Loss of Magnesium from Soil

effect of fertilizers on content of exchangeable magnesium in citrus soil studied in long-range fertility investigation

P. F. Pratt and R. B. Harding

Relatively large losses of magnesium from the soil in the long-term fertility trial plot at Riverside—during a 28-year period—were revealed by analysis of soil samples taken in 1927 and in 1955. The losses of magnesium increased with increase in amount of fertilizers and gypsum added to the soil.

The suggestion from the data is not that the use of fertilizers and soil amendments should be stopped but that after years of their use—without additions of magnesium—soil or leaf samples, or both, should be checked for possible magnesium deficiency. According to recent work at Riverside, leaf magnesium contents of 0.20% or less, or ratios of exchangeable potassium to exchangeable magnesium of more than 0.40 in the 18–30″ depth of soil, are indicative of magnesium deficiencies for citrus. If magnesium deficiencies are indicated, the application of magnesium-containing fertilizers should be included in the fertilizer program.

The trees in the long-term fertility trial at Riverside were planted in 1917. In 1927 differential treatments with various fertilizers, soil amendments, and organic materials were begun. Samples of the 0–12″, 12–24″, and 24–36″ depths of soil taken in 1927 and in 1955 were analyzed for exchangeable magnesium, and the decreases in exchangeable magnesium during the 28-year time interval were calculated for various treatments included in the trial.

The accompanying table presents data for the decrease in exchangeable magnesium from the 0–36″ depth of soil and the amount of fertilizer salts added for several treatments. The decrease in exchangeable magnesium was highly correlated with the amounts of salts added to the soil as gypsum and fertilizers. However, because the manure contained magnesium, there was less decrease in those treatments than in the check treatment. The decrease with urea as a source of nitrogen was lower than with other sources of nitrogen added at the same rate in pounds equivalents per acre.

The amount of magnesium and the ratio of calcium to magnesium in the irrigation water are both factors that should be considered as important in the decrease in exchangeable magnesium in the soil of this fertility trial or any other irrigated soil. The water used for this experiment contained 0.76 milliequivalents magnesium per liter and 2.43 milliequivalents calcium per liter. The ratio of calcium to magnesium was 3.1. This ratio of calcium to magnesium was conducive to magnesium loss from the soil. This effect, however, was not great because of the relatively small quantities of calcium and magnesium that were in the water.

In some cases irrigation waters contain relatively large amounts of calcium with a high ratio of calcium to magnesium. In these cases the exchangeable magnesium theoretically could be reduced to a low level when the quantities of exchangeable calcium and magnesium in the soil come to equilibrium with the quantities in the irrigation water. With soils of low cation-exchange capacity—as in sandy soils low in organic matter—the effect of high calcium and low magnesium in the irrigation water would be most likely to produce deficiencies of magnesium.

Calculations—using the weight of fruit harvested and the value 0.01% magnesium in the fruit—indicate that approximately 40 pounds magnesium per acre were removed in the harvested fruit during the 28 years of the experiment. The quantity of magnesium in the trees, at the time of the 1955 soil sampling, was about 40 pounds per acre. The quantity of magnesium accumulated under the trees from leaf and fruit fall is estimated to be 300 pounds per acre. However, soil from this area of accumulation was not sampled for this study. The total magnesium removed from the soil during the experiment is thus estimated to be 380 pounds per acre. This is the same order of magnitude as the decrease—346 pounds per acre—in exchangeable magnesium in the check treatment. The agreement of these rates of removal suggests that in the check treatment the amount of magnesium added to the soil in irrigation water was approximately the same as the amount leached from the soil.

Magnesium and Salts in Soil Sampled

Loss of exchangeable magnesium from the 0–36″ depth of soil and amounts of salts added for several treatments during 28 years in the long-term fertility trial with citrus at Riverside.

No.	Treatment	Salts added in soil amendments and fertilizers during 28 yrs., lb. equivalents/ac.	Decrease in exchangeable magnesium in 0–36″ depth of soil, lbs./ac.
1	Check	0	350
2	Urea	560	550
15	Ammonium sulfate	560	950
20	Calcium nitrate, 3 lbs. N* per tree	560	940
26	Sodium nitrate	560	1110
23	Calcium nitrate, 5 lbs. N per tree	850	1450
13	Mixed fertilizer (8–8–8)	1170	1700
28	Sodium nitrate plus gypsum	1370	1800
30	Manure, 3 lbs. N per tree	not known	274
Least significant difference (5%)			187

* Nitrogen.

There are two possibilities for loss of magnesium from the soil in this experiment: removal by the trees, and removal by leaching. Because the quantity removed by the trees was estimated to be 380 pounds per acre, the major proportion of the decreases in exchangeable magnesium—as shown in the table—must have resulted from leaching losses. Also, the leaching losses must have been accelerated by the addition of fertilizers and gypsum.

There has been increasing evidence of magnesium deficiencies in the soils of southern California. Other research workers have reported deficiencies of magnesium for citrus in several locations in the coastal area of southern California. These probably resulted from two factors: *1*, the use of potassium fertilizers on some orchards increased the uptake of potassium and reduced the uptake of magnesium by the trees, and *2*, the use of fertilizers and soil amendments produced losses of magnesium from the treated soils.

P. F. Pratt is Assistant Chemist in Soils and Plant Nutrition, University of California, Riverside.

R. B. Harding is Assistant Chemist in Soils and Plant Nutrition, University of California, Riverside.

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