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Leaf and soil analyses as guides for

Citrus Fertilizer Practices

in southern California orchards

Leaf and soil analyses are the best means of determining fertilizer needs for citrus orchards. On the basis of an initial orchard evaluation and preliminary leaf and soil analyses, current nutrient and salinity status can be assessed, and the grower can be advised whether his present fertilizer and soil management practices are right or wrong. Such analyses will tell him whether he is spending too much for nitrogen or not enough; whether he is applying fertilizers that are not needed; whether the levels of the minor elements should be built up or decreased; whether too much exchangeable sodium or potassium is building up in any part of the root zone; whether the soil is acid enough to require lime, or alkaline enough to require sulfur or gypsum, and whether to use acid- or alkaline-base nitrogen fertilizers.

Detailed studies of soil conditions and leaf analysis in citrus orchards show that, even in high-yielding and well-managed orchards, changes are sometimes indicated to help keep the orchards productive, anticipate possible nutritional troubles before they occur, and, in some cases, reduce fertilizer costs.

Three points are important in initiating a program of leaf and soil analysis: *1,* the need for thorough initial orchard and soil evaluation; *2,* the absolute necessity of securing proper and representative leaf and soil samples and insuring correct handling and analytical procedures; and *3,* continuity.

In the case of large operations, involving hundreds of acres, leaf and/or soil analyses are already being made in company-owned laboratories, usually by a trained horticulturist or agronomist.

For the smaller operator, a number of commercial laboratories specializing in agricultural analyses and consultation are available, as are commercial agricultural consultants. These are listed with farm advisor offices.

As the use of leaf and soil analysis increases, and expands to include other crops, current commercial facilities will be enlarged. Groups of growers may wish to establish cooperative laboratories on an area basis.

In getting started on a leaf and soil analysis program, acceptable leaf and soil sampling and handling techniques and accurate analyses are essential. Grab samples of leaves or of soils and application of quick-test methods are a waste of time, and the information derived is likely to be unreliable or actually misleading.

Another requirement, at least at the outset, is that a fairly complete leaf analysis be made. Ideally, an analysis of the soil should include not only pH and total soluble salts, but exchangeable bases, phosphate, and nitrate. If some unusual condition is suspected, soil and leaf analysis may need to go even farther at the outset. Also needed is a general orchard and management appraisal.

Another point that requires emphasis is the need for continuity in the program. Much valuable information will emerge from an initial orchard appraisal, but periodic check-ups are needed to determine whether practices changed as the result of analysis are producing the de-

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Single Value Citrus Leaf Analysis Standards Consistent with Top Performance[1]

(Based on 4- to 7-month old spring cycle orange leaves from fruit bearing terminals)

Element	Percent in dry matter of leaf	Element	Ppm in dry matter of leaf
Calcium(Ca)	5.00	Boron(B)	75.00
Magnesium(Mg)	0.40	Copper(Cu)	5.00
Potassium(K)	1.00[2]	Iron(Fe)	60.00
Sodium(Na)	0.05	Manganese(Mn)	35.00
Nitrogen(N)	2.40	Molybdenum(Mo)	0.20
Phosphorus(P)	0.12	Zinc(Zn)	25.00
Sulfur(S)	0.30	Arsenic(As)	<0.05
Chloride(Cl)	0.05	Bromine(Br)	<100.00
		Chromium(Cr)	<0.10
		Fluorine(F)	<20.00
		Lithium(Li)	<0.50
		Cobalt(Co)	<0.40
		Nickel(Ni)	<0.40

[1] These are the citrus leaf values toward which fertilizer and soil management practices should be aimed. Obviously their attainment will not necessarily guarantee maximum performnace for many other factors will influence yield and quality, as for example: moisture supply, insect infestation and insect control methods, soil microbiological conditions, climate, disease, variety and rootstock, and physical soil conditions.

[2] For smaller fruit, potassium levels should be at about half this percentage.

Some Tentative Soil Analysis Standards[1]

Measurement	Range consistent with excellent citrus performance
pH—(on 1:2.5 soil water suspension)	5.5–7.5
Soluble salts in saturation extract as measured by electrical conductivity—ECx10[3] (Millimhos)	0.2–1.9
Exchangeable bases as per cent exchange capacity	
(a) Calcium (Ca)	60.0–70.0
(b) Magnesium (Mg)	20.0–35.0
(c) Potassium (K)	5.0–10.0
(d) Sodium (Na)	Less than 5.0
Magnesium; Ratio Exchangeable $\frac{K}{Mg}$ (K and Mg expressed in milliequivalents/100 g. soil)	0.10–0.30
Phosphorus	
(a) Water soluble (by Bingham method)	1.00–4.00 ppm in dry soil
(b) 0.5 M. NaBicarbonate method (Olson, et al.)	More than 11 ppm in dry soil
Potassium	
(a) Exchangeable in milliequivalents (me/100 g. soil)	More than 0.25
(b) As per cent exchange capacity	5.0–10.0
Nitrate Nitrogen (N) in ppm dry soil	More than 5.0

[1] While these values are consistent with excellent citrus yields and quality, they, of course, do not guarantee it. Likewise satisfactory performance will be found in situations where there is considerable departure from these standards. As with leaf analysis standards, they are simply goals toward which soil management practices should be pointed.

ANALYSES

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sired end. Findings of the check-ups should be correlated with tree condition, yield, and quality.

For example, if potassium and magnesium are low in the leaf, subsequent analyses at yearly intervals will be needed to determine whether the fertilizer additions made are bringing about the desired change and how rapidly. Suppose the lower root zone shows excessive salt. Subsequent soil analyses will be needed to check on the effectiveness of the changed irrigation practices recommended.

Because of these several requirements, the costs involved are rather high. However, they can be reduced substantially by the grower who has the time or interest. Much of the initial appraisal information on orchard and soil can be supplied by him, and with a little help from his farm advisor he can learn how to take proper leaf and soil samples.

After the analyses have been made by an appropriate commercial laboratory, the farm advisor can help interpret them, and recommend changed practices where necessary.

Steady progress is being made in developing more rapid analytical procedures which are still sufficiently accurate, thereby cutting both time and cost of analyses.

The use of the flame photometer has greatly decreased costs of sodium, potassium, magnesium, and calcium analyses and a comparatively new instrument, the X-ray spectrophotometer, will enable costs to be reduced on a great many other elements. The spectrograph is also useful for many trace elements.

Work is continuing on determining current costs of initiating and carrying forward a program of leaf and soil analysis by present methods and techniques. This information will enable us to determine costs on a per acre basis so that growers can judge whether they can afford this type of service. It is certain that with improved analytical methods, proper organization, and sufficient volume, future costs can be greatly reduced.

Example of Leaf and Soil Analysis Values in a Mature High Producing Navel Orange Orchard

Nature of Orchard: Mature navel orchard in Arlington Heights area.
Age: About 64 years.
Average production for 3 years (1945–48): 7.2 field boxes/tree.
Size and quality: Excellent.
Soil: Greenfield sandy loam.
Culture: Cultivated: Volunteer weeds in winter.
Irrigation: Every 30 days with good quality water.
Fertilizer practices: Manure, ammonium sulfate, anhydrous ammonia.
Estimated nitrogen rate 500 lbs./acre/year.
Zinc sprays used regularly.

Leaf Analysis Data
(5-month old spring cycle leaves from fruit bearing terminals)

Percent in dry matter								Ppm in dry matter			
Ca	Mg	K	Na	N	P	S	Cl	B	Cu	Fe	Mn
5.04	0.24	1.07	0.07	2.76	0.12	0.39	0.10	55	4.2	49	11

Soil Analysis Data

Soil depth	pH on paste	Elec. Cond. of Sat. Extr. $EC \times 10^6$	Exch. Cap. me/100 g.	Exchangeable bases in % Exch. Cap.				Ratio	Phosphate (PO_4) (Ppm dry soil)	
				Ca	Mg	K	Na	K/Mg	water sol.	acid sol.
0 –6″	6.9	3.57	9.74	76.8	13.1	8.6	1.5	0.65	1.1	1763
6″–18″	6.9	1.54	6.86	66.1	20.8	10.7	2.3	0.51	0.9	810
18″–36″	7.2	1.13	6.86	63.8	25.4	8.6	2.2	0.34	0.4	336
36″–48″	7.2	0.94	9.44	62.8	30.5	3.6	3.1	0.12	0.2	396

Evaluation

1. Nitrogen: Decrease rate to 200–300 pounds per acre.
2. Potassium: Level in leaf and soil satisfactory; discontinue manure for a few years.
3. Phosphorus: High in soil; discontinue manure for a few years.
4. Magnesium: Leaf and soil values indicate desirability of raising levels somewhat, suggest adding magnesium sulfate (epsom salts) at 5 lbs./tree for several years until leaf levels are brought up to 0.30–0.40%.
5. Sulfur: A little high, use NH_4NO_3 or urea in place of $(NH_4)_2SO_4$.
6. Micronutrients: Manganese low; include manganese with future zinc sprays.
7. Soluble salts: A little high in surface, but winter rains will probably flush this down into lower horizons; conditions there are satisfactory. These data indicate that irrigation practice from the standpoint of salt accumulation is satisfactory.
8. pH: Is in satisfactory range.

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The foregoing article is based, in part, on Leaf and Soil Analysis in Citrus Orchards *by H. D. Chapman, Manual 25 (75¢).*

Role of pantothenic acid in

EMBRYONIC DEVELOPMENT

Congenital abnormalities of children and of livestock may result from a deficiency of certain essential nutrients in the diet of the mother.

Research in progress at Davis is studying the role of pantothenic acid—one of the B-complex vitamins—in embryonic development. Pantothenic acid functions in the body as a part of a specific coenzyme—Coenzyme A—a molecule necessary for many important chemical reactions in the body. Analyses of Coenzyme A activity, and of pantothenic acid content, in the tissues of embryos are being made periodically during gestation to learn when the embryo is able to convert the vitamin to the active coenzyme form.

Current experiments are designed to determine whether certain periods of pantothenic acid deficiency in the mother's diet during gestation will produce congenital abnormalities in the offspring, and to correlate such changes with levels of the vitamin and the coenzyme in the embryonic tissues.

Such experiments may lead to a better understanding of the mechanisms responsible for the occurrence of congenital abnormalities, and may also help to clarify the functions of nutritional factors in metabolism.—*Lucille S. Hurley, Dept. of Home Economics, Davis.*

Inventory of uplands by

SOIL-VEGETATION SURVEY

A study of soils and associated vegetative cover of foothill and mountainous lands is being conducted by the State Cooperative Soil-Vegetation Survey to gain basic information for the best use of the acreage for timber, forage, water, and recreation.

One part of the work—specifically for range management purposes—is a study of the nutrient relationships of herbaceous vegetation associated with various soil series. The nutrient relationships are determined by greenhouse pot tests and field fertilizer trials.—*W. Robert Powell, Dept. of Agronomy, Davis.*