LEAF ANALYSIS FOR CALIFORNIA DECIDUOUS FRUITS

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Leaf analysis of tree fruits can be used to identify nutritional problems, to detect low levels of nutrients before harmful deficiencies occur, and to measure tree responses to applied fertilizers. Such analyses are extremely helpful in identifying multiple deficiencies and excess levels. They also provide a basis for determining the effects of nutrient levels on the performance of trees growing in different climates and under different management practices. Certain toxicities (B, Cl, Na) may be detected by leaf analysis but should be confirmed by soil analysis. Tissue analyses are not a substitute for careful observation of non-nutritional factors such as diseases, pests, soil depth and moisture, crop control, and generally good horticultural practices.

SAMPLING

Results of a leaf analysis can be no better than the sampling and analytical procedures used. Only fully-expanded, mature leaves, 2 to 5 months old, are satisfactory for leaf samples for deciduous fruit and nut trees. In California, all leaf analysis standards are based on spur leaves (almond, apple, apricot, cherry, pear, plum, prune) and basal to mid-shoot leaves for peaches. Leaves from non-fruiting spurs are easiest to collect and give the most consistent results. The critical levels of nutrients presented here are for the June-July period, but samples may be taken in August or September if interpretation of results is adjusted for seasonal effects.

Ideally, every 10 acres of an orchard, every soil type, and every variety should be sampled separately. Growers, however, prefer to sample problem blocks and take a few samples per year from good blocks. Answers to problem areas are often found by comparing samples from the problem areas with samples from good areas in the same orchard.

The sampling unit should represent trees of the same age, variety, and rootstock, growing on similar soils of the same fertility level. Each sample should be collected so that leaves come from representative trees over the entire sample area. Leaves may be picked 4 to 6 feet from the ground, should be of the same chronological age and type, and should come from different sides of the trees. Where samples taken annually are to be compared, the pattern of sampling should be the same; better yet, samples should be taken from the same marked trees or rows. All off-type trees, odd varieties, replants, and atypical trees and leaves should be avoided. Each leaf sample should be large enough to adequately represent the orchard or plot, and to provide sufficient tissue for analysis of several elements. Adequate samples consist of at least 40 leaves from small plots, or 100 leaves from orchard blocks of 10 to 20 acres.

Most of the California leaf analysis standards are based on samples of 60 to 100 leaves. Size of leaf is also an important consideration. Commonly about 60 to 80 peach or pear leaves are used per sample, 30 fig leaves, and 80 to 100 almond leaves. Where small plots are being checked, ten leaves are taken from each tree, and the total sample may involve four to eight trees. For a random sample of an orchard, only one leaf is taken from each of 50 to 100 trees spread over the orchard area. Leaves may be collected by walking up one row and returning on another row about 200 to 400 feet away.

Sample handling. Normally, leaves are collected in paper bags and stored in portable ice chests. Plastic bags are often used, especially for samples that must be kept fresh for several days until washed. Leaves in plastic bags must be kept cool and protected from direct sunlight.

Leaves to be analyzed for macronutrients usually need not be washed. If micronutrient analyses (B, Cu, Mn, and Zn) are to be made, leaves should be washed in water containing a small amount of detergent followed by rinsing in tap water and by two distilled water rinses. Leaves should be dried in forced-draft ovens at 65° to 70°C.

Spray residues of micronutrients cannot be washed off leaves satisfactorily, so it is worthless to analyze micronutrient-sprayed leaves. Where N and K sprays are used, the amount of macroelement spray residue is small compared to total content of N and K in the leaf, and therefore analyses can be safely made a week after application.

CRITICAL NUTRIENT LEVELS

Table 4 gives critical nutrient levels in leaves for all of the major deciduous fruit and nut crops of California. The values are total content of nutrients listed and are based on June-July samples, although August and early September samples may be used if 0.2 percent is subtracted from June-July levels for N and K. Values for other elements are about the same for August and for June-July samples. Excess levels of N are indicated by the underlined values. Excesses of B, Cl, and Na are shown. Concentrations associated with excesses of other elements are unknown.

When properly sampled and analyzed, differences of 10 percent between nutrient levels are significant at the 95 percent confidence level. Reasons for variations in nutrient concentrations from year to year are not always obvious. Size of crop markedly affects nutrient levels. Excessive crops reduce the percentage of K, increase Ca and Mg levels, but have little effect on the micronutrients. High levels of available soil moisture tend to increase P, K, Mg and Ca levels, presumably due to better root activity, and to decreased percentage N due to dilution by growth. Other seasonal variations are due to weather or cultural practices.

FOLLOW-UP RECOMMENDATIONS

Nitrogen. As leaf color and shoot growth are only fair indicators of the N status of most fruit crops, annual leaf samples will help maintain N levels within reason.

If leaf analysis shows N levels in excess of optimum, reduce the application rate next year by one-half and repeat the leaf analysis. If this fails to bring N within the optimum range, apply none or at most only 50 pounds of N per acre annually until adjustment occurs. Other sources of N (as from irrigation water) should be checked to determine the sources of the excess.

If trees are N-deficient, existing rates of N fertilization should be doubled or raised to the level common to the area. Where sod or summer cover crops are used, at least 75 pounds of N per acre must be added for use by the cover crop. In addition to cover crop use, fruit crops grown in the San Joaquin and Sacramento valleys need 100 to 200 pounds of N per acre. Some fruit crops in the coastal areas (apricots and prunes) need about 60 pounds of N per acre. Usually, N is applied in the late summer or early fall. Orchards on sandy soils may be benefited by split applications (winter and spring). Early season shipping apricots and peaches should not be fertilized until after the crop is picked, and then, for early maturity, apply about 40 pounds of N per acre for apricots and 80 pounds per acre for peaches.

Potassium. Deficiencies of K can usually be corrected by an application of 1 ton per acre of K_2SO_4 drilled 6 to 8 inches deep in one to two bands on opposite sides of the tree row. This rate works for both low density (75 trees per acre) and high density orchards (300 trees per

TABLE 4. CRITICAL NUTRIENT LEVELS IN THE LEAVES OF FRUIT AND NUT TREES (JULY SAMPLES)*

	N†		K‡		Ca	Mg	Na	Cl§	B			Zn
Crop	Defic. below	Adequate	Defic. below	Adequate over	Adequate Over	Adequate Over	Excess Over	Excess Over	Defic. below	Adequate	Excess over	Adequate over
	%	%	%	%	%	%	%	%	*ppm*	*ppm*	*ppm*	*ppm*
Almonds	2.0	2.2-2.5	1.0	1.4	2.0	0.25	0.25	0.3	25	30-65	85	18
Apples	1.9	2.0-2.4	1.0	1.2	1.0	0.25	-	0.3	20	25-70	100	18
Apricots (ship)	1.8	2.0-2.5	2.0	2.5	2.0	-	0.1	0.2	15	20-70	90	16
Apricots (can)	2.0	2.5-3.0	2.0	2.5	2.0	-	0.1	0.2	15	20-70	90	16
Cherries (sweet)	-	2.0-3.0	0.9	-	-	-	-	-	20	-	-	14
Figs	1.7	2.0-2.5	0.7	1.0	3.0	-	-	-	-	-	300	-
Olives	1.4	1.5-2.0	0.4	0.8	1.0	0.10	0.2	0.5	14	19-150	185	-
Nectarines and Peaches (freestone)	2.3	2.4-3.3	1.0	1.2	1.0	0.25	0.2	0.3	18	20-80	100	20
Peaches (cling)	2.4	2.6-3.5	1.0	1.2	1.0	0.25	0.2	0.3	18	20-80	100	20
Pears	2.2	2.3-2.8	0.7	1.0	1.0	0.25	0.25	0.3	15	21-70	80	18
Plums (Japanese)	-	2.3-2.8	1.0	1.1	1.0	0.25	0.2	0.3	25	30-60	80	18
Prunes	2.2	2.3-2.8	1.0	1.3	1.0	0.25	0.2	0.3	25	30-80	100	18
Walnuts	2.1	2.2-3.2	0.9	1.2	1.0	0.3	0.1	0.3	20	36-200	300	18

Adequate levels for all fruit and nut crops: Phosphorus (P) is 0.1-0.3%; copper (Cu), over 4 ppm; Manganese (Mn), over 20 ppm.

* Leaves are from nonfruiting spurs on spur-bearing trees, fully expanded basal to mid-shoot leaves on peaches, and olives, and terminal leaflet on walnut.

† Percentage N in August and September samples can be 0.2-3% lower than July samples and still be equivalent. Nitrogren levels higher than underlined values will adversely affect fruit quality and tree growth. Maximum N for Blenheims should be 3.0% and for Tiltons, 3.5%.

‡ Potassium levels between deficient and adequate are considered "low" and may cause reduced fruit sizes in some years. Potassium fertilizer applications are recommended for deficient orchards but test applications only for "low" K orchards.

§ Excess Na or Cl cause reduced growth at the levels shown. Leaf burn may or may not occur when levels are higher. Confirm salinity problems with soil or root samples.

acre). In heavy clay soils and those soils where 1 ton has proved inadequate, applications of 2 tons per acre are advisable. For the acid sandy soils of the Merced area, 500 to 1,000 pounds per acre of K_2SO_4 are adequate, even when broadcast on the surface. Repeat applications are needed only when leaf analysis again shows low K levels, which may occur in 3 to 5 years. Results from K applications to the soil can occur the first year, but usually require 2 years after application.

Foliar sprays of 8 pounds of KNO_3 per 100 gallons of solution (30 pounds per acre) applied 4, 6, 8, and 10 weeks after full bloom have been beneficial in reducing K deficiency in prunes and may help other species. Potassium nitrate sprays may supplement soil applications for correction of K deficiency.

Orchards under sod or nontillage will show less K deficiency than those normally disked. Permitting roots to grow in surface soils increases uptake of K.

Crop control is essential to control K deficiency in fruit crops such as prunes which set excessive crops. Overcropping results in poor top and root growth. Dieback of prune tops will cause reduction of bearing surface and tend toward alternate cropping. Crop control is best obtained by chemically thinning fruit at blossom time, or by thinning fruit mechanically or chemically 30 to 45 days after bloom. Good irrigation practice, crop control, and K fertilizer applications will usually correct all forms of K deficiency.

Phosphorus. Deficiency of P is rare in fruit crops but can occur in trees growing on soils very low in available P. It can be corrected with surface applications every 3 years of 5 to 6 cubic yards of chicken manure or 1,000 pounds per acre of treble superphosphate. Broadcast applications have been effective, but strip or ring applications at the drip-line of the tree are better.

Magnesium. Deficiencies of Mg are rare in California fruit orchards, and control procedures have not been adequately checked. Sprays of $Mg(NO_3)_2$ may be necessary with heavy soils, or dolomitic lime applications to acid soils.

Zinc. Deficiencies of Zn must be corrected by foliar or dormant sprays. Recommendations vary among crops, thus general recommendations are given.

Spring foliage applications give good correction and are most practical. Applications of 4 to 5 pounds of basic Zn-sulfate (50 percent Zn) per 100 gallons of spray solution to supply 12 to 20 pounds of basic Zn-sulfate per acre are generally perferred, although 4 pounds of Zn-oxide per 100 gallons are satisfactory. An application of 2 pounds of Zn-EDTA per 100 gallons is also corrective. In prunes and plums, phytotoxicity may result should rain occur shortly after the Zn application. For walnuts and cherries, both of which absorb Zn poorly through their leaves, repeat applications of 2 pounds of Zn-EDTA per 100 gallons or ½ to 1 pound of Zn-sulfate per 100 gallons have been successful.

Fall foliar applications of 5 to 10 pounds of Zn-sulfate (36 percent Zn) per 100 gallons (20 to 40 pounds per acre) give good correction if made in October before leaf drop. Sprays will burn leaves and give correction in almonds, apricots, cherries, and pears. Some injury can occur on peaches, so the lower rate is maximum.

Dormant applications of Zn help to correct deficiency but are less satisfactory or practical than are foliage sprays. Rates of 10 to 20 pounds of Zn-sulfate per 100 gallons of spray (25 to 50 pounds per acre) will correct Zn deficiency. *Zinc sulfate and oil will cause injury and should not be applied within 30 days of each other during the dormant period.*

In severe cases of Zn deficiency, dormant and foliage applications should be made in the same year. Annual maintenance applications of Zn are desirable in areas of severe deficiency.

Manganese. Deficiencies of Mn in fruit trees can be corrected by foliage sprays of 1 to 2 pounds of Mn-sulfate or Mn-EDTA per 100 gallons (4 to 8 pounds per acre) applied in April.

Copper. Deficiencies of Cu in pears, walnuts, or apples can be corrected by foliage sprays of Cu-EDTA or Bordeaux mixture.

Boron. Deficiencies of B are corrected by soil applications of 50 pounds of borax per acre. Foliar sprays of 1 pound of "Solubor®" per 100 gallons of solution give control of B deficiencies for 1 or more years.

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