Citrus Leaf Analysis

nutrient deficiencies, excesses and fertilizer requirements of soil indicated by diagnostic aid

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Analysis of citrus leaves as an aid in the diagnosis of the nutritional status of orchard trees—with particular attention given to the potassium state of orange trees—has been under study for a number of years at the Riverside Experiment Station.

Extensive experimental work indicates that when values for total potassium in three- to seven-months-old orange leaves fall below 0.35%, trials with potassium fertilizer should be made in the orchard from which the leaves were taken.

If the potassium values are higher than 0.40% it is doubtful whether yield responses to potassium fertilizer will be obtained. If the values are 1.50% to 2%—or beyond—deficiencies other than potassium should be looked for, since this level may suggest nutrient unbalance within the tree.

As part of these studies all available information—on levels of inorganic constituents associated with or suggestive of nutrient deficiencies and excesses—was tabulated.

The critical values for the other elements—shown in the accompanying table—are less well established than for potassium. Considerable information exists, however, which suggests that when values for any one of these elements fall below or are in the neighborhood of those listed in the table, that particular element may be deficient and field tests should be started.

The values given in the table are for spring cycle orange leaves of a given range in age of three to seven months—leaves which emerged at the time of bloom in the spring and which have attained an age of three to seven months. This means that only spring cycle leaves picked from orange trees in the period of July through October—under California conditions—should be used for analysis if these standards are to be applied.

To be sure of the age of the leaves it was the practice in these studies to take leaves from behind the green fruit and from shoots which emerged in the spring. Usually, anywhere from one to five or six leaves were found on such shoots, and any one of these leaves was selected.

In general, 20 to 30 leaves—one per shoot—were taken in a circle around the tree. About 10 trees in a representative part of the orchard were thus sampled and all of the leaves combined into one sample.

The leaves were either washed individually in tap water and rinsed in distilled water or else individually wiped with dampened clean cheesecloth. The leaves must not have dried out prior to this cleaning procedure.

If the samples have to be stored a few days before cleaning, it is good practice to put them in cellophane bags, and if possible store them in a refrigerator.

After cleaning, the leaves should be air-dried or oven-dried, then crushed or ground, and appropriate sized samples taken for analysis. Standard methods of analysis were used in the studies, since the errors involved in quick tests or methods which give approximations are likely to be sufficiently off to invalidate the interpretation, especially when the values for a given element are in the vicinity of the critical levels.

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Inorganic Composition of Orange Leaves Associated with or Suggestive of Mineral Deficiencies or Excesses, and Range of Values Found in High-Performance California Orchards

Element	Per cent in dry matter of 3- to 7[1]-month-old spring-cycle orange leaves				Effect of deficiency of element in column (1) on direction of[2] change in other constituents when compared to healthy leaves of like age, or to average values shown in column (4)											
	Associated with or suggestive of deficiency < means less than > means more than	Range and average in high-performance orchards: Range	Av.	Associated with or suggestive of excess or nutrient unbalance	N	P	S	Ca	Mg	K	Fe	Mn	Zn	B	Cu	Mo
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Nitrogen (N)	< 2.00	2.00 –3.16	2.45	> 3.50?	....	Incr.	Incr.	SL Decr.	SL Decr.	Incr.	?	?	?	?	?	?
Phosphorus (P)	0.075	0.092 –0.182	0.13	0.30	Incr.	....	?	Decr.?	Incr.?	Incr.	?	?	?	?	?	?
Sulfur (S)	0.130?	0.200 –0.300	0.25	0.40	Incr.	Incr.	....	Decr.	Incr.	Incr.	?	?	?	?	?	?
Calcium (Ca)	1.500?	3.00 –5.52	4.70	7.00	?	Decr.	?	....	Incr.	Incr.	?	?	?	?	?	?
Magnesium (Mg)	0.150	0.20 –0.40	0.30	0.60	Decr.	Decr.	?	Decr.	....	Incr.	Incr.?	Decr.?	?	?	?	?
Potassium (K)	0.350	0.38 –1.12	0.71	2.00	Incr.	?	?	Incr.	Incr.	....	?	?	?	?	?	?
Iron (Fe)	0.005	0.007 –0.020	0.12	?	?	?	?	Decr.	?	Incr.	....	?	?	?	?	?
Manganese (Mn)	0.0015	0.002 –0.008	0.003	0.02	?	?	?	?	?	?	?	....	?	?	?	?
Zinc (Zn)	0.0015	0.002 –0.008	0.003	?	Incr.	Incr.	Incr.?	Decr.	Incr.?	Incr.	Incr.?	?	....	?	?	?
Boron (B)	0.0012	0.002 –0.010	0.004	0.020	Incr.	Decr.	?	Decr.	Decr.	Incr.	...	....	....	....	....	...
Copper (Cu)	0.0004	0.0004–0.010	0.007	0.0015	?	?	?	?	?	?	?	?	?	?	....	?
Molybdenum (Mo)	.00002	0.0002–0.001	0.0005	?	?	?	?	?	?	?	?	?	?	?	?	....
Sodium (Na)	Not essential	0.02 –0.15	0.06	0.25	?	?	?	?	?	Decr.	?	?	?	?	?	?
Chlorine (Cl)	Not essential	0.02 –0.20	0.08	0.25	?	?	?	?	?	?	?	?	?	?	?	?

[1] All of the data and information of this table, while based on a considerable amount of information, should be regarded as tentative and of suggestive or general guidance value only. No doubt as more information develops it will be necessary to alter these values somewhat. When a question mark (?) follows a figure it means that while some data exists, a greater element of doubt exists as to the value than where no question mark is entered.

[2] Insufficient information is available to assign numerical values indicating the exact change in composition of these various elements when another element is deficient. However, the direction of change is well established in many cases and by referring to column (3) where the normal range of values associated with good performance is given, a broader base for estimating or judging nutritional status is provided.

SWINE

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was run with three 240 pound hogs at a room temperature of 100° F.

All were distressed, with an average body temperature of 106.8° F and an average respiratory rate of 150 breaths per minute. When four liters of water at 100° F were poured on the floor to make a wet area, the hogs began to roll in the water immediately. In twenty minutes the body temperatures were lowered an average of 1.0° F and the respiratory rate lowered by 50%. In 90 minutes the body temperature was lowered by 2.0° F and the respiratory rate by 80%.

Air Motion

In another experiment three hogs weighing around 250 pounds were on a wet floor at approximately 119° F. Air motion in the chamber varied from 20 to 30 feet per minute at hog level. A fan was turned on, which increased the air motion to an estimated average of 175 feet per minute, but varying from 100 to 250 feet. In 30 minutes, the respiration was lowered by about 60%, and the body temperature was reduced on the average about 2.5° F. In 80 minutes, the body temperature was reduced an average of 3.0° F, when the hogs were on the wet floor with an accelerated rate of air motion.

In contrast, four pigs averaging about 100 pounds were on a dry floor at 113° F. The fan was turned on, increasing the air velocity as before. At first the respiratory rate and body temperature decreased slightly, since it was not possible to have the floor completely dry and the hogs were slightly damp. As the floor and hogs dried, the respiratory rate and body temperature increased again to that at the start.

After five hours with the accelerated air motion and a dry floor, there was no apparent benefit to the comfort of the animals. This type of experiment has been repeated with four hogs averaging 187 pounds at 99° F and another four hogs averaging 236 pounds at 100° F, with no apparent effects.

As the air temperature rose above 80° F the animals became increasingly lazy and lay flat on the floor. The light weight pigs weighing around 100 pounds were still fairly active at 80° F.

Under the conditions of these experiments, with constant temperatures, swine weighing around 100 pounds utilized feed to a greater degree and gained weight more rapidly in the neighborhood of 75° F, whereas heavier weight hogs weighing approximately 200 pounds did better in the neighborhood of 60° F.

As the air temperature was increased or decreased beyond these averages, rate of gain declined and utilization of food was lowered.

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BUDS

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buds were growing on lots 1 and 4 but none on lots 2 and 3. Visible growth of a few buds on the latter two lots did not occur until June 27th. In the succeeding days the number of growing buds increased on all lots of trees, but many more grew on lots 1 and 4 than on lots 2 and 3. The maximum numbers of growing buds were reached on July 3d on lots 1 and 4, but not until July 15th on lots 2 and 3. The final number of buds which grew were as follows: lot 1, 84%; lot 2, 29%; lot 3, 50%; lot 4, 72%; of the total buds present.

It is clear that the treatments applied to lots 2 and 3 both retarded the rest breaking process in comparison with those applied to lots 1 and 4. The retardation expressed itself in two ways: in the smaller numbers of buds growing and in the slowness with which they started growth. In the smaller illustration are shown two trees from each lot, the one with least and the other with most buds growing. The trees in lots 2 and 3 resemble those in the larger photograph which had received too short cold treatment—less than 50 days.

Lots 2 and 3 received a cumulative exposure at 37° F of 52 days, the same as lot 4 received without interruption.

It is apparent that a few hours daily warm treatment partly offset the effect of 18 hours daily cold treatment.

Although lots 2 and 3 were both strongly retarded in comparison with lots 1 and 4, nearly twice as many buds grew on lot 3 as on lot 2.

The average temperature outdoors during the daily warm treatment of lot 3 was 9° F lower than that to which lot 2 was subjected. This difference in temperature may have caused the difference in behavior, but there is also the possibility that the strong summer sunlight may have stimulated growth of buds on lot 3. Strong radiation such as X rays in suitable dosage has been shown to break the rest of buds, and some evidence exists that ordinary light shortens the rest of certain buds. In the orchard it has been generally believed that much direct sunlight during the winter days tends to prolong the rest because it raises the temperature of twigs and buds somewhat. The part that light of varying intensity may play in retarding or hastening the ending of the rest is still not very clear. It may at winter intensities and duration be a retarding influence and become a stimulating influence at the higher intensities and longer duration of spring and summer.

The gardner and orchardist in regions of mild winters is thus confronted with a rather complicated situation involving temperature, light, variation of response of different kinds of plants, and possibly other factors, all of which affect spring growth. It appears clear from experience, however, that shade in winter is beneficial for plants with strong rest periods. It seems a reasonable deduction from the experimental results described above that plants subjected to fluctuating outdoor conditions may require a longer exposure to break the rest of buds than would be required under continuous low temperature.

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The above progress report is based on Research Project No. 989.

CITRUS

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The range of values and the average for each of the constituents in a group of high performance California orange orchards are shown in the table. A section—columns six to 17 inclusive—shows the effect of a deficiency of any given element in the direction of change in other elements, insofar as information is available. These standards are tentative and may need to be shifted in one direction or another as more information develops.

Use of Table on Page 10

As an example of the use of this table: suppose a sample of orange leaves has been collected, cleaned, and analyzed.

If the total nitrogen turns out to be 2% or less, this would suggest that nitrogen may be limiting—deficient—in the orchard sampled. With nitrogen levels of 2% or less, it could be expected to find that other elements—columns six to 17—shifted in the directions indicated. Thus phosphorus likely would be increased, and values greater than 0.13% might be expected.

Total sulfur would be slightly increased, and values greater than 0.25% might be slightly decreased from the average values shown in column four, while potassium would be increased.

Though no actual values for other elements can be stated with certainty when

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