Phosphorus in Citrus Soils

removal and redistribution of phosphorus from the soil during twenty-eight years of cropping with citrus studied

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Soil samples taken in 1955—from a 38-year-old citrus orchard—were compared with soil samples taken in 1927 when a long-term fertility trial with various fertilizer treatments was started. The main factors known to have influenced yields in the fertility trial are available nitrogen and structural conditions of the soil. The application of phosphorus fertilizers did not influence the yields or the quality of the fruit.

In the majority of citrus orchards in southern California the supply of available phosphorus is adequate to meet the needs of the trees and the cover crops grown between the tree rows. However, there are soil areas—mainly in San Diego County—where citrus orchards must be fertilized with phosphates to obtain and maintain thrifty trees and high yields.

One explanation for the absence of phosphorus deficiencies for citrus in most soils in southern California is suggested by the findings in this study.

The soil samples collected in 1927 were taken from the 0″–12″, 12″–24″, 24″–36″, and 36″–48″ depths. Those collected in 1955 were taken from the same depths except that two samples—0″–6″ and 6″–12″—were taken from the surface foot.

The change in phosphorus content of the soil in the irrigated middles of test plots are presented in the table below.

The loss of phosphorus from the soil, excluding loss by erosion and loss by leaching, should be balanced by a removal in harvested fruit plus deposition under the trees from leaf and fruit fall plus the amount in the roots, trunk, and leaves of the trees at time of sampling of the soil in 1955. Data on the quantities of phosphorus removed in the harvested fruit from the plots of various treatments are presented in the table to the right.

Change in Phosphorus Content of the 0″–36″ Depth of Soil in the Irrigated Middles of Plots Cropped with Citrus Over a 28-year Period, 1927 to 1955*

Plot treatment	Total phosphorus in soil samples, ppm				Difference as % of phosphorus in irrigated middles
	1927	1955	Difference	L.S.D.** at 5% for difference	
Check	398	363	35	21	8.8
Cover crop	366	341	25	14	6.3
Urea	435	393	42	20	10.5
Average	400	366	34	18	8.5

*Samples taken from about 18″ from the drip of the trees.

**L.S.D. = Least significant difference.

The difference in quantities removed reflect the differences in yield of fruit. The average amount removed in the fruit was only 1.0% of the total phosphorus in the soil and only 16% of the phosphorus loss from the irrigated middles.

The soil under the trees in plots of two treatments was sampled and analyzed to find the quantity of phosphorus that had accumulated from leaf and fruit fall. The accumulation was mostly in the 0″–6″ depth of soil with a small amount in the 6″–12″ depth. The accumulation represented 3.5% of the total phosphorus in the soil and 58% of the loss of phosphorus from the irrigated middles.

Phosphorus in Fruit

The phosphorus removed from the plots in harvested fruit was a relatively small percentage of the total phosphorus in the 0″–36″ depth of soil. In the urea treatment it was 1.8%, and even in the treatment with calcium nitrate plus cover crop, which was one of those that produced the highest yields, the phosphorus removed in the fruit was only 2.2% of the total phosphorus in the soil. Thus, the removal of phosphorus in the fruit is so slow that if a soil were adequately supplied with total and avaliable phosphorus at the start of the cropping period it would take many years to deplete the soil by this process.

Percentage in Trees

In contrast to the small amount of phosphorus removed in the fruit, the data indicated that from five to ten times as much phosphorus had been absorbed by the trees. About 60% of this had been deposited under the trees as a result of leaf and fruit fall. As a result of this deposition, each tree had an area of soil, surrounding the trunk, in which the total and available phosphorus was higher than the rest of the soil area.

Phosphorus that accumulates under a tree is in a form more available to plants than the original phosphorus of the soil. Thus, as a result of such accumulation the phosphorus available to the trees probably would increase—at least, not decrease—with time. Thus under citrus culture in soil originally well supplied with phosphorus there is little possibility of the development of phosphorus deficiencies for citrus.

Balance Between Phosphorus Removal from the Soil by Trees and the Phosphorus Accumulation Under Trees from Leaf Fall, Removal in Fruit, and Estimated Quantity in the Trees at Time of Sampling

1	2	3	4	5	6
Treatment	Accumulation of phosphorus under trees	Removal of phosphorus in fruit	Estimated phosphorus in trees	Sum of columns 2, 3, 4	Loss of phosphorus from irrigated middles
	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre
Check	209	23	55	287	301
Urea	130	85	55	270	353
Cover crop	....	32	55	...	210
Average	165	47	55	278	288

Moisture and Availability

If the soil containing the accumulated phosphorus is moistened during irrigation the phosphorus would undoubtedly be available to the tree. However, if that part of the soil is not moistened during irrigation, the availability would depend on rainfall. Also, the area of surface accumulation in most orchards extends into the irrigated section of the field so the area of surface accumulation would become moist with each irrigation.

The accumulation of phosphorus and other mineral elements in the area under the trees should probably be taken into consideration when soil samples are taken for the purpose of estimating the availabilities of these elements to the trees. There is a possibility that some cases of low correlations between soil analysis and leaf composition with citrus have resulted from a failure to recognize this surface accumulation of available elements.

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