TABLE 1. 11-YEAR SUMMARY FRESNO COUNTY CMT TESTING

Year	Average no. cows tested per month	Average no. cows CMT 2 and 3	Percent cows CMT 2 and 3
1961	11,206	1786	15.93
1962	12,844	1682	13.10
1963	13,999	2249	16.06
1964	15,327	1975	12.89
1965	16,866	1894	11.23
1966	17,043	2067	12.13
1967	16,709	1565	9.37
1968	18,067	1268	7.02
1969	18,365	1661	9.04
1970	19,059	1381	7.25
1971	22,687	1510	6.66
Month			
January	15,782	1889	11.97
February	15,829	2015	12.73
March	16,008	1952	12.19
April	16,079	1849	11.50
May	16,469	1788	10.86
June	16,621	1665	10.02
July	16,897	1601	9.47
August	16,975	1609	9.48
September	17,143	1589	9.27
October	17,083	1522	8.91
November	16,998	1560	9.18
December	16,845	1727	10.25

TABLE 2. FOUR-YEAR STUDY (1968–1971) AVERAGES OF FRESNO COUNTY CMT TESTING

Month	Average monthly temperature	Average monthly precipitation	Ave. 5 rep. dairies CMT 2 & 3 score	Ave. co. dairy CMT 2 & 3 score
	°F	inches	no. cows	no. cows
January	46.10	3.46	9.54	7.93
February	50.90	2.06	10.33	8.86
March	54.65	1.22	10.83	8.65
April	59.33	.90	9.72	8.39
May	68.38	.42	9.17	7.71
June	75.45	.03	10.01	7.63
July	82.13	.01	9.30	7.26
August	79.48	0	8.73	7.27
September	73.95	.02	8.56	6.66
October	61.83	.41	7.91	6.08
November	52.78	1.42	7.93	6.09
December	44.68	2.16	9.86	6.77

additional stresses must act well before the mastitic leukocyte reaction takes place. These stresses could be low temperature, the precipitation that often follows these temperature drops and the corral conditions that result—all acting as stresses that combine to promote a mastitis flare-up.

More recently, in the four years (1968–1971) following the first study, similar but less striking correlations were noted. When Fresno county data were used, with no lag period between the temperature drop and CMT score, a correlation of −.166 was noted (table 2 data used). When there was a one month lag between average monthly temperature and average CMT 2 and 3 score, the correlation was −.598, again showing the effect of seasonal temperature. For five representative dairies in which no CMT tester changes occurred during these four years, the correlations were very similar, −.263 with no lag period and −.622 with one month lag between temperature and the CMT score. The reasons for this lesser relationship than in the earlier study may well be the reduction of other contributing factors such as milking machine irritation, better corral drainage, etc.

Average monthly rainfall also shows a correlation to CMT 2 and 3 score. For the same four-year period, county data showed correlations between average monthly precipitation and average months the CMT score was +.267 for the immediate month and +.745 for a one month lag (table 2 data used). The five representative dairies had correlations of +.322 and +.70 respectively as above. Rainfall in conjunction with prolonged muddy corrals might well be a stress to be especially concerned about. Cows just finished milking may not have a completely closed teat sphincter and immediate exposure of the udder to deep mud and manure might encourage pronounced mastitis problems.

Rain-temperature

An important consideration is that rain and temperature are also closely related. In this four-year period the correlation between average monthly precipitation and average monthly temperature was −.894. This correlation was stronger than any other observed and suggests that these stresses actually affect mastitis scores.

Other factors influencing CMT reactions are numerous. Many of these are already known by each dairyman, more remain to be discovered. One factor, already mentioned, is faulty milking systems. Research has shown that a faulty milking system and/or improper use of a milking system can predispose cattle to mastitis.

The program of teat dipping is based upon the theory that after dipping there will be fewer organisms present to penetrate the teat sphincter that is still partially relaxed following milking. This program appears to be successful in reducing the incidence of mastitis.

While there already seems to be a trend of decreasing seasonal effects of mastitis, Fresno County herds, by using proper veterinary care combined with best use of present knowledge such as reducing the number of controllable forms of udder trauma, will further reduce mastitis problems.

Bob H. Bokma is a graduate student in the Department of Animal Science, University of California, Davis. Richard N. Eide is Farm Advisor, Fresno County.

Contribution FROM

THE INCREASED AWARENESS of environmental qualities has made it desirable to obtain quantitative data on the contributions of agricultural and urban sources to water pollution. For this reason an investigation was initiated in the Coachella Valley on (1) the chemical composition of drainage water from cropped fields under various agricultural managements and (2) the effluents from the Indio sewage treatment plant.

The Coachella Valley is particularly well suited for such studies because it is possible to collect drainage samples from entire fields under single crops and because the water in the White Water River (the main drainage of the valley) is supplied virtually completely by agricultural and sewage effluents.

Emphasis

The research emphasis was on those nutrients suspected of playing a major role in eutrophication; but a large number of other chemical elements and various other properties were also included in the study.

Sampling stations were carefully selected to represent a single crop and a single management. Of the ten study fields, three were in citrus, two in grapes, one in dates, one in carrots, one in asparagus and two in corn. Their size ranged from a few ten acre plots to some of several hundred acres. Surface runoff and subsurface drainage of a large feedyard (about 100,000 head per year) were also sampled. A test farm which was irrigated frequently, but neither cropped nor fertilized, furnished two controls. Sewage of the Indio treatment plant, which handles up to 10 million liters per day, was col-

to water pollution

AGRICULTURAL AND URBAN SOURCES

in the Coachella Valley

J. J. OERTLI · G. R. BRADFORD

lected at a location immediately before release to the White Water River. Samples were also taken from the Salton Sea, the Coachella Canal carrying Colorado River water, and at strategic locations along the White Water River.

Water samples were collected periodically in late 1969 and the first half of 1970 and a number of stations were revisited early in 1973. The samples were brought to the laboratory where chemical composition and electrical conductivity were determined.

Nitrogen

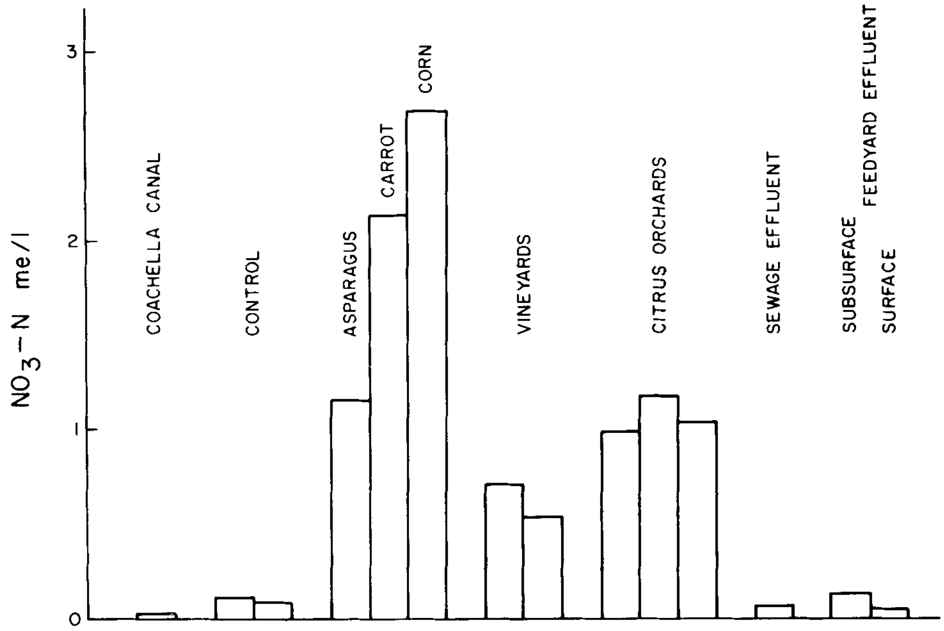
Apparently the drainage water from corn, carrot, and asparagus fields contains the largest amounts of nitrates, up to 1/5 of a Hoagland solution (graph 1). It is well known that farmers tend to fertilize these crops very abundantly. Following in decreasing order are the nitrate concentrations from citrus orchards and vineyards—whereas the nitrate levels in effluents of a sewage treatment plant or feedyard are very low. Nitrate concentrations in the subsurface effluent from a feedyard are again higher, presumably because there was more time available for nitrification.

In the White Water River the nitrate-N concentrations increase in a downstream direction (graph 2). Considering that the volume flow also increases almost linearly with distance (graph 5), the absolute quantity of nitrates contained in the river increases about 100 times over a distance of 20 km. Interestingly, although nitrate levels in the river are highest at the mouth, the concentrations in the Salton Sea are low.

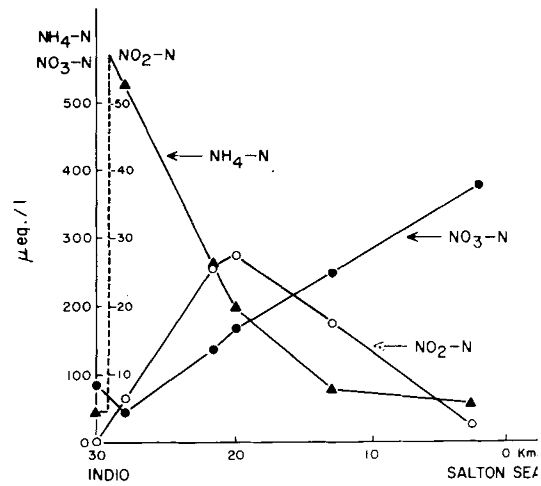
The contribution of nitrogen by the sewage treatment plant is mainly in the ammonia-form, part of which is rapidly transferred into nitrites; a few km downstream a peak-concentration in excess of 25 μeq/l is reached. The subsequent decrease of nitrite concentrations may have two causes: one is the dilution through influx of drainage water; the other is oxidation to nitrates. On the other hand, there is also an influx of reduced nitrogen via drainage water from the cropped field. For example, the ratio of reduced to oxidized nitrogen in the effluent of a vineyard was 1:4.

The total nitrogen of Colorado River water in the Coachella Canal is very low. Above the Indio sewage treatment plants, the White Water River contained between 0.1 and 0.4 me/l; the effluent

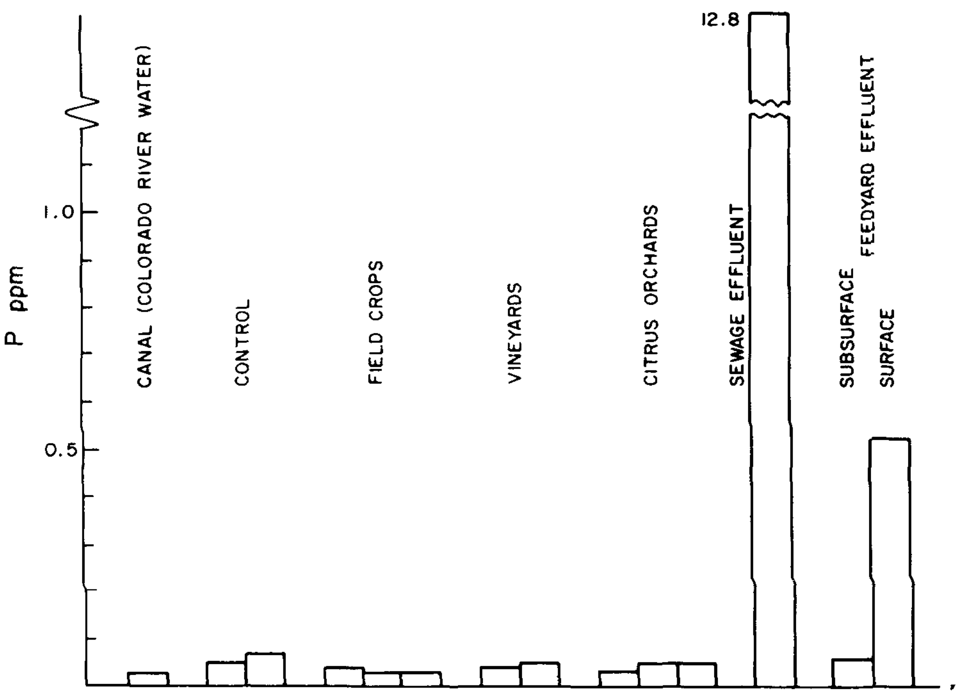
GRAPH 1. CONCENTRATIONS OF NITRATE IN WATER SAMPLES OF THE COACHELLA VALLEY.



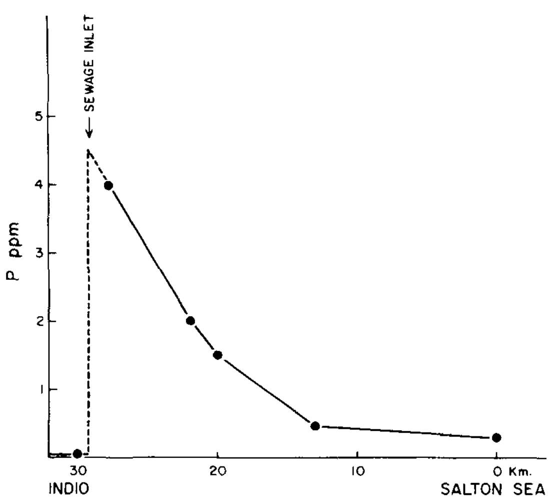
GRAPH 2. CONCENTRATIONS OF NITRATE-, NITRITE-, AND AMMONIUM-NITROGEN IN THE WHITE WATER RIVER OF THE COACHELLA VALLEY.



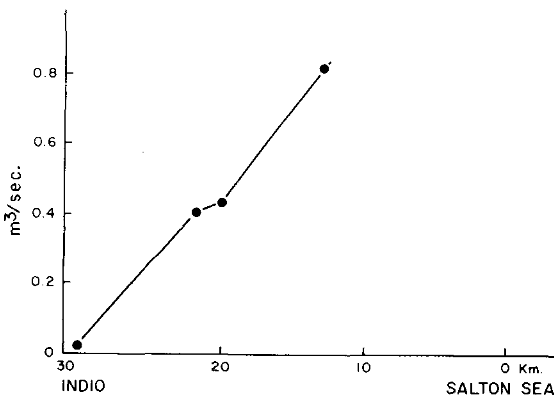
GRAPH 3. CONCENTRATIONS OF PHOSPHORUS IN WATER SAMPLES OF THE COACHELLA VALLEY.



GRAPH 4. CONCENTRATIONS OF PHOSPHORUS IN THE WHITE WATER RIVER OF THE COACHELLA VALLEY.



GRAPH 5. VOLUME FLOW OF THE WHITE WATER RIVER (MAY 1970).



from the treatment plant, containing from 1 to 2 me/l total N, raises the level in the river to 0.6 me/l. Further downstream, the total N decreases to 0.4 me/l and subsequently tends to increase slightly again (graph 2). Considering the large increase in volume flow (graph 5) with nearly constant total nitrogen concentration, it appears that nitrogen in the White Water River originates mainly from agricultural sources.

Phosphorus

Graph 3 shows that phosphate levels in drainage water are extremely low, and comparable with those of Colorado River water. The most significant contributor to phosphates in the White Water River is the Indio sewage treatment plant, the effluent of which (in early 1970) contained 12.8 ppm P and raised the level of P in the White Water River from virtually zero to above 4 (graph 4). The subsequent decrease of P-concentrations in downstream direction can fully be accounted for by dilution from the influx of agricultural drainage water.

Not only are phosphate contents low in drainage effluents from soils, but passage through the soil will even remove phosphates: the surface runoff from the feedyard contained relatively large amounts of P whereas the concentrations in the drainage water from the same field were low and comparable with effluents from cropped fields.

Two clearly different patterns are thus apparent for phosphates and nitrates. The sewage effluent is the major contributor to the phosphorus content in the White Water River and in a downstream direction from this source, the water becomes more diluted in P because of additions of drainage water from cropped fields. Passage through the soil of P-containing solutions actually reduces the P content. In contrast, the major contributor to nitrates and to total nitrogen is the drainage from cropped fields. Although nitrogen levels in the sewage are high, their total amount is small relative to the contribution from cropped fields.

The combination of both urban sewage and drainage effluents from agriculture seems to produce a solution highly fertile in the two nutrients.

Other elements

Twenty-four other inorganic elements have been studied. A number of them, namely boron, silicon, potassium and sodium, follow the trend of nitrates; others show an irregular pattern. The trend of phosphorus seems to be unique. The trace elements molybdenum and strontium were relatively high; the former reached 0.1 ppm in some samples, the latter 5 ppm (17 in the Salton Sea).

Salinity

The total salt concentration is also an important water quality criterion, particularly if agricultural reuses of water or the continuous salinization of the Salton Sea are considered. The electrical conductivity in the Coachella Canal was slightly in excess of 1 mmhos/cm; in the White Water River it was twice as high and increased in a downstream direction. Drainage effluents from cropped fields measured between 2 and 3 mmhos/cm, whereas the effluent from the sewage treatment plant had a conductivity of only 0.6 to 0.7 mmhos/cm. With 0.3 mmhos/cm, the surface runoff from the feedyard was very low, whereas drainage from the feedyard was very saline with 7.5 mmhos/cm. Chemical analyses showed that NaCl was the main contributor in this case.

With respect to total salinity, the water quality was best from the sewage effluent and surface runoff from the feedyard.

J. J. Oertli is Professor, and G. R. Bradford is Specialist, Department of Soil Science and Agricultural Engineering, University of California, Riverside.