrease in consumption. The past two years it has been around 5% a year which could translate into a decreased need for up to 16,000 acres per year. Unfortunately, some of this acreage comes from Kern County since production costs are higher and grapes are in demand only in years of short supply. Growing a crop of wine grapes without a contract in a water short year is not for the faint hearted. This is an opportunity to make a decision which will come sooner or later and use the water on other crops or by removing the

vineyard, position yourself to grow higher value crops in the future. Some older table grape vineyards might also be in this group.

Keep the Vine Alive. Minimum irrigation to keep the vines alive is an alternative being looked at by several growers. In this case, no crop is desired but the vineyard is strong and young enough to be considered an asset in the future. The procedure is not hard and fast but would go something like this. Under drip irrigation 8-9 ac in of water, under furrow and sprinkler irrigation 9-10 inches might be needed due to the differences in irrigation efficiency. Under furrow irrigation, narrow furrows on each side of the vine will help to minimize evaporation losses and confine water to the vines most active root zone. **One very important point when using low E.T. application rates with drip irrigation--irrigation must be every day.** Applying six gallons one day and no water for the next two days will cause more stress than two gallons applied each day.

Application Sequence. One of the objectives will be to develop shoots with sufficient caliper to support a normal crop in 1992. The majority of the water should be available between start growth to early /mid-June. After making 12-18 inches of growth and maturing the wood, the vine can be allowed to go dormant.

Under drip irrigation, following a schedule based upon .3 E.T. will result in the application of approximately 7 inches of water for the season. A better sequence might be .5 E.T. through early June est 3.8 ac in water then .2 E.T. through August est 3.2 ac in water. [3.8+3.2=7 acre inches of applied water]. Again, this is based upon daily irrigation.

Under furrow and sprinkler irrigation, the main point will be to minimize losses due to evaporation and deep percolation. Three to four inches of stored water in the soil profile should carry the vines through mid-April/early May. At the most, one or two additional three-inch irrigations will use up the remaining 5 inches of water. The vines will be on their own for the rest of the season.

Sufficient Water for a Normal Crop. In 1991, this will be a blend of well and surface water. Some of this water will be saltier than normal and if sprinklers are used, marginal leaf burn will be moderate to severe. It will be important to schedule irrigations to the vines needs (evapotranspiration) in order to efficiently utilize available water.

Drip Irrigation. Drip irrigation and microjet sprinklers will be the easiest to work with since they usually have the higher coefficient of uniformity. A normal crop should be obtained with 20-24 inches of water through mid-August harvest, 24-28 acre inches of water through September, and 30-34 acre inches of water through October. Since normally cropped vines have a large canopy, it would be advisable to continue light applications of water until the first of October. After harvest, irrigation at .2-.3 E.T. should keep the vine from excess stress. When using drip irrigation, daily irrigation is preferred over running the drip system until the soil is flooded (a form of furrow irrigation).

Furrow Irrigation. Water management with furrow irrigation presents a greater challenge than with drip irrigation. Water usage will approximate 22-26 inches for mid-August harvest, 26-28 inches through September, and 31-37 acre inches through October. Some points to consider:

1. If using a return flow system, evaluate water penetration. If water penetration is poor, you can end up recirculating water and the vines can be under water stress.

2. To conserve water, growers might consider **not** growing the normal grass cover crop this year. Even though cultivation is more expensive, some water can be saved. Sunburn should not be any more of a problem than under drip irrigation.

3. The flip side to No. 2 above is that well water can improve water penetration over canal water. Cultivation combined with long irrigation runs could result in excessive infiltration and wasted water.

4. It is important that you know what your water flows are to evaluate water application and irrigation efficiency.

5. With improved water penetration from well water, narrower furrows might be in order to better control application. It would **not** be out of place to have a current water analysis on each of your wells, especially those being used for drip irrigation.

DRIP IRRIGATION SCHEDULING--GALLONS/VINE/---DAY

THIS TABLE IS BASED UPON INCREASING WATER APPLICATIONS THRU JUNE THEN DRAWING ON THIS STORED WATER DURING AUGUST AND SEPT.

Gallons per day column is the actual water needed based upon evapotranspiration for grapes. The season total will be 26.45 inches of water per acre. Under deficit irrigation the ET will have to be decreased by the deficit then increased by the irrigation efficiency. i.e. 26.45 ac in /ac X .8 ET(deficit) = 21.16 ac in/ ac.; 21.16 ac in/ac +.81(drip irrigation efficiency) = 26.13 acre inches per acre. to irrigate @.8ET rather than 1.0ET

Water application for grapevines under drip irrigation in gallons per vine per day .
*** = Columns based upon irrigation efficiency of 81% under drip irrigation**

	454 vines per acre (8'x12')		519 vines *	605 vines*	495 vines*	566 vines*
DATE	Gallons per Day ET	gal/day @ 81% Eff.*	per acre 7'x12'	per acre 6'x12'	per acre 8'x11'	per acre 7'x11
Apr 1-7	0.5	0.6	0.5	0.5	0.6	0.5
8-14	0.9	1.1	1.0	0.8	1.0	0.9
15-21	2.6	3.2	2.8	2.4	2.9	2.6
22-28	3.6	4.4	3.9	3.3	4.1	3.6
29-5	4.8	5.9	5.2	4.4	5.4	4.8
Gallons monthly cum.	86.8	107.2	93.7	80.4	98.3	86.0
May 6-12	6.7	8.3	7.2	6.2	7.6	6.6
13-19	7.4	9.1	8.0	6.9	8.4	7.3
20-26	9	11.1	9.7	8.3	10.2	8.9
27-2	9	11.1	9.7	8.3	10.2	8.9
Gallons monthly cum.	311.5	384.6	336.4	288.6	352.7	308.5
Jun 3-9	9.5	11.7	10.3	8.8	10.8	9.4
10-16	11.5	14.2	12.4	10.7	13.0	11.4
17-23	12	14.8	13.0	11.1	13.6	11.9
24-30	12.5	15.4	13.5	11.6	14.2	12.4
Gallons monthly cum.	630.0	777.8	680.4	583.7	713.4	623.9
Jul 1-7	13	16.0	14.0	12.0	14.7	12.9
8-14	13	16.0	14.0	12.0	14.7	12.9
15-21	12.5	15.4	13.5	11.6	14.2	12.4
22-28	12.5	15.4	13.5	11.6	14.2	12.4
29-4	12.5	15.4	13.5	11.6	14.2	12.4
Gallons monthly cum.	1074.5	1326.5	1160.4	995.5	1216.7	1064.0
Aug 5-11	10.5	13.0	11.3	9.7	11.9	10.4
12-18	10.5	13.0	11.3	9.7	11.9	10.4
19-25	9	11.1	9.7	8.3	10.2	8.9
26-1	8	9.9	8.6	7.4	9.1	7.9
Gallons monthly cum.	1340.5	1654.9	1447.7	1241.9	1517.9	1327.5
Sep 2-8	6.5	8.0	7.0	6.0	7.4	6.4
9-15	5.2	6.4	5.6	4.8	5.9	5.1
16-22	4.5	5.6	4.9	4.2	5.1	4.5
23-29	4.5	5.6	4.9	4.2	5.1	4.5
30-6	3	3.7	3.2	2.8	3.4	3.0
Gallons monthly cum.	1506.4	1859.8	1626.8	1395.6	1705.7	1491.7
Oct 7-20	1.5	1.9	1.6	1.4	1.7	1.5
21-3	1.5	1.9	1.6	1.4	1.7	1.5
Gallons monthly cum.	1548.4	1911.6	1672.2	1434.5	1753.3	1533.3
Nov 4-30	1.2	1.5	1.3	1.1	1.4	1.2
Gallons total for year	1582.0	1953.1	1708.5	1465.6	1791.3	1566.6
Acre inches applied	26.45	32.65	32.65	32.65	32.65	32.65

DRIP IRRIGATION SCHEDULING--GALLONS/VINE/---WEEK

THIS TABLE IS BASED UPON ET USE PROJECTED ON A DAILY BASIS

Gallons per week column is the actual water needed based upon evapotranspiration for grapes. The season total will be 26.8 inches of water per acre. Under deficit irrigation the ET will have to be decreased by the deficit then increased by the irrigation efficiency. i.e. 26.8ac in /ac times .8 ET(deficit) = 21.44 ac in/ ac.; 21.44 ac in/ac +.81(drip irrigation efficiency) = 26.5 acre inches per acre. 26.5 acre inches per acre needs to be applied in order to irrigate @.8ET rather than 1.0ET

Water application for grapevines under drip irrigation in gallons per vine per day .
*** = Columns based upon irrigation efficiency of 81% under drip irrigation**

DATE	454 vines per acre (8'x12') Gallons per week ET	454 vines per acre (8'x12') gal/week @ 81% Eff.*	519 vines * per acre 7'x12'	605 vines* per acre 6'x12'	495 vines* per acre 8'x11'	566 vines* per acre 7'x11
Apr 1-7	3.5	4.3	3.8	3.2	4.0	3.5
8-14	6.3	7.8	6.8	5.8	7.1	6.2
15-21	8.4	10.4	9.1	7.8	9.5	8.3
22-28	9.1	11.2	9.8	8.4	10.3	9.0
29-5	11.9	14.7	12.9	11.0	13.5	11.8
Gallons monthly cum.	39.2	48.4	42.3	36.3	44.4	38.8
May 6-12	21	25.9	22.7	19.5	23.8	20.8
13-19	30.1	37.2	32.5	27.9	34.1	29.8
20-26	42	51.9	45.4	38.9	47.6	41.6
27-2	51.8	64.0	55.9	48.0	58.7	51.3
Gallons monthly cum.	184.1	227.3	198.8	170.6	208.5	182.3
Jun 3-9	60.9	75.2	65.8	56.4	69.0	60.3
10-16	68.6	84.7	74.1	63.6	77.7	67.9
17-23	75.6	93.3	81.6	70.0	85.6	74.9
24-30	81.2	100.2	87.7	75.2	91.9	80.4
Gallons monthly cum.	470.4	580.7	508.0	435.8	532.6	465.8
Jul 1-7	85.4	105.4	92.2	79.1	96.7	84.6
8-14	88.9	109.8	96.0	82.4	100.7	88.0
15-21	88.9	109.8	96.0	82.4	100.7	88.0
22-28	87.5	108.0	94.5	81.1	99.1	86.6
29-4	85.4	105.4	92.2	79.1	96.7	84.6
Gallons monthly cum.	906.5	1119.1	979.0	839.8	1026.4	897.7
Aug 5-11	81.9	101.1	88.4	75.9	92.7	81.1
12-18	77.7	95.9	83.9	72.0	88.0	76.9
19-25	74.2	91.6	80.1	68.7	84.0	73.5
26-1	70.7	87.3	76.4	65.5	80.1	70.0
Gallons monthly cum.	1211.0	1495.1	1307.8	1121.9	1371.2	1199.2
Sep 2-8	66.5	82.1	71.8	61.6	75.3	65.9
9-15	61.6	76.0	66.5	57.1	69.8	61.0
16-22	53.9	66.5	58.2	49.9	61.0	53.4
23-29	44.8	55.3	48.4	41.5	50.7	44.4
30-6	37.8	46.7	40.8	35.0	42.8	37.4
Gallons monthly cum.	1475.6	1821.7	1593.6	1367.0	1670.8	1461.2
Oct 7-20	56	69.1	60.5	51.9	63.4	55.5
21-3	39.2	48.4	42.3	36.3	44.4	38.8
Gallons monthly cum.	1570.8	1939.3	1696.4	1455.2	1778.6	1555.5
Nov 4-30	32.4	40.0	35.0	30.0	36.7	32.1
Gallons total for year	1603.2	1979.3	1731.4	1485.3	1815.3	1587.6
Acre inches applied	26.80	33.09	33.09	33.09	33.09	33.09

FURROW IRRIGATION SCHEDULING--ACRE INCHES/ACRE/---WEEK

Water application for grapevines under furrow irrigation in acre inches per acre per day .
*** = Columns based upon irrigation efficiency of 72% under furrow irrigation**

DATE	454 vines per acre (8'x12') Gallons per week ET	acre inches/week @ 72% Eff.*	Cumulative every other week irrigation 72% Eff.	acre inches every other week @ 72% Eff
Apr 1-7	3.5	0.08		
8-14	6.3	0.15	0.2	0.23
15-21	8.4	0.20		
22-28	9.1	0.21	0.6	0.41
29-5	11.9	0.28		
Inches monthly cum.	39.2	0.91		
May 6-12	21	0.49	1.4	0.76
13-19	30.1	0.70		
20-26	42	0.98	3.1	1.67
27-2	51.8	1.20		
Inches monthly cum.	184.1	4.3		
Jun 3-9	60.9	1.41	5.7	2.62
10-16	68.6	1.59		
17-23	75.6	1.76	9.0	3.35
24-30	81.2	1.89		
Inches monthly cum.	470.4	10.9		
Jul 1-7	85.4	1.98	12.9	3.87
8-14	88.9	2.06		
15-21	88.9	2.06	17.0	4.13
22-28	87.5	2.03		
29-4	85.4	1.98	21.1	4.01
Inches monthly cum.	906.5	21.1		
Aug 5-11	81.9	1.90		
12-18	77.7	1.80	24.8	3.71
19-25	74.2	1.72		
26-1	70.7	1.64	28.1	3.36
Inches monthly cum.	1211.0	28.1		
Sep 2-8	66.5	1.54		
9-15	61.6	1.43	31.1	2.97
16-22	53.9	1.25		
23-29	44.8	1.04	33.4	2.29
30-6	37.8	0.88		
Inches monthly cum.	1475.6	34.3		
Oct 7-20	56	1.30	35.6	2.18
21-3	39.2	0.91		
Inches monthly cum.	1570.8	36.5		
Nov 4-30	32.4	0.75	37.2	1.66
Total yearly cum.	1603.2	37.2	37.2	37.23
Acre inches applied	26.8	37.2	37.2	37.23

IRRIGATION IN A DROUGHT YEAR FOR DECIDUOUS ORCHARDS

We are facing one more drought year in California. This is the worst year because we are facing a very limited amount of water from the water districts. To maximize it, we must consider plant growth and development, the soil characteristics and the amount and quality of the water.

PLANT GROWTH AND DEVELOPMENT

The stages in plant growth and development that will be discussed are root growth, bloom fruit set, shoot growth, fruit growth and development and flower bud differentiation. All these stages are sensitive to water deprivation. In a normal water year, it's not advisable to deprive the trees at any of these stages.

Root Growth. It begins the last week in December and continues to grow at a very rapid rate until bloom, then as fruit set begins and shoot growth starts, root growth begins to decline very rapidly. The rate of root growth declines even more during fruit growth and development.

Soil moisture is required for root growth and development. Without root growth, we can severely limit the growth of the tree in the spring. An irrigation of at least two inches is required before growth begins (December-January).

Bloom-Fruit Set-Shoot Growth. These growth processes take place early in the season. When the demand for water is very low due to lower temperatures which create a low evaporative demand. Therefore, deficit irrigation or water deprivation is not going to save much water. However, it may limit present and future crops.

Deficit irrigation early in the season will limit foliage development, which in turn will limit the photosynthetic capability of the tree. Carbohydrates are a product of photosynthesis which are necessary for fruit growth and development as well as for flower bud differentiation.

Fruit growth and Development. Water deprivation at this stage will decrease fruit or nut size. If fruit size is a must, water deficit should be avoided for all fruits. Water has a significant role late in the development curve for both fruits and nuts. Water is the driving force for all volume increase. It also provides the turgor pressure for hullsplit in almonds. In fact, it can be said that 11 acre inches of water are needed for hullsplit.

Flower Bud Differentiation. This stage occurs in August-September depending on the fruit tree species. In some cases, it can be at the end of harvest as it is in the case of almonds. This period is very sensitive to water stress. If water deprivation takes place, significant yield losses will occur the following year. Therefore, it is important to maintain some foliage on the trees until mid-fall.

STRATEGIES FOR SPECIFIC FRUIT AND TREE SPECIES

The following is an adaptation from Dave Goldhamer's "Strategies for Specific Fruit and Nut Tree Species."

Peach, Nectarine, Plums. Early season varieties should receive full irrigation through harvest. Postharvest irrigations can be reduced except during bud differentiations (usually mid- to late August to prevent fruit "doubling." Late varieties can be stressed during Stage 2 of fruit growth (about 4 weeks after fruit set and when pit hardening occurs through the start of rapid fruit growth in Stage 3). Late varieties can be stressed postharvest without any major problems.

Apple and Pears. They appear to be tolerant of water stress until the fruit is 1/3 to 1/2 grown, then full irrigations are needed for full fruit size. Fruit sunburn is a potential problem and there is no whitewash that can prevent this type of damage.

Apricots. All of our apricot varieties are early and they require full irrigations for good size. It is important to maintain good soil moisture during flower bud differentiation during the summer. Apricots can be severely pruned by removing 70-80% of the current year's growth in early July. This will reduce water demand by the tree.

Walnut and Pecan. For hedgerow plantings, apply some water throughout the season with the exception of the final two to three weeks in the fall. The percentage of normally applied amounts depend on the limitation of water supplies. For example, with about 20 acre inch/acre, irrigate at about 50% of normal rates with 10 acre inches/acre, apply about 25% of normal. Conventional density plantings suffered an 80% yield reduction in the year following a simulated drought when a total of 16 acre inches/acre were applied, mostly during the early part of the season (mid-March through late May) followed by a progressive cutback through harvest. Spreading out application amounts over the season as with hedgerow plantings appear to be a better strategy. For heat sensitive cultivars, irrigation at near normal levels in the two-week period prior to harvest may reduce sunburn.

Almonds. Fruit irrigation early in the season is important for good fruitwood growth necessary to insure long-term tree productivity. Between mid-June and harvest (about a two-month period) for early and mid-season harvest varieties, irrigation can be severely curtailed. Late harvest varieties can also tolerate two months of water deprivation prior to harvest. While kernel weight is reduced by only about 10%, hullsplit is drastically lowered. Resuming full irrigation two weeks before harvest can improve hullsplitting. Postharvest water management can be extremely important for the following year's crop. Recent research on shallow, drip irrigated soils showed that postharvest water deprivation lowered fruit set, and to a lesser extent, bloom. Growers should reserve at least 3 to 4 acre inches/acre (of the normal 8 inches) for postharvest water application. Irrigation should begin as soon as possible after harvest. A good indicator of inadequate postharvest water is whether the tree starts to prematurely defoliate. Preharvest defoliation followed by postharvest irrigation can lead to refoliation (a new leaf canopy). This action benefits the tree (as opposed to the conventional wisdom) in that it improves tree water status during a critical period of flower bud morphogenesis.

ADDITIONAL CONSIDERATIONS

Young Trees. They should have full irrigation. Their water demand is low. The water savings from a water deficit irrigation may reduce tree development and future production. Irrigate as close as possible to the root zone. Don't irrigate the middle.

Pruning. Drastic pruning, such as "Dehorning"--cutting all scaffolds at waist level, may help a tree to survive a drought year, but the production will suffer for many years to come.

Bees. If there is no water available, bees are not necessary in an almond orchard. By eliminating the crop, one can save up to 11 acre inches/acre of water which is required for hullsplit.

Fertilization. With a limited supply of water, there is no need for 200 to 300 units of nitrogen. After fruit set, the grower needs to estimate his crop. A 1,000 meat pound crop only needs 100 units of nitrogen. Excess nitrogen fertilization can create excessive vegetative growth which can't be supported with a limited water supply.

Pruning. Deficit irrigation will decrease the amount of vegetative shoot growth. Therefore, pruning can be eliminated this coming winter.

DROUGHT STRATEGIES

The following tables represent drought strategies for different deciduous fruit and nut crops in Kern County.

Table 1. Normal Water Use by Almond Trees and Their Critical Developmental Stage

Almond Stage	Dates	ET(in)	Totals
Bloom	Feb 15-Mar 31	1.03	
Fruit Set	April 1-15	1.32	2.35
Nut Growth and	April 16-30	1.73	
Development Plus	May 1-15	2.20	
Shoot Growth	May 16-31	2.86	6.79
Dry Weight and Some	June 1-15	3.14	
Shoot Growth	June 16-30	3.39	6.53
Hull Split and	July 1-15	3.64	
Foliage Maintenance	July 16-31	3.78	7.42
Harvest--The Beginning of	Aug 1-15	3.24	
Flower Bud Differentiation	Aug 16-31	3.08	6.32
Flower Bud	Sep 1-15	2.54	
Differentiation	Sep 16-30	2.10	
Foliage Maintenance	Oct 1-15	1.58	
	Oct 16-31	1.19	
	Nov 1-15	0.71	8.12
*Dormant - Root Growth	Dec 16-31		
	Jan 1-15		37.53

*At this time 3.00 inches should be applied to fill the soil profile

Table 2. Drought Strategies, Plan I, Where Preharvest Irrigation is Eliminated, but Full Irrigations are Applied Postharvest

Almond Stage	Dates	ET(in)	Totals
Bloom	Feb 15-Mar 31	1.03	
Fruit Set	April 1-15	1.32	2.35
Nut Growth and	April 16-30	1.73	
Development Plus	May 1-15	2.20	
Shoot Growth	May 16-31	2.86	6.79
Dry Weight and Some	June 1-15	3.14	
Shoot Growth	June 16-30	3.39	6.53
Hull Split and	July 1-15		
Foliage Maintenance	July 16-31		
Harvest--The Beginning of	Aug 1-15		
Flower Bud Differentiation	Aug 16-31		
Flower Bud Differentiation	Sep 1-15	2.54	
	Sep 16-30	2.10	
Foliage Maintenance	Oct 1-15		
	Oct 16-31		
	Nov 1-15		4.64
*Dormant-Root Growth	Dec 16-31		
	Jan 1-15		20.31

*Dormant at this time 2.00 inches should be applied to fill soil profile

Table 3. Drought Strategies, Plan II Where Preharvest Irrigation is Eliminated and 50% of Normal ET is Applied From May to Postharvest Irrigation

Almond Stage	Dates	ET(in)	Totals
Bloom	Feb 15-Mar 31	1.03	
Fruit Set and Shoot Growth	Apr 1-15	1.32	2.35
Nut Growth and Development	Apr 16-30	1.73	
Plus shoot Growth	May 1-15	1.10*	
	May 16-31	1.43*	4.26
Dry Weight and Some	June 1-15	1.57*	
Shoot Growth	June 16-30	1.69*	3.26
Hull split and Foliage	July 1-15		
Maintenance	July 16-31		
Harvest--The Beginning of	Aug 1-15		
Flower Bud Differentiation	Aug 16-31		
Flower Bud Differentiation	Sep 1-15	1.27*	
	Sep 16-30	1.05*	2.32
Foliage Maintenance	Oct 1-15		
	Oct 16-31		
	Nov 1-15		
*Dormant-Root Growth	Dec 16-31		
			12.19

*50% of ET
**Dormant at this time 2.00 inches should be applied

Table 4. Drought Strategy for Early and Late Peach, Nectarines and Plum Varieties

	Peach - Nectarine - Plum	
Date	Early ET(in)	Late ET(in)
March 16-31	1.03	1.03
April 1-15	1.32	1.32
April 16-30	1.73	1.73
May 1-15	2.20	2.20
May 16-31	2.86	2.86
June 1-15	1.57*	3.14
June 16-30	1.70*	3.39
July 1-15	1.82*	3.64
July 16-31	1.89*	3.78
Aug 1-15	3.24	3.24
Aug 16-31	3.08	3.08
Sep 1-15	0.64**	2.54
Sep 16-30	0.53**	0.53**
Oct 1-15	0.40**	0.40**
Oct 16-31	0.35**	0.35**
Nov 1-15	.--	.--
Total	24.36	33.95

*ET was reduced to 50% of normal
**ET was reduced to 25% of normal

Table 5. Drought Strategy for Early Apricots

Date	ET(in)
March 16-31	1.03
April 1-15	1.32
April 16-30	1.73
May 1-15	2.20
May 16-31	2.86
June 1-15	3.14
June 15-30	1.70*
July 1-15	0.91*
July 16-31	0.94*
Aug 1-15	3.24
Aug 16-31	3.08
Sep 1-15	0.89**
Sep 16-31	0.53**
Oct 1-15	0.40**
Oct 16-31	0.34**
Nov 1-15	.--
Total	24.31

*ET was reduced to 50% of normal
**ET was reduced to 25% of normal

Table 6. Drought Strategy for Walnuts and Pecans

Date	ET(in)
March 1-16	0.23
April 1-15	1.27
April 16-30	1.84
May 1-15	2.49
May 16-31	3.10
June 1-15	3.48
June 16-30	1.90
July 1-15	2.31*
July 16-31	2.72*
Aug 1-15	2.50*
Aug 16-31	1.88*
Sep 1-15	1.54*
Sep 16-30	0.58**
Oct 1-15	0.40**
Oct 16-31	0.23**
Nov 1-15	-.--
Total	26.47

*ET was reduced to 50% of normal
**ET was reduced to 25% of normal

IRRIGATION MANAGEMENT

The understanding of the orchard soil is basic for a good irrigation program. In order to determine how much water to apply and how frequently it should be applied, we need to know the soil depth and its water holding capacities. We must also be aware of the possible water penetration problems.

Fruit trees can root very deep, depending on soil depth. It is common to find root ten feet deep. However, sixty percent of the roots are found in the top three feet of soil. Therefore, it is not advisable to irrigate with more water than is needed to wet the top three feet of soil.

The water holding capacity of the soil is determined by its soil texture. The following table shows the estimated available water per foot of soil for soils of various textures.

Soil Type	Available Water (in water/ft soil)
Sand	0.5-0.7
Fine Sand	0.7-0.9
Loamy Sand	0.7-1.1
Sandy Loam	0.8-1.4
Fine Sandy Loam	0.9-1.6
Loam	1.0-1.8
Silt Loam	1.2-1.8
Clay Loam	1.3-2.1
Silty Clay Loam	1.4-2.5

Any given soil type can only hold a certain amount of water. Water that is applied in excess to its water holding capacity will be lost to percolation.

Water penetration problems should be corrected by any means. In some soils, gypsum application may be required and/or cover crops may be necessary to increase the soil water intake. The water intake rate has increased in some soils after they have been ripped by the grower.

Water Quality.
We are using water with a high salt content to irrigate almond trees. This is highly undesirable since almonds are very sensitive to sodium, chloride and boron. When high salt water is the only irrigation water available, deficit irrigation is not recommended. In fact, excess water should be applied to maintain a salt balance. This is to say, enough water should be applied so that the salt concentration in the soil will not exceed the salt concentration of the water.

HOW TO USE WATER IN A DROUGHT YEAR

The basic idea of irrigation is to apply water to the soil occupied by roots for tree growth and production. Well prepared land permits efficient irrigation and can save water and labor. In a normal water year, growers tend to use water more abundantly to obtain maximum production. This year because of the drought, some growers may only have sufficient supplies to maintain live trees.

It is now evident that during this season, irrigation strategies must be planned in most of the irrigated crops in Kern County. In some cases, the water will only be used for survival of the trees or vines. Kern County has 750,000 acres of irrigated land and about 250,000 are permanent crops. Where the water wells are available, more water will be pumped from the ground and some normal horticultural practices will be changed in order to cope with water shortage. Deficit irrigation should be based on scientific knowledge of the tree growth and fruit

production. Conversion of irrigation delivery systems with controlled deficit scheduling may be required. Water always has been considered the principle of life and a minimum amount of water is essential for the tree to grow. Water is a component of plant tissue, avenue for nutrient uptake from the roots and transport within the plant and is an important component in all the physiological and photosynthesis processes. With some crops, the effects of one year's water deficit results in growth and production problems for several seasons. We know that tree water needs are more critical in certain growth stages than others; although this is more appropriate with deciduous fruits and nuts where three stages of growth are well defined. Generally, the amount of water required is related to the climate, the size of the plant or tree, and the extent of vegetative growth.

The trees should not be stressed during pre-bloom, flowering and fruit set. Provide moisture during this period and delay stress for late summer and fall. The first indication of stress is when the leaves wilt on young shoots. In this stage, the tree growth ceases, young leaves show severe curling and old leaves begin to drop. At this point, fruit growth stops and even if the water is available later, harvest is delayed, and fruit size is smaller.

Citrus

Most of the root systems are found in the top 1½-2 foot depth and if the top foot indicates dryness, some water is needed. Work done by the University of California, Riverside, indicates that a controlled water deficit causes tree growth to stop, without causing tree injuries. The following table shows the affect of irrigation in Riverside County on citrus yield reported in the Citrus Industry Vol. III.

EFFECT OF IRRIGATION ON CITRUS YIELD

Water Application Range (Inches per Year)	Yield Average (Boxes per Tree)
32-36	4.36
28-32	5.15
24-28	5.21
20-24	4.73
16-20	4.31
12-16	3.32

Obviously, low or very low amounts of water are associated with lesser yields. The increasing popularity of low volume mini-sprinkler on citrus enables a grower to irrigate citrus with a controlled deficit irrigation regime when water is in short supply. The interval or the frequency is also an important consideration. The University reported that the yields are normally higher when trees are irrigated at shorter intervals.

Drought Strategies

Survival requirements are not precisely known but in general, slight to moderate tree wilt will not impede tree survival. On lemons, withholding water for two months during the summer causing trees to reach the permanent wilt stage followed by irrigating, results in resumed growth without any damage.

Heavy pruning, topping or topping and hedging during a drought should be postponed. The heavy new growth flush after the pruning causes high transpiration rate. In some cases, moisture stress will reduce fruit size, cause twig dieback and June drop, to the end of July. Lemons are the most appropriate to manage even under severe water stress and the recovery is rapid after the soil moisture becomes available. Reports on scale control indicate that in a year of severe water stress, the application of light oil spray alone or in combination of a pesticide reduces water transpiration during the hottest months from June to August. If daytime temperature is above 90°F, night spraying is recommended.

Changing from furrow irrigation to low volume type helps control runoff and deep percolation, and the placement of the emitters under the tree canopy, minimizes evaporation losses. In a normal irrigation year, about three acre feet of water is applied for citrus from March to early November and the peak demand is from May to August. Irrigation of alternate rows is also useful during limited water supply. The attached table estimates the daily water requirement in gallons for large, medium and young citrus trees. The figures are based on the average evapotranspiration (ET) measurement in the Southern San Joaquin Valley.

Estimated (Daily) Water Requirement for Citrus–Central Valley									
Irrigation Season (Time of Year)	Tree Size Large Mature Tree 16'-18' shadow	Deficit 1/3	2/3	Medium Mature Tree 11'-13' shadow	Deficit 1/3	2/3	Young Tree 8'-9' shadow	Deficit 1/3	2/3
April									
1st week	30	20	7	15	10	5	7 1/2	5	2 1/2
2nd week	33	22	7	17	11	6	7 1/2	5	2 1/2
3rd week	37	25	8	18	12	6	7 1/2	5	2 1/2
4th week	40	27	9	20	13	7	10	7	3
May									
1	44	29	10	22	15	7	10	7	3
2	46	31	10	23	15	8	10	7	3
3	48	32	11	24	16	8	12 1/2	8	4
4	50	33	11	25	17	8	12 1/2	8	4
June									
1	52	35	12	26	17	9	12 1/2	8	4
2	54	36	12	27	18	9	12 1/2	8	4
3	56	37	12	28	19	9	12 1/2	8	4
4	56	37	12	28	19	9	12 1/2	8	4
July									
1	58	39	13	29	19	10	12 1/2	8	4
2	58	39	13	29	19	10	12 1/2	8	4
3	60	40	13	30	20	10	15	10	5
4	60	40	13	30	20	10	15	10	5
Aug									
1	60	40	13	30	20	10	15	10	5
2	55	37	12	27	18	9	12 1/2	8	4
3	50	33	11	25	17	8	10	7	3
4	45	30	10	23	15	8	10	6	3
Sept									
1	40	27	9	20	13	7	10	6	3
2	38	25	8	19	13	6	10	6	3
3	35	23	8	17	11	6	7 1/2	5	2 1/2
4	30	20	7	15	10	5	7 1/2	5	2 1/2
Oct									
1	26	17	6	13	9	3	7 1/2	5	2 1/2
2	24	16	5	12	8	3	7 1/2	5	2 1/2
3	20	13	4	10	7	2	5	3	2
4	18	12	4	9	6	2	5	3	2

In some extreme cases, if the water is very limited, below 12" per acre, the growers must make a decision if it is worth while to save the crop. If the decision is made to save only the trees, the crop at bloom time or soon after can be partially or completely dropped by spraying NAA(napthaleneacetic acid), a growth regulator, registered on citrus for fruit thinning. The time and rate to accomplish good results are very important and the Farm Advisor should be contacted.

Using the table of estimated water requirements with a low volume system permits the following several strategies. The entire season may be a controlled deficit, however, crop reduction may extend into a second year. An alternative plan is to provide as much of the water requirement as possible for the first part of the growing season, up to June drop, and then allow more stress during the remainder of the year. Hopefully, water supply negotiations will obtain supplies for the later months.

CONTROLLED DEFICIT IRRIGATION IN PISTACHIO

Pistachio is considered drought tolerant and in several places in the world, still growing without irrigation. In these countries, the winter precipitation is generally higher than the Southern San Joaquin Valley. In our climate and soil condition, it is impossible to grow commercial pistachio without irrigation. In recent studies done by the University of California, it was found that pistachio could use up to 40" of water per acre.

Most of the other commercial fruits and nuts suffer drastically in growth and yields if they are subjected to high water stress, but the pistachio tree has the mechanism to tolerate a great amount of stress. A minimum amount of water must be supplied in a drought year and if this is done by taking into consideration the pistachio phenology, the adverse affects might be minimized.

PISTACHIO PHENOLOGY IN KERN COUNTY	
March	Growth initiation of previous year vegetative and infloresce buds
Early to Mid April	Bloom and Pollination (male flowers 7-10 days earlier)
Late April to May	Shoot elongation and flower bud differentiation
Late May to end June	Shell hardening
Late June	Seed Growing
Mid- to late July	Seed Filling
Mid- to late August	Shell Splitting
Late August	Hull Slipping from Shell
Early September	Hull Breakdown and Discoloration
Mid- to late September	Harvesting
The dates are based on when 50% of the tree growth and nuts are at that stage. A nut can be in two stages at the same time.	

If no water is applied during the season or small amounts are used indiscriminately, the growth, yield, and nut quality are drastically affected. The effects are proportional to the amount of water used. The controlled irrigation strategies are the practice of applying less water than normal during the season. During the growing season, certain stages of tree growth and nut development are more vulnerable to water stress than others and in a year of limited water availability, more than ever water should be applied based on the minimum requirement and at the most appropriate time.

Pistachio nuts like most of the other stone and nut crops are less sensitive to water during the shell hardening to seed growing stage (named Stage 2). During this stage, which normally occurs from mid-May to the end of June, the shell is sticking and attains full size. Research indicates that during this stage, if water is limited, there are limited or no adverse affects on pistachio growth and production. On the contrary, during the time the water is limited and from the time the tree breaks the bud dormancy, until mid-May (Stage 1), the tree has limitations in supplying carbohydrates for the important process of bloom, flowering, fruit set, shoot growth and flower bud differentiation for the next year's crop. Likewise from late June to the end of August (Stage 3) there is rapid seed growing and filling development and severe stress during August through harvest will decrease nut quality.

One of the big differences found on well watered and stressed trees is the percentage of split and unsplit nuts (stressed), smaller nut size, and lateral bearing shoot formation. The amount of blanking, where the embryo fails to develop, in both water regimes applications is not affected. It is also important to report that unlike other nut trees, mature pistachio trees, grown with very little water throughout the season do not drop the leaves. The pistachio tree, during the summer when temperature is high, is adjusting by controlling the stomata aperture to reduce transpiration rate.

After the harvesting, the tree can tolerate water stress without negative effects. Irrigation scheduling on when to irrigate and how much to apply are very important in a drought year. It is possible that by using controlled deficit irrigation during Stage 2 and postharvest, the minimum impact on the productivity can be accomplished.

In conclusion, it is important, if a limited amount of water is available, to use it before and soon after the bud break and shoot elongation and later in July and August to near harvest. Other irrigation strategies during the year include: irrigation at night to reduce evaporation and drift loss. Since, in Kern County, most of the pistachio orchards are irrigated by low pressure drip and micro-sprinkler systems, frequent applications of short duration are recommended. Good maintenance of water filtration and efficiency of low volume system is of primary importance.

FREEZE DAMAGE AND IRRIGATION STRATEGIES FOR OLIVES

Recently, Doctor George Martin, Professor of Pomology, University of California, Davis, wrote one article to emphasize olive freeze damage and the irrigation strategies in a drought year. The main points of his interesting and appropriate article are as follows:

Cold damage is a type of stress to a tree. Cold kills the conducting tissue that moves water and nutrients up and down the tree. With less water and nutrients available to the tree damage from cold is increased. All orchards must start the growing season with a moist root zone in the soil profile. Anything less than a moist root zone will add to the stress brought about by cold and olive knot damage.

Olive trees are notorious for their ability to recover from all kinds of damage. This ability to recover is why olive trees live for hundreds of years. Still, trees can be killed to the ground level from cold and subsequent poor irrigation. Given the proper care, olive trees will repair damage to the conducting tissue and this repair will take place most rapidly when trees are properly treated for olive knot and given timely irrigation.

Water shortage is going to occur in 1991. Water allotments are likely because of the drought. If you have a water allotment that is short of the normal requirement, make certain you start the growing season with a moist root zone. Why? Because the moment spring growth starts, the trees water requirements increase. When deficient soil moisture is coupled with a damaged conducting system in the tree, then even greater tree damage occurs. Further, the current dry spell means that a winter irrigation is necessary in all olive orchards in the Sacramento and San Joaquin Valleys. Irrigate now and again in March unless you have 6 to 10" of rain between now and April.

Remember, whether you have crop or not in 1991, tree repair must take place in order to have a crop in 1992. Tree repair will take place rapidly by reducing stress. By properly irrigating your olive trees in 1991, stress will be reduced and rapid tree repair will take place.

What should be done in 1991?
Olive growers should discuss 1991 orchard management strategies with their farm advisor. No single approach will work in all situations. Tree age, variety, extent of freeze damage and olive knot infection are factors that must be taken into account to decide your own management strategy. Finally, the amount of irrigation water allotted and when it will be available will guide the final management decision.

The six following broadly described orchard cases should be discussed with your farm advisor before making costly orchard management decisions for 1991:

A. **No freeze damage to trees, no buildup of olive knot and full water allotment.**

   Orchards that fit that description can be managed as usual. You are lucky!

B. **No Freeze damage, no buildup of olive knot and 50% of full water allotment.**

   Start the growing season with a wet soil profile, then apportion your remaining water to achieve size on the crop late in the season. Too much water shortage March through May will reduce the fruit population.

C. **No Freeze damage, no buildup of olive knot and 20% of full water allotment.**

   Start the growing season with a wet soil profile, then apply the remaining water near the end of the growing season. The 1991 crop will have

high value and fruit retention will depend on moisture from March to May. The remaining water will help attain minimum tree conditions and fruit sizing.

D. **Freeze damage, buildup of olive knot and full water allotment.**

Assess the extent of freeze damage, do not prune until June, do not add nitrogen until May, treat for olive knot and maintain soil moisture throughout the growing season (March-November).

E. **Freeze damage, buildup of olive knot and 50% water allotment.**

Now the decisions become very difficult. The less difficult part first, assess the freeze damage, treat for olive knot, do not prune until June and add no nitrogen until May. With only 50% water, when should it be applied? My guess is to start the growing season with a moist soil profile. Why? To speed repair of the tree. Freeze damaged trees with olive knot and lacking water will be slower to heal injured areas. Further, water stress from March to May will likely result in no fruit production. Previous research has shown that irrigated trees that are water stressed during March to May produce fewer flowers and the remaining flowers are only partially developed, and thus, will not become fruits. Still, my major argument involves tissue repair. All orchard practices for 1991 that reduce tree stress, will enhance recovery from freeze damage. Available moisture and a cool summer would be the best possible environment for tree recovery.

F. **Freeze damage, buildup of olive knot and 20% water allotment.**

This situation is the worst case I care to think about. Assess freeze damage, treat for olive knot, do not prune until June and do not add nitrogen until May (if a heavy soil, do not add nitrogen in 1991). To ensure tissue repair, irrigate before growth starts and consider crop removal at bloom with 200ppm NAA and apply the remaining water later in the growing season in response to the condition and symptoms of stress.

DROUGHT STRATEGIES FOR VEGETABLE CROPS

Vegetables in Kern County vary considerably in the amount of water required to produce a crop. Much depends on the time of year they are planted, length of the growing season, moisture holding capacity of the soil, and the kind of irrigation system used. In general, vegetable crops do not tolerate a great deal of water stress and must be kept moist at all times. This allows little room for adjusting the irrigation schedules growers are now using.

However, there are certain strategies that growers can use to stretch their irrigation water further:

- Make certain to pre-irrigate the field before planting or at least start the season with good soil moisture in the entire rooting zone of that crop. This provides a readily available supply of water, allowing the roots to develop deeply and take full advantage of deep soil moisture.

- With sprinkler irrigation, consider running shorter irrigation sets to minimize water lost to deep percolation. Many shallow rooted vegetables such as onions and garlic don't need long irrigation sets to replenish the water used by the crop.

- Use tail-water return flow systems when possible. Recovery of runoff water will increase your efficiency of irrigation.

- For furrow irrigation, with crops such as tomatoes and melons, the uniformity of irrigation can be improved by shortening the irrigation run lengths and increasing the furrow inflow rate.

- Match water applications closely to crop needs. Apply the amount of water to refill the soil just to the depth of rooting. Evapotranspiration data can be used to estimate the rate of water use by any particular crop. Also, the soil capacity for water storage in the root zone can be estimated. Then a simplified budget procedure can be followed to determine approximate time of irrigation and amount to be applied without wasting water.

The following table, developed by the California State Department of Water Resources provides

estimates of water usage for several vegetable crops grown in Kern County. It can be used as a guide for irrigation and estimating peak demands of water usage by crop.

NORMAL CROP WATER USE[1/]
SAN JOAQUIN VALLEY VEGETABLE CROPS
EVAPOTRANSPIRATION (CONSUMPTIVE USE) TABLE

Estimated Monthly Evapotranspiration (inches)[3/]

Crop & Growing Period [2/]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Tomatoes													
3/1 - 8/15			0.8	1.3	4.2	8.6	8.5	2.9					26.3
4/1 - 8/31				1.2	2.6	7.1	9.2	6.3					26.4
5/1 - 9/15					1.8	4.7	8.9	7.3	2.3				25.0
Potatoes													
1/1 - 5/15	0.5	0.9	3.2	5.7	2.6								12.9
2/1 - 6/15		0.8	2.7	5.7	6.6	1.8							17.6
3/1 - 6/30			2.0	4.9	7.8	5.0							19.7
Melons													
2/15 - 6/30		0.1	0.9	4.0	7.2	4.2							16.4
3/15 - 7/31			0.3	1.4	6.0	8.3	4.5						20.5
4/15 - 8/15				0.5	2.2	7.4	8.0	0.7					18.8
Onions													
9/15 - 5/31	1.2	1.7	3.7	5.1	5.4				0.5	0.9	0.9	0.8	20.2
11/15 - 7/31	0.9	1.7	3.7	5.4	7.5	8.2	6.5				0.1	0.3	34.3
3/1 - 9/30			1.0	2.3	6.3	8.6	8.4	5.4					32.0

1/ Evapotranspiration (Consumptive Use) for each crop is a measure of the moisture used by the by the crop and evaporated from surrounding soil surfaces. It does not include water lost through deep percolation or runoff from the field, which must be added in to calculate the total irrigation requirement.

2. Planting to harvest.

3. Other crops which have similar growing seasons, ground cover, and growth characteristics would have similar ET requirements.

PUBLICATIONS AVAILABLE AT THE UC COOPERATIVE EXTENSION OFFICE

1031 S. Mt. Vernon Avenue
Bakersfield, CA 93307
Telephone: 805-861-8631

The following are priced publications and must be picked up at our local office. Many other technology publications are available. **SORRY--WE CANNOT MAIL PRICED PUBLICATIONS.**

21414	How Farmers Irrigate in California. 1986.	$ .50
21453	Drought Irrigation Strategies for Deciduous Orchards	1.00
21466	Drought Tips for Vegetable and Field Crop Production	2.00
21199	Basic Irrigation Scheduling	Free
	Water Management in a Dry Year	(Kern County publication in process)

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