COOPERATIVE EXTENSION UNIVERSITY OF CALIFORNIA

SOIL and WATER

Spring 1977 - No. 32

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Edited by George A. Pearson, Extension Soils Specialist, University of California, Davis.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture. George B. Alcorn, Director, Cooperative Extension, University of California.

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Cover: Folsom Dam, April 13, 1977 with 291,100 A-ft. Photo courtesy of U. C. Extension Service, W. E. Wildman, pilot and Jack K. Clark, photographer.

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Dr. Frank J. Veihmeyer, a long-time U C D irrigation scientist, died on April 7, 1977 at the age of 90. Dr. Veihmeyer joined the staff of the University of California at Davis as an Assistant Professor of Irrigation in 1918. Before retirement in 1954 he achieved the rank of Professor and served for 18 years as Chairman of the Irrigation Department now part of Land, Air and Water Resources.

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Home Owners Can Make Softened Water Suitable for Watering Plants

Many homeowners in drought-stricken areas of California are finding it necessary to use inferior-quality household wastewater to keep their plants alive. Normally, use of softened water for watering plants is discouraged because of its increased sodium content. Long-term use of such water can cause soils to become much less permeable and can cause the leaves of sodium-sensitive plants to burn.

Homeowners, however, can treat their softened water themselves and eliminate these hazards. The treatment involves simply adding calcium to the water to restore the calcium that was present before softening removed it. This can nullify the effect of the sodium added in the softening process.

Gypsum (calcium sulfate), available at most nurseries, is a cheap and safe material to use for this purpose. Its safety feature is its relatively low solubility, yet enough gypsum can be dissolved to treat softened waters effectively. One half level teaspoon per gallon of softened water, or one tablespoon per six gallons, should be sufficient in most cases to supply the necessary calcium and change softened water to an unsoftened state, thereby eliminating the risk of its use.

A convenient alternative to measuring out the gypsum for each batch of water treated, would be to keep some gypsum always in the bottom of the water container. Stirring it will dissolve the necessary gypsum and the excess can be allowed to settle for the treatment of the next batch of water.

-- Roy L. Branson

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Summary of Reservoir Conditions

To keep you up to date the following table presents a summary of the water situation as shown by (1) storage reservoir, (2) total capacity, (3) % of capacity as of late March or early April and (4) % of capacity on same date last year.

Contents (Acre-Feet)

RESERVOIR	Capacity (A.F.)	Date	PRESENT	% Cap.	Same Time Last Year	% Cap.
Clair Engle Lake	2,448,000	4/3	1,053,400	43	1,852,000	76
Shasta Lake	4,552,000	4/3	1,449,600	32	3,145,300	69
Black Butte Res.	160,000	4/3	13,900	9	32,600	20
Folsom Lake	1,010,300	4/3	285,600	28	632,000	63
Millerton Lake	520,500	4/3	226,500	43	358,000	69
San Luis Res.	2,041,000	4/3	1,207,400	59	1,907,400	93
Clear Lake Res.	526,800	2/26	224,100	42	301,000	57
East Park Res.	50,900	3/25	8,740	17	14,340	28
Stony Gorge Res.	50,000	3/25	11,030	22	31,160	62
Lake Oroville	3,538,000	4/3	1,566,500	44	2,853,000	81
Lake Berryessa	1,602,300	3/31	982,200	61	1,311,000	82
New Hogan Lake	323,800	4/3	56,100	17	136,700	42
Pine Flat Lake	1,000,000	4/3	293,200	29	516,200	52
Lake Cachuma	204,900	3/31	134,800	66	172,400	84

From: U. S. Department of the Interior, Bureau of Reclamation. Central Valley Project - Calif. - Mid-Pacific Region. Daily Report of Operations - Monday, April 4, 1977.

-- Robert S. Ayers

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New Drainage and Groundwater Specialist

Dr. Blaine R. Hanson, the new Groundwater and Drainage Specialist, is originally from Las Cruces, New Mexico. He received a B. S. degree in Civil Engineering from New Mexico State University in 1969 and then obtained a M. S. degree in Civil Engineering from Utah State University in 1971. After four years in the Air Force, Dr. Hanson then attended Colorado State University where he completed the requirements for a Ph.D degree in Agricultural Engineering (specializing in groundwater and drainage) in January, 1977.

His areas of special interest are drainage, flow in porous media, pump design, well hydraulics, and groundwater hydrology.

Dr. Hanson's office is located in Veihmeyer Hall, Room 231 and his phone number is (916) 752-1130.

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Entrapped Air in an Unconfined Aquifer

Laboratory research conducted in the past has indicated that when a soil or aquifer material is saturated at atmospheric pressure with water (such as occurs due to infiltration or rising water table), air may become trapped in the void spaces of the material. This entrapped air can significantly reduce the hydraulic conductivity and specific yield of the material thus affecting the flow of water through it. This past research has revealed that as much as 38 percent of the void space of a saturatec material may be occupied by entrapped air and that this air may reduce the hydraulic conductivity to 25 percent of the maximum value.

A recent field study has indicated that significant amounts of entrapped air may exist in an unconfined aquifer due to a rising water table. Measurements made on samples of undisturbed aquifer material revealed that the entrapped air content at the water table of a recently risen water table (within one week) may be 20-25 percent of the void volume. However, it was found that the air content decreased to about 12-15 percent within one to two weeks after the material was saturated. Air contents at depths where the material had been saturated for at least one month were about 4-5 percent of the void volume.

In conjunction with this field study, a laboratory study on the effect of the entrapped air contents measured in the field on the hydraulic conductivity was conducted. It was found that entrapped air contents of 20-25 percent may reduce the conductivity of the material by 30-40 percent of the maximum. The conductivity increased as the entrapped air percentages decreased until at 4% entrapped air the hydraulic conductivity was approximately 80% of maximum.

-- Blaine R. Hanson

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Excerpts of Western Fresno County Conditions

The drought is here -- for real -- but not to stay -- we hope. Les Stromberg advises us that the Federal San Luis Project in Western Fresno County (approximately 600,000 acres) has not dried up and blown away -- not yet --. Most of the acreage is scheduled to receive 6.34 inches for the calendar year of 1977. That is, all but 180,000 acres that will receive 4.08 inches and another 17,000 acres that will receive none at all. Water requirements for optimum yields on some common crops in that area are: alfalfa, 50"; almonds, 36"; canning tomatoes, 32"; cotton, 36"; melons, 24"; sugar beets, 50" and vines, 24".

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Summary of Central Valley Water Conditions

Records are falling. The mountain snowpack has the lowest water content of record. Most Central Valley streams will produce record low water runoff this year, and reservoirs will have minimum carryover storage for 1978. With the precipitation season nearly over, this second and more severe drought year is creating many drought related problems throughout the State.

Factors affecting water supply conditions remained below average during March. Precipitation in the Central Valley drainage area was 35 percent of the March average, varying from 45 percent in the Pit River Basin to 25 percent in the Kaweah River Basin. An exception was precipitation of about 120 percent in a small area around Bakersfield. Water year precipitation over the Central Valley drainage averaged 30 percent of normal for the six-month period, October 1 through March 31.

April 1 snow surveys showed that 15 out of 17 major river basins in the Central Valley have the lowest snow water storage recorded in the last 47 years, which for the Stanislaus through the Kern River Basins were set only last year. Snow sensor data indicates that water content accumulation for the season has peaked, and melt has started at all elevations.

Runoff during March was only 18 percent of average in the Central Valley, ranging from a low of 5 percent for the Cosumnes River to a high of 58 percent for the Pit. Runoff for the water year October through March continued to set record low flows for all streams in the Central Valley except the Kings and Kern Rivers. Central Valley runoff for the six-month period was 24 percent of normal, which represented a deficit of 9,500,000 acre-feet (11.7×10^9 cubic metres). Forecasts of snowmelt runoff indicate that volumes for the April through July period will be the lowest of record in all basins from the Yuba through the Kern Rivers, except for the Stanislaus and Tule Rivers.

Reservoir storage in the Central Valley on April 1 was 9,700,000 acre-feet (12×10^9 cubic metres) below normal. Runoff in the Central Valley for the 1977 water year is forecasted at about 6,600,000 acre-feet (8.1×10^9 cubic metres), or 25 percent of average.

-- Robert S. Ayers

SUMMARY OF WATER CONDITIONS IN PERCENT OF AVERAGE

HYDROGRAPHIC AREA	PRECIPITATION OCTOBER 1 TO DATE	SNOW WATER CONTENT	RESERVOIR STORAGE	RUNOFF OCTOBER 1 TO DATE	RUNOFF APR-JUL FORECAST	RUNOFF WATER YEAR FORECAST
North Coastal	35	40	50	10	25	25
San Francisco Bay	45	--	60	5	--	25
Central Coastal	45	--	60	5	--	25
South Coastal	55	--	75	20	--	30
Sacramento Valley	30	25	50	25	30	30
San Joaquin Valley	30	20	55	20	20	20
Lahontan	35	30	60	40	25	25
Colorado Desert	55	--	--	--	--	--
STATEWIDE	35	25	55	20	25	25

Department of Water Resources
Water Conditions in California
Summary No. 3

Pumping Efficiencies and Costs

Recent concern about both water and power supplies has heightened the interest in pumping, its efficiency, and its cost. The major power companies are conducting pump tests on request but have a backlog. Dean Halsey, Farm Advisor in Coachella Valley, has prepared a newsletter, distributed in his area, that provides interesting and useful information for farmers and even home owners who want to calculate the efficiency of pumps and pumping costs. The method could also be used to measure power requirements of various electrical appliances. What follows is Dean's newsletter and worksheet with slight modification.

"The rising price for electrical power should inspire each irrigator to become thoroughly familiar with his pumping equipment and the factors that affect cost. If you know or can estimate fairly closely:

1. The amount of water you are pumping in gallons/minute (GPM).

2. The height you are lifting the water plus the pressure against which the pump is operating. (The lift in a well must be measured while the pump is operating. Use an electric sounder or an air line.)

3. The price you are paying per kilowatt hour for power. You can then determine in a few minutes some very important things about your equipment including:

a) The efficiency of your pump and motor.

b) The power cost per acre foot of water applied.

"This knowledge may help you avoid, improve or eliminate such costly mistakes as:

1. Worn or defective pumps or motors.

2. Pumps that are inefficient because they are not suited to the jobs they are doing.

3. Pumps operating at higher pressure than required with the pressure being dissipated by control valves, flow regulators or pressure regulators.

4. Systems with capacity far in excess of requirements where depreciation and the standby charges are larger than necessary. Remember the standby charge is <u>added</u> to the power charge and must be paid whether or not the unit is operating.

Once you have assembled the required information above, all you need is a stopwatch and a ten dollar calculator. With the stopwatch, time ten revolutions of the disk (or other convenient number) in your electric power meter while the unit is operating normally. Obtain the Kh factor and the meter constant from the front of the meter and insert the data in the proper spot in the table attached. In small installations the meter may show a constant of ten or none. If none is shown, use one in the equation. I have gone through the calculations in three actual installations. Why not give it a try on yours?"

-- Albert W. Marsh

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Irrigation Conference

The 15th Annual Turfgrass Sprinkler Irrigation Conference will be held at the University of California Lake Arrowhead Conference Center from 3:00 P.M., June 10, to 1:00 P.M., June 12.

-- A. W. M.

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WORK SHEET FOR DETERMINING EFFICIENCY OF PUMP AND MOTOR AND COST OF PUMPING

		Example #1 Drip Irrigation of Grapes Pumping out of Reservoir.	Example #2 Tube Irrigation of Citrus Pumping out of pipeline.	Example #3 Domestic Well pumping into storage tank.	Your Example
	WATER OUTPUT				
	Rated HP of Motor	100	7	20	
	Flow, GPM	1333	85	440	
	Lift in feet	10	0	24.4	
	Pressure PSI	90	70	3.5	
(1)	Total Head in feet	218	162	32:5	
(2)	Water Horsepower	73.4	3.5	3.6	
	POWER INPUT				
	Kh on meter	1.2	4	14.4	
	Meter constant	160	0	0	
	Time for 10 Disk Rev. (Sec)	97.5	20	73.3	
(3)	Kilowatts	70.9	7.2	7.1	
(4)	Electrical HP	95.0	9.7	9.5	
(5)	Pump & Motor Effic.	77%	36%	38%	
(6)	Acre ft water delivered/hour	.24685	.01574	.08	
(7)	Power cost/hour/@ $.035/KWH	$ 2.48	$ 0.252	$0.2485	
(8)	Pumping Cost Per Acre Foot	$10.05	$16.01	$3.11	

Footnotes:

(1) Head in feet = PSA x 2.31 plus feet of lift to pump.

(2) Water Horsepower = $\frac{\text{GPM x Total Head in Feet}}{3960}$

(3) Kilowatts = $\frac{\text{Revolutions of disk x Kh x Meter Constant x 3.6}}{\text{Time in seconds for disk revolutions counted}}$

(4) Electrical HP = KW x 1.34

(5) Pump & Motor Efficiency = $\frac{\text{Water HP (work accomplished)}}{\text{Electrical HP (work expended)}}$

(6) Acre ft/hour = $\frac{\text{GPM}}{5400}$

(7) Power Cost/Hour = KW x $.035 (or use your own cost if you know it.)

(8) Cost/Acre Foot = $\frac{\text{Power Cost/Hour}}{\text{Acre feet pumped/hour}}$

Evapotranspiration in the Sacramento and San Joaquin Valleys

In cooperation with Staff members of the University of California and other Agencies, water-use data are being compiled for many of the crops grown in California.

For the purposes of this study the State of California has been divided into 11 zones of similar evaporative demand (see map).

To estimate the water use of different crops, coefficients relating pan evaporation to crop ET have been developed from research conducted by the University of California, State Department of Water Resources and other agencies. These coeffients, in conjunction with pan evaporation data, are being used to develop estimated monthly evapotranspiration requirements. Data for several crops grown in the Sacramento and San Joaquin Valleys have been completed and are presented here. These figures are based on a normal "average" year. If this year's weather is markedly different, the ET will also be different. Hopefully, this information will be useful in scheduling irrigations during this water-short season.

-- Elias Fereres

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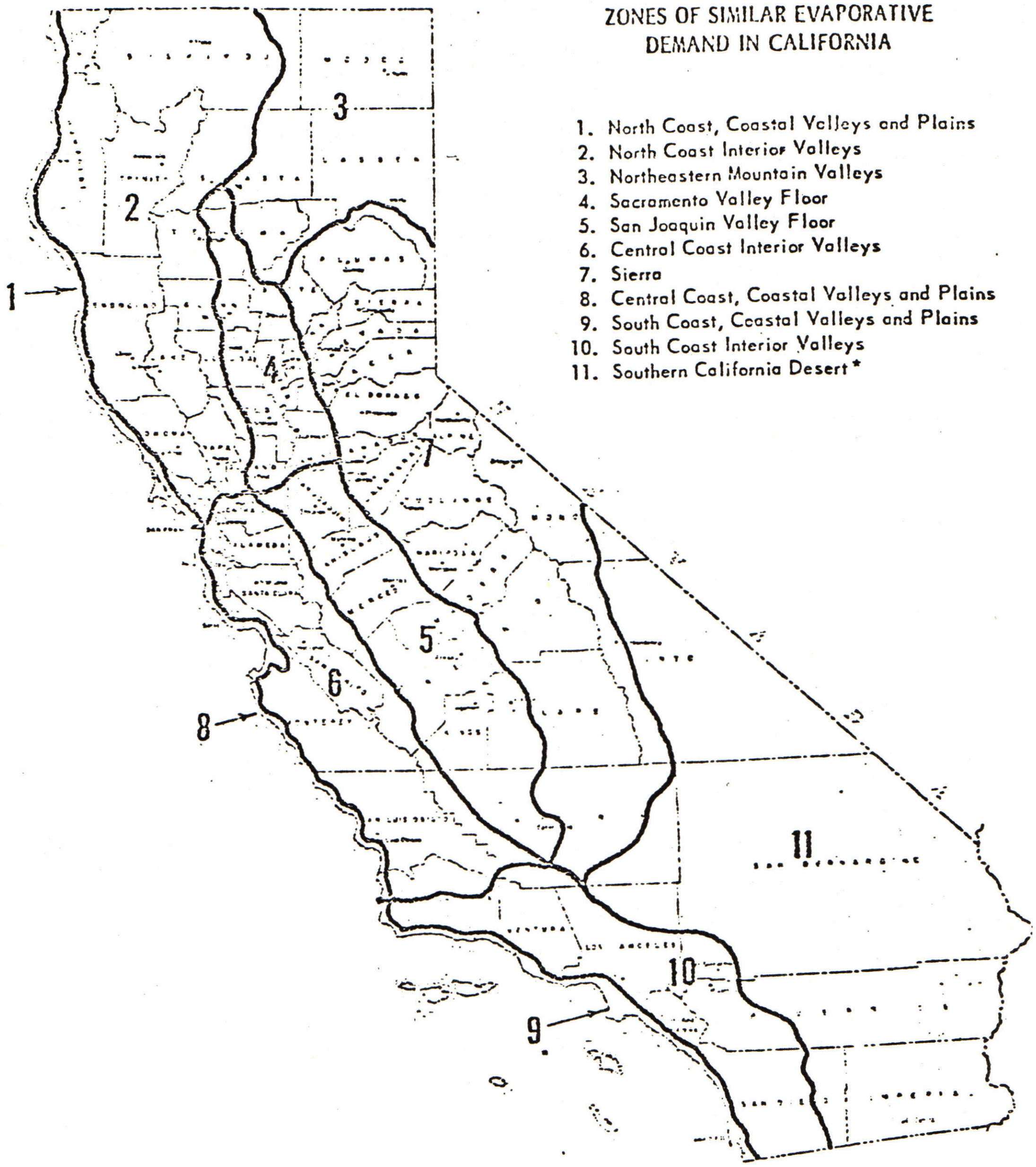
SACRAMENTO VALLEY CROP WATER REQUIREMENT

Crop and length of growing season	Estimated Monthly Evapotranspiration (inches)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Grain Sorghum 5/10-10/15					0.5	2.0	8.3	8.0	4.8	0.95			24.6
Deciduous Orchard Clean Cultivated 3/1-10/31			1.9	3.1	5.1	6.6	7.5	6.9	4.8	2.7			38.6
Deciduous Orchard w/Cover Crop 3/1-10/31			3.1	4.7	7.0	8.6	9.4	8.6	6.1	3.8			51.3
Table Grapes 3/15-10/15			0.3	1.6	4.3	6.0	6.5	5.7	3.11	0.5			28.0
Pasture Annual	1.2	1.7	3.1	4.3	6.1	7,2	7.8	7.2	5.3	3.4	1.7	1.0	50.0
Alfalfa Annual	1.2	1.7	3.1	4.2	5.9	7.0	7.6	7.0	5.2	3.5	1.7	1.1	49.2
Citrus Annual	1.0	1.4	2.3	3.1	4.4	4.8	5.2	4.8	3.5	2.6	1.3	0.8	35.2
Tomatoes 4/1-8/31				1.1	2.4	6.8	9.2	6.8					26.3
Rice 4/15-9/15				2.4	6.5	8.9	10.0	8.9	3.1				39.8
Beans 6/1-9/15						2.0	8.7	7.7	1.5				19.9
Corn 5/1-9/30					1.4	4.7	9.2	8.4	4.4				28.1
Small Grains 10/15-5/31	1.4	2.2	3.9	5.0	3.8					0.4	0.6	0.8	18.1
Sugar Beets 3/15-9/31			0.3	1.4	5.1	8.3	9.2	8.7	6.2				39.2

ZONES OF SIMILAR EVAPORATIVE DEMAND IN CALIFORNIA



*Reliable Data on evaporative demand is generally unavailable in the Southern California Desert. Studies by other agencies are in progress in Imperial Valley and Palo Verde Valley (Zone 11)

SAN JOAQUIN VALLEY CROP WATER REQUIREMENT

Crop and length of growing season	Estimated Monthly Evapotranspiration (inches)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cotton 4/15-10/15				0.3	1.7	5.7	9.8	8.3	4.7	1.0			31.5
Alfalfa 2/1-11/15	1.0	1.4	3.2	4.6	6.3	7.3	7.6	6.4	4.8	3.2	1.4	0.7	47.9
Sugar Beets 3/15-9/15			0.3	1.3	5.0	8.7	9.1	7.6	2.8				34.8
Corn 4/15-9/15				0.5	2.3	7.1	9.4	6.7	1.6				27.4
Corn 5/15-9/30					0.7	2.9	8.6	7.8	4.2				24.1
Pasture	1.0	1.4	3.2	4.7	6.5	7.5	7.8	6.6	4.9	3.2	1.4	0.6	48.7
Beans 5/1-8/15					1.8	8.4	8.4	1.8					20.4
Milo 5/1-9/30					1.2	3.9	8.9	6.8	3.5				24.3
Milo 6/15-10/31						0.5	2.8	7.6	5.2	1.9			18.1
Rice 4/1-8/31				4.8	7.4	9.6	10.0	7.6					39.4
Small Grains 12/1-5/31	0.6	1.5	3.9	5.4	4.1							0.2	15.7
Potatoes 2/1-6/15		0.8	2.7	5.7	6.6	1.8							17.6
Tomatoes 4/1-8/30				1.2	2.6	7.1	9.2	6.3					26.3
Melons 3/15-8/15			0.3	1.4	6.0	8.3	4.5						20.5
Onions 9/15-5/31	1.2	1.7	3.7	5.1	5.4				0.5	0.9	0.9	0.8	20.3
Grapes 3/15-10/15			0.3	1.7	4.5	6.3	6.5	5.3	2.9	0.5			27.9
Deciduous Orchard Clean Cultivated 3/15-11/15			1.0	3.1	5.1	6.5	7.4	6.3	4.6	2.7	0.7		37.5
Deciduous Orchard w/Cover Crop 3/15-11/15			1.8	4.9	7.3	8.8	9.4	8.0	5.8	3.7	1.1		50.6
Citrus 3/15-12/15	0.8	1.1	2.3	3.3	4.7	5.0	5.2	4.4	3.3	2.4	1.0	0.5	34.0

Aerial Photos of Reservoirs Document California's Water Shortage

In October 1976, the Extension aerial photo team photographed 19 of the larger reservoirs bordering the Sacramento and San Joaquin Valleys. The purpose was to record the unusually low levels of storage, so that Californians could be reminded in the future that plentiful water cannot always be taken for granted. In October, we hurried to get the photos before the rains came and refilled the reservoirs. Little did we know!

In April 1977, most reservoirs were even lower than they were the previous fall, with little hope of much runoff from the very light snowpack. It seemed that another round of aerial photos would be useful as history and for educational use in promoting water conservation. This time we took a much more extensive set of photos. We couldn't get over the whole state, but we did try to photograph most of the publicly developed, irrigation district, and utility owned reservoirs in northern and central California. These reservoirs provide a large part of the water and hydroelectric power consumed in the state. We managed to photograph 146 reservoirs and one farm pond (we found out later).

California Extension personnel have already received lists of the reservoirs photographed, and may order color slides or black and white prints to use in their educational programs. We will be able to provide these products on a limited basis for use by other agencies. If you are interested in obtaining a reservoir photo list, including price list and order form, write to:

Hays Fisher
Visual Aids
University of California
Davis, CA 95616

-- Bill Wildman

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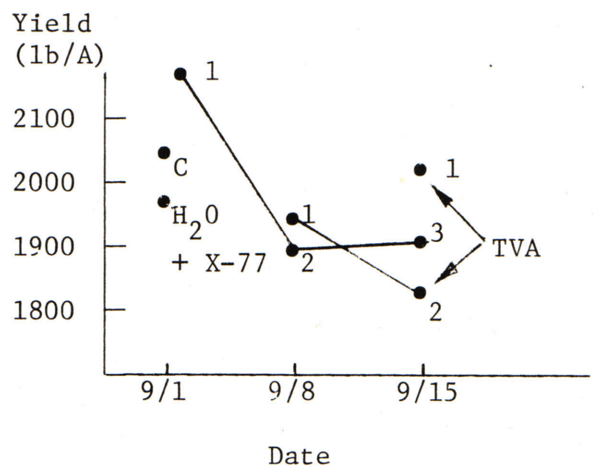
Correction - Last Newsletter

We discovered that the figures indicating yield responses from foliar applied fertilizer were incorrect. The following is a corrected copy:

BUTTE - Kidney



-- R. D. Meyer

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George A. Pearson
Extension Soils Specialist

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