Nitrogen Needs of Citrus

losses caused by leaching and volatilization can be reduced by management and irrigation practices

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Nitrogen fertilizer bills for citrus in California can be reduced by application of frequent small doses of nitrogen to the irrigation water, use of low head sprinkler irrigation, noncultivation, and making neutral and alkaline soils slightly more acid.

California citrus growers spend more than five million dollars a year for nitrogen fertilizer. Many growers apply 200 to 400 pounds annually per acre to maintain production, but only 40 to 60 pounds are removed by the fruit.

A 15-year citrus nutritional and soil study investigated the reasons why citrus requires such heavy fertilization, and sought nitrogen-conserving practices that can be applied in the orchards of California.

Causes of Nitrogen Loss

There is no evidence that the actual nitrogen requirement of the citrus tree differs sufficiently from that of other fruit trees to account for the heavy nitrogen fertilization required to maintain citrus yields and healthy tree condition.

Leaching and volatilization losses account in large measure for the disparity between nitrogen permanently removed in fruit, and amounts necessary to maintain good yields and tree vigor.

Unusually heavy leaching losses of nitrogen occur because of irregular root distribution and reduced root development in the irrigated-fertilized middles of many citrus groves. This loss is caused by structural deterioration due primarily to cultivation and to some degree to irrigation and fertilization itself. Considerable amounts of nitrogen pass down through and out of the root zone.

In addition, the gradual seasonal accumulation of nitrate in the cultivated layer which occurs as the irrigation season progresses is carried down by winter rains at a time when rate of absorption by citrus roots is at a minimum. Heaviest winter rainfall on the average is during January and February, the two months when absorption of nitrate by citrus roots is lowest.

The considerable amounts of nitrate found in deep borings, in wells fed by seepage from citrus groves, and the disappearance of nitrate from the soils of citrus orchards during the winter rainy period prove that leaching is responsible for substantial losses of nitrogen.

Volatilization losses vary from grove to grove but are thought to be substantial. In one experiment where nitrogen fertilization—from calcium nitrate—was at a rate of 200 pounds nitrogen per acre per year, 60 pounds annually were unaccounted for.

Nitrate and total nitrogen disappear from soils under fully aerobic conditions and these losses are greatly increased when decomposable organic matter is present.

Losses of ammonia by volatilization occur when ammonium-containing or forming compounds are added to neutral or alkaline soils. Laboratory studies indicate that these losses may amount to 25% or more of the nitrogen added.

Phosphate Fertilization

High phosphate in the soil, possibly by stimulating biological activity, is believed to increase nitrogen volatilization losses. Heavy phosphate fertilization brings on nitrogen starvation symptoms in the tree. In controlled culture work, nitrogen absorption could not be depressed by increasing phosphate levels. A possible explanation is that in soil high phosphate stimulates nitrogen volatilization losses.

The accumulation of phosphate in many older citrus orchards due to past use of manures and mixed fertilizers undoubtedly is a factor in the high nitrogen requirement, whatever the explanation of the phosphate-nitrogen effect. This factor may be a further reason why citrus orchards require heavier nitrogen fertilization than other tree crops which have not accumulated phosphate to the same degree.

Calcium-potassium balance and sulfate accumulations may also influence nitrogen effectiveness.

Suggested Remedies

These findings suggest various possible nitrogen-conserving practices in citrus orchards.

Where ammonium or ammonia fertilizers are used consistently, it might pay to slightly acidify soils which are neutral or alkaline in reaction. Only the cultivated layer need be acidified and only enough to bring the reaction down to pH 6.0. This degree of acidification will not completely prevent losses when anhydrous ammonia is used because even on fairly acid soils there is sufficient temporary increase in alkalinity following a nominal application of anhydrous ammonia to cause some loss.

Another practice which should conserve nitrogen in the citrus orchard is noncultivation. There are reasons to believe that noncultivation will bring about a gradual structural regeneration of the soil, and more citrus roots will develop in the irrigated middles. Leaching losses should gradually decrease and, since no organic matter is added to the soil except falling leaves and twigs, nitrogen decomposition losses should decrease.

A further saving on nitrogen might be effected under a sprinkling or basin system of irrigation, avoiding the gradual seasonal accumulation of nitrogen in furrow crests. Both leaching and decompositional losses are aggravated by this buildup of nitrate in the surface horizon. However, there are some disadvantages to the sprinkling or basin system, which should be weighed against the possible gain in nitrogen economy.

Another procedure by which some growers might save money is to have their soils periodically tested for nitrate. When the total supply in the root zone exceeds a certain average concentration—an average of five parts per million nitrogen as nitrate in the dry soil—no further nitrogen is added until the supply drops below this amount.

A further reason for keeping the nitrogen supply low is to stimulate nitrogen fixation. In some experiments net gains from both symbiotic and nonsymbiotic fixation occurred when soil nitrogen was low and net losses—not accounted for—showed up when the nitrogen supply was high.

While it is inevitable that some losses of nitrogen will occur under any system which requires fairly heavy fertilization, the suggested practices will substantially reduce the nitrogen fertilizer bill for citrus.

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