

**Review Article**

A review of certain aspects of fertilizer placement  
for citrus in the U. S. A.

by

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Proper placement of fertilizer is beginning to rank with proper amounts in the minds of today's farmers. Improper placement has limiting fertilizer responses to a great extent. It is important to have it where it will intercept the roots of the young plant. An estimate of the fertilizer applications in the western section of the United States (Camp, 1947) indicates that approximately 70 percent of the acreage receives nitrogen by hand. Only one percent of the acreage receives nitrogen application in the form of foliage sprays while 20 percent of the acreage receives a part of the nitrogen in the form of urea sprays. In the eastern section too, the percentage of application by hand is 70 per cent. Aside from a few experiments in California and Florida, there is scarcely any detailed work on this important aspect.

**Principles and methods of placement of fertilizers:** For many years fertilizers were distributed by hand. Plantings were small and machine spreaders such as are used now in large acreages in the U. S. A. were unknown. Even as late as 1945 growers were still going around the trees with a bucket and old coffee cans depositing all the nitrate in a ring at the drip of the trees. Coit (1945) observes that this out-moded method not only fails to supply the great mass of feeder roots in the middles but it often causes damage by over-concentration of high nitrate fertilizer. In case of light rain there is often injury to roots passing under the deposits.

The methods of applying fertilizers depend on the kind of plant, the type of fertilizer, the soil and the climatic conditions. In an orchard of young trees it is not necessary to fertilize the ground beyond the spread of the roots but in older orchards particularly, all the soil should be fertilized as the roots are found below the entire surface area.

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1. **Soil applications :** Animal manures and other bulky organic material may be spread broadcast and disked or ploughed under. This method has the apparent advantage of encircling all or most of the area of the root system and there is a likelihood of improvement of the physical condition of a correspondingly large area of soil. Dairy manure applied in trenches 10-12" deep is not considered to be as effective as spreading manure broadcast.

In the United States, citrus fertilizer practices are extremely variable. This is in part due to the diversity of soils and the use of irrigation water plus the fact that fertilizer practice rests on a variable and composite base of research evidence and practical experience.

In the application of granular nitrogenous fertilizer to citrus trees, the common practice has been to apply it broadcast. The question of whether the material should be broadcast in the irrigated middles between the rows or under the trees has never been satisfactorily answered. Jones and Cree (1953) conducted experiments on this aspect at Riverside, California. The differential treatments consisted of (1) fertilizer applied in the cultivated zone or the row middle and (2) fertilizer applied under the skirt of the tree. Navel orange, Valencia orange and grape fruit trees were used. Nitrogen was applied at the rate of 3 lb. per tree each year. The trees were 10 years old when the yield records in the experiment started in 1927. All the trees were treated uniformly for 8 years. During the fall of 1933 the differential fertilizer treatments started and were continued until 1952. The different placement treatments were found to have had no influence on production.

Decision on the best method of applying commercial nitrates depends on the time of the year. In the rainy season nitrate is broadcasted on the surface so that it is dissolved by rain and taken into the soil. In the dry season, with furrow irrigation different methods are used, else the plant food will remain near the surface and not reach the main mass of feeder roots until carried down by rains the following fall

On some of the larger ranches in the U. S. A. power broadcasters are used with advantage. In orchards irrigated by sprinkling, nitrate is broadcasted in summer. The great majority of groves are still furrow irrigated in the U. S. A. A common practice is to distribute the nitrate in the furrows previous to

irrigation. According to Coit (*loc. cit*) use of home-made furrow drills economic time and labour as furrowing and fertilizing are performed by one man at one operation. They are efficient in getting all of the fertilizer in contact with the roots. The rate of application is varied by lever from the driver's seat to suit different sizes of trees.

The method of distribution of fertilizers in Florida citrus orchards has been well standardised. In bearing orchards, the fertilizer is spread from trunk to trunk as evenly as possible. In order to accomplish this spreading, mechanical spreaders as used which operate on the centrifugal principle. Commenting on the efficacy of the rotary distributor, Camp (*loc. cit*) observes that material that has a high specific gravity is thrown a long way and light material only a short distance. The result is that the fertilizer tends to be distributed rather loosely in bands.

A fertilizer spreader which can apply the fertilizer in a 2 to 4 foot band under the drip of the branches is considered the best. If the fertilizer is spread out over the orchard floor it is necessary to apply considerably more fertilizer per acre in order that the tree may get what it needs from beneath its branches. Fertilizer applied between the rows may have little or no effect on growth of the trees except possibly indirectly by its effect on the cover crop.

A tractor mounted whirlwind applicator is used in some groves which is driven around the tree to place the fertilizer under the drip of the branches. Its cost is in the neighbourhood of \$ 225 roughly Rs. 1000,-. It saves the grower more labour than any other tool on the farm.

Hume (1957) describes a machine commonly used for spreading fertilizer which consists of a truck with body space in which sacked fertilizer is carried, a hopper into which the fertilizer is fed, and two spinning disks at the rear separated by a step. The disks broadcast the fertilizer over the entire inter-tree spaces. It is operated by four men - a driver, two men who feed fertilizer into the hopper and a fourth who regulates distribution from the rear step by means of controls, one on each side of the hopper. A machine of newer type is operated by only one man.

2. Application through irrigation water: During recent years an increasing amount of nitrogenous fertilizer has been applied to citrus in irrigation water. The Shell Chemical Company markets anhydrous

ammonia in cylinders and by suitable arrangements this is released into weir boxes or open canals where water is being delivered to the acreage being fertilized. For other soluble N fertilizers such as ammonium sulphate, urea, sodium nitrate, etc., various methods of introducing this into irrigation water are now in use. They range from reservoir tanks with float valves so arranged that the concentrated fertilizer solution is delivered into the irrigation water to more crude methods where the bags of fertilizer materials are simply dumped into weir boxes or irrigation canals. Two ends are accomplished (1) economy in labour and (2) application of small, frequent doses of fertilizer during the irrigating season. Chapman (1958) estimates that more than 50% of all nitrogen now applied to California citrus orchards is through the irrigation water.

3. **Application through tonage sprays:** The fact that nutrient elements will enter the plant through the foliage has been used to advantage in the application of micro-nutrients for many years. Not until Hamilton *et al* in 1943, cited by Jones *et al* (1956) demonstrated that appreciable amounts of N could be absorbed through the foliage from urea sprays was interest aroused. They suggested that non-protein organic nitrogen (urea) could be applied to apple tree foliage without injury. Following this work it has been found that N could be applied to many plants by urea foliage sprays. Early in the work on citrus it was found that citrus is sensitive to biuret and that urea containing more than 0.25% biuret could not be safely used. Studies by Jones, *et al* (*loc. cit*) with Valencia oranges revealed that fruit production is reduced at low nitrogen levels. Fruit quality is affected above N levels required to maintain production. High N is associated with fruit that has thick peel, low percentage of juice and low ascorbic acid. Foliage application of one pound of N as urea is about equal to two pounds of N applied to the soil in maintaining production. Foliage application of N appears to be less detrimental to fruit quality than soil application.

Chapman (1947) observes that one pound of N per tree per year applied in three foliar applications has proven adequate. In many instances urea spraying could be combined with minor elements or insecticidal spray. Zinc, boron, copper, manganese and molybdenum are applied as foliage sprays, wherever possible in conjunction with insecticidal sprays. In Florida, very little nitrogen is applied in the form of foliage sprays although a certain amount is reported as being done.

Parker (1951) observes that sprays containing urea have been successful in increasing the nitrogen content of leaf to levels which have not been attained by very heavy fertilization of the soil. Preliminary indications are that three sprays a year (10 lb. per 100 gallons) will maintain yields at levels equal to those resulting from heavy soil applications of N fertilizers. However, two types of injury have frequently resulted from urea sprays. One, a chlorosis of the leaves when developing leaves were treated. It is severe when heavy concentrations are used. Burning of the tips or margins of leaves at times even more injurious, results in partial defoliation of the trees, which is more severe in orchards near the coast. Until a better understanding of these types of injury is obtained, the use of urea, according to Parker, is not generally recommended for citrus in California.

Experimental work with spray applications of P began in 1944—'45 (Parker, loc. cit). Strongly acidic compounds were found to be injurious to orange trees. In two subsequent experiments three sprays a year with nearly neutral or somewhat alkaline phosphates in solution or in suspension caused small increase in the P in the leaves and tended to reduce the thickness of the peel and a reduction in the acidity of the orange juice.

On the basis of three year's observations (Parker, loc. cit), the application to orange trees of three K sprays a year tended to increase the acidity of the orange juice and to increase the size of the fruit. It was observed that sodium was readily absorbed by orange leaves. This element is frequently present in citrus leaves in concentrations which approach toxicity and further absorption is not desirable. This may also be true of other elements such as chlorine. Low concentration of arsenic in sprays have long been known to reduce acidity of citrus fruit juices.

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## REFERENCES

- Camp, A. F. 1947 Excerpts from letters of Sub-Committee on fruit trees and nuts. *Proc. Nat'l Joint Comm. Fert. Applic.—Citrus Exp. Sta., Lake Alfred, Fla*
- Chapman, H. D. 1947 Methods of applying fertilizer (Citrus) in California. *Ibid.*
- Chapman, H. D. 1958 Report of Citrus Sub-Committee. *Ibid.*
- Coit, J. E. 1945 Application of nitrate to fruit trees. *Calif. Citrogr.* 30: 188.
- Harold Hume, H. 1957 *The cultivation of Citrus Fruits.* The Macmillan Co., New York.
- Jones, W. W. and C. B. Cree 1953 Fertilizer placement for Citrus. *Calif. Citrogr.* 38: 363.
- Jones, W. W., T. W. Embleton & M. L. Stainacker 1956 Urea foliage sprays on Citrus. *Proc. Nat'l Joint Comm. Fert. Applic. Citrus Exp. Sta., Lake Alfred, Fla*
- Parker, E. R. 1951 Present status of foliage application of Fertilizers to Citrus trees in California. *Ibid.*

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