phate is hydrolyzed enzymatically to the orthophosphate ion by phosphatase enzymes. Thus, with hydrolysis of glycerophosphate to the orthophosphate ion, the material was able to undergo the normal precipitation and adsorption reactions with soil to prevent further movement. Apparently, the hydrolysis reaction was rapid enough to cause complete hydrolysis of the glycerophosphate by the time the solution infiltrated 13 cm (5.2 inches) of Panoche soil, at the infiltration rates of this experiment.

It is expected that the depth of movement of glycerophosphate will be highly dependent upon the infiltration rate, inasmuch as the enzymatic hydrolysis of the material is a time-dependent reaction. Consequently, the initial water content of the soil should also influence the depth of movement.

Potential usage

It has not been feasible to make corrective applications of phosphorus to plants in mid-season, because of the inability to enter the field with equipment to achieve the proper placement of phosphate. With organic phosphate it becomes possible to achieve placement by topical soil applications, or application in the irrigation water. This capability would be of great value where specialized irrigation such as sprinkler and drip systems make it extremely difficult to achieve placement mechanically. Furthermore, topical soil applications may be "irrigated in," thus, preventing destruction of plants or damage to roots of perennial plants such as orchards, alfalfa, and turf.

Since the normal phosphate fertilizer use is by application of the phosphorus before planting, a greater opportunity for phosphate "fixation" occurs, resulting in low efficiencies. By being able to adjust the time of application more in relation to the nutrient demand of the plant, higher efficiencies may be obtained. By proper placement and timing of surface applications, an increased efficiency in the use of a limited natural resource may also be achieved.

In addition, glycerophosphate may decrease a potential environmental hazard in phosphate enrichment of surface waters. Since erosion of the soil surface is one of the contributors of phosphorus to surface waters, the ability of the organic phosphate to move into the soil profile decreases the buildup of phosphorus near the soil surface, thereby decreasing the potential of unwanted environmental change. The rapidity of enzymatic hydrolysis in the soil prevents the movement of the organic phosphate into the ground water.

The projected cost per unit of glycerophosphate P is presently two to three times that of common inorganic phosphorus fertilizers. However, this cost may be reduced with refinements in synthesis techniques. If an increased fertilizer efficiency is attained, the total amount needed to grow a crop would decrease, thus decreasing total costs. In addition, growers may be willing to pay more for phosphorus fertilizer if placement and labor savings can be realized for specialized cropping and irrigation systems. The development of glycerophosphate as a phosphate fertilizer, and learning how to manage its placement, may be extremely beneficial in providing food in the most efficient manner—yet maintaining an obligation to minimize or prevent unwanted environmental changes.

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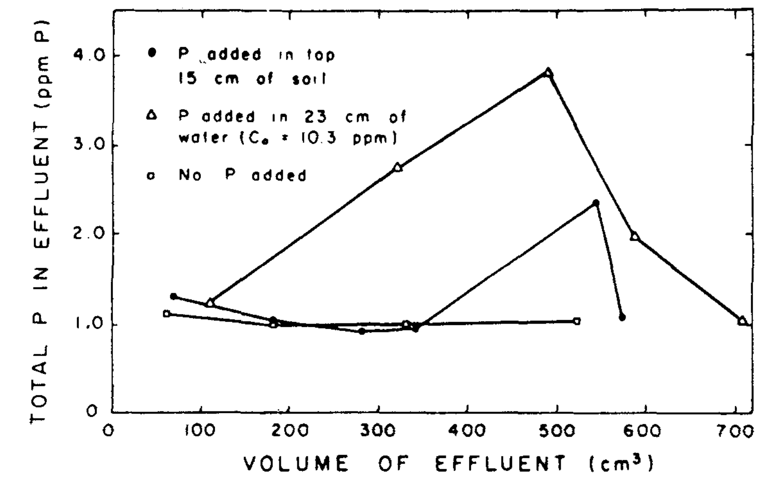
GRAPH 2. CONCENTRATION OF TOTAL PHOSPHORUS IN THE EFFLUENT FROM THREE SOIL COLUMNS OF HANFORD SANDY LOAM AS A FUNCTION OF VOLUME OF EFFLUENT COLLECTED



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BORON *of the*

When the California Aqueduct was completed, it brought high quality water from northern California to replace poor quality local well water, which usually contained high levels of boron and salts and made much of the area unsuitable for many crops.

New experimental and commercial plantings of a variety of crops are continuing to be made to determine whether production, quality and economics warrant more extensive plantings. Grapes are one of the crops receiving wide interest.

This study indicates that suitability of the area for grapes is strongly related to a reduction in soil boron, which accumulated in soils during irrigation or was present from natural causes. Boron can be removed by leaching, although copious amounts of good quality water are needed to remove it. However, good irrigation practices with the new water supply can be expected to reduce boron to acceptable levels within a few years for all crops in well-drained soils. Soil and plant analysis can be used to evaluate the progress in reclamation and to determine soil suitability for planting.

In 1968, 10 NEW GRAPE PLANTINGS (4 to 6 years old) and one old planting (48 years old) in western Fresno County were selected for salinity and boron studies. All vineyards had previously been irrigated only with well water, but a switch to canal water was anticipated. Initial soil samples and plant tissue samples were collected in 1968 from a typical location in each vineyard. Vine appearance and leaf symptoms were also

Typical boron deficiency symptoms on grape leaves are shown in photos above: center, slight-to-moderate deficiency; right, moderate-to-severe; and left leaf, normal with no symptoms of deficiency.

AND SALINITY–IN VINEYARDS

West Side, Fresno County

noted. In 1969 and 1970, only plant tissue samples were taken, but both soil and plant tissue samples were again taken in 1971.

Most of the vineyards improved during the study period, except for localized problem areas in some of the plantings. Four vineyards were selected as representative of the conditions of the study. The oldest (located near Mendota) was 48 years old in 1968, was planted to White Malaga grapes on Panoche clay loam and was converted from well to canal water irrigation in early 1968. The second vineyard, also located near Mendota, was six years old in 1968, and was planted to Royalty grapes on Panoche clay loam. Canal water was brought in about mid-1968, and also to the third vineyard, which was at Levis Station, south of Mendota. This third vineyard was four years old in 1968, and was planted to Grenache grapes on Oxalis silty clay. The fourth vineyard, at Huron, was four years old in 1968, and was planted to Carignane on Panoche loam. Irrigation changed from well to canal water in mid-1971.

The vineyards receiving canal water through most of the four-year study period showed a reduction in sodium, chloride, and boron both in the soil and the plants—down to levels now considered satisfactory for grape production. Vine vigor and condition were improved and the toxicity symptoms were reduced.

However, most of the study vineyards still contained localized problem areas with weak vines. Sampling indicated that these spots have persistent excess boron and salinity levels. They were also areas with a soil profile restriction or soil textural interface two to three ft deep, consisting of abrupt sandy subsoil layers or dense clay subsoils which would restrict subsurface drainage and deep vine root development. Proper irrigation to avoid the additional effects of water stress in these problem areas was found to be important to vine condition, especially in the fall, during prolonged droughty periods through harvest.

The data gathered in this study indicate that to grow grapes successfully in western Fresno County, growers should (1) select only vineyard sites receiving canal water or high quality well water; (2) avoid soils with sodium, salinity, and boron levels unacceptable for successful vineyard establishment, or which cannot readily be reclaimed—especially if restrictive or dense clay subsoil layers exist. (Problems increase when the active root zone soil boron reaches 1.5 to 2.0 ppm, when salinity reaches EC_e at 3 to 4 mmhos/cm, and when exchangeable sodium percentages (ESP) reach 10); (3) manage irrigation to accomplish leaching and reduction of salts and boron to safe levels as soon as possible (three to four years of furrow or flood irrigation with canal water has been adequate where highly restrictive subsoil layers are not present); and (4) avoid low-lying areas which may be injured by rising water tables.

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TABLE 1.
SALINITY AND BORON LEVELS FOR SOILS IN FOUR VINEYARDS, WEST SIDE FRESNO COUNTY

	Vineyard 1		Vineyard 2			Vineyard 3			Vineyard 4	
	1968	1971	1968	1971		1968	1971		1968	1971
	a*	a	a	a	b†	a	a	b	a	a
	Mmhos/cm as determined on soil saturation extract (for an approximate salinity in TDS units, ppm, multiply by 640)									
SALINITY										
1 ft	2.3	0.8	4.7	0.7	1.3	2.0	0.8	3.3	2.7	4.5
2 ft	2.2	0.6	1.6	0.9	1.8	2.6	0.9	6.2	2.7	3.6
3 ft	2.6	0.6	1.2	1.0	1.7	2.7	1.0	7.9	4.6	4.5
4 ft	3.4	0.6	1.7	1.0	1.3	4.3	0.9	8.1	5.1	4.9
5 ft	–	0.6	–	3.3	1.1	–	1.0	8.1	–	4.4
	PPM boron in soil saturation extract									
BORON										
1 ft	2.5	0.2	1.9	1.1	1.5	1.9	0.5	2.6	1.7	1.2
2 ft	1.5	0.3	1.3	1.1	2.2	1.6	0.9	4.6	1.4	0.9
3 ft	1.3	0.2	1.3	1.1	2.0	1.7	1.2	4.5	1.9	1.2
4 ft	1.5	0.1	1.8	1.2	1.4	2.0	0.9	5.2	1.9	1.2
5 ft	–	0.1	–	1.2	1.4	–	0.9	6.5	–	1.0

*a = study area, typical location
†b = problem area, localized

TABLE 2.
PLANT TISSUE COMPARISONS OF SALINITY AND BORON LEVELS (DRY WEIGHT) AND ASSOCIATED VINE CONDITION IN FOUR VINEYARDS, WEST SIDE FRESNO COUNTY

	Vineyard 1		Vineyard 2			Vineyard 3			Vineyard 4	
	1968	1971	1968	1971		1968	1971		1968	1971
	a*	a	a	a	b†	a	a	b	a	a
Sodium % (RMB)‡	.05	.01	–	.01	.13	.02	.01	.01	–	.02
(OMB)§	.06	.01	0.19	.09	.33	–	.01	.01	.10	.02
Chloride (RMB)	.18	.02	–	.05	.13	.01	.01	.06	–	.13
% (OMB)	.52	.08	0.11	.14	.11	–	.18	.15	0.19	.18
Boron (RMB)	300	88	–	175	750	1020	500	600	–	650
(B)ppm (OMB)	500	82	300	212	1125	580	550	750	275	475
Vine condition *and symptoms*	good; mod. B excess symptoms, leaf margin scorch	excellent; no symptoms	good; mild B excess symptoms	very good; very light, infrequent B excess symptoms	weak; mod. B excess symptoms, general & margin leaf scorch	fair; mod. to severe B excess symptoms	good; mild to mod. B excess symptoms	very weak mod. B excess symptoms, general leaf scorch	fair; no symptoms	good; mild B excess symptoms

*a = study area, typical location.
†b = problem area, localized.
‡ RMB = recently matured blades.
§ OMB = old matured blades.