

Chapter 7

Interpreting Soil Nutrient Analysis Data

Definition of “Low,” “Sufficient,” and “High” Nutrient Levels

R. S. Yost and R. Uchida

What do the terms “very low,” “low,” “sufficient,” “high,” and “very high” mean when used in soil analysis reports? These interpretations of the analysis data are intended to help you understand the soil fertility level. The terms indicate, in general, what actions are required in managing nutrients in the next crop. They do not indicate how much nutrient should be added, or why. That is the function of the next steps in processing the analytical data and information about the cropping system.

When a soil sample is analyzed, the amounts of nutrients and the soil pH are measured, and these numbers must be interpreted in order for them to be meaningful. A similar situation occurs when a medical technician measures your blood cholesterol: a number will be obtained, but the meaning of the number awaits the interpretation of someone with experience or research on the effects of such values. The important thing to remember is that the analytical value has little meaning unless it is related to research, a nutrient survey, or previous studies with your soil or similar soils. The necessary research to allow a realistic interpretation is outlined in Chapter 8.

Table 7-1 (from Tamimi et al. 1994) lists generalized adequate soil fertility levels for acidity, phosphorus, potassium, calcium, magnesium, and salinity for soils of three textures. Table 7-2 provides generalized interpretations intended to help you decide which soil nutrients must be supplemented to support an intended crop. If you have been growing a particular crop on an

established farm, the interpretations can help you decide if changes in your fertilization program are needed.

Fertilizer recommendations are based on analysis data and the other data that you provide about your cropping system. The recommendations also consider the particular crop, possible interactions among the nutrients applied, and many environmental factors.

Soil pH is one factor that can affect interpretation of data for certain nutrients. For example, in a soil with very low amounts of micronutrients and a high pH, micronutrient problems will be observed much more quickly than in a soil with very low amounts of micronutrients and a low pH. Thus, in determining micronutrient sufficiency, evaluating micronutrient levels is only part of the story.

Another soil characteristic affecting the categorization of analysis data into ranges is the soil texture, as measured by its bulk density. “Heavy” soils with high clay content have a bulk density of about 1 gram per cubic centimeter; “light” soils with less clay and more sand and silt size particles have a bulk density of about half that (0.5 g/cc). And, in Hawaii, a group of very young soils derived from *a‘ā* lava, consisting mostly of crushed lava and some organic matter, require special interpretation of nutrient levels.

Soil texture also affects recommendations of fertilizer applications to bring nutrient levels into the range of general adequacy. Table 7-3 shows how textural classification can result in broad variation in recommendations for phosphorus and potassium applications in Hawaii.

Table 7-1. Generalized adequate soil test analysis levels for soils in Hawaii.^a

Soil property		Heavy soil ^b	Light soil ^c	A'ā land ^d
Acidity	(pH) ^e	5.8–6.2	5.8–6.2	5.5–6.2
Phosphorus	(ppm P) ^f	25–35	50–85	80–100
Potassium	(ppm K) ^g	200–300	200–400	400–600
Calcium	(ppm Ca) ^g	1500–2000	3000–4000	1500–2000
Magnesium	(ppm Mg) ^g	300–400	600–800	300–400
Salinity	(EC, mmhos/cm) ^e	< 3.0		

^aAdapted from *Adequate nutrient levels in soils and plants in Hawaii (general guide)* by Y.N. Tamimi, J.A. Silva, R.S. Yost, and N.V. Hue; CTAHR publication AS-3, 1997. The levels given are thought to be adequate for vegetable crops, while slightly lower levels may be adequate for tree crops and pastures. Crops with limited root volume or grown in media with very low bulk density may respond to higher levels of soil-available nutrients.

^bSoils with bulk density close to 1.0 g/cm³.

^cSoils with bulk density close to 0.5 g/cm³.

^dA'ā lands have young soils derived from a'ā lava and are typical of the Puna region of the island of Hawaii.

^eMeasured as paste in distilled water; EC (electrical conductivity) tolerance varies among crops.

^fExtracted with the Modified Truog method (0.01 M H₂SO₄ + 0.02 M (NH₄)₂SO₄ with a soil:solution ratio of 1:100.

^gExtracted with neutral 1 M ammonium acetate with a soil:solution ratio of 1:20.

Table 7-2. Conditions and actions indicated by levels of pH and nutrients in a standard soil test.

Soil test level	Factor measured				
	Soil pH	Phosphorus	Potassium	Calcium	Magnesium
Very low	Your former fertilizer program was inadequate; you need both to add nutrients and change the fertilizer program.				
Low	Low pH has many adverse effects, including toxicities as well as low amounts of Ca and Mg	Soil P levels are inadequate; P fertilizer is needed	Soil K is too low for most plants; K fertilizer is needed; perhaps K is leaching (too much water?)	Soil Ca is too low for most plants; liming is the low-cost alternative	Soil Mg is too low for most plants; Mg needed either as Mg sulfate or dolomite, depending on soil pH
Sufficient	No need for additional fertilization				
High	Levels are higher than desired, but not likely to be a problem				
Very high	Soil pH is too high and could result in micronutrient deficiencies, low P, and other nutrient imbalances; the liming program should be revised	Soil P is too high; too much P has been added, which could lead to micronutrient deficiencies; environmental contamination could result; the fertilizer program should be revised	Soil K is too high; this could lead to nutrient imbalances, especially with Mg; the fertilizer program should be revised	Be prepared for problems such as nutrient imbalances, particularly micronutrient problems; the fertilizer program should be revised	Soil Mg is too high; in some cases, Ca/Mg ratios less than 1 can be detrimental; the fertilizer program should be revised

Table 7-3. Generalized soil phosphorus and potassium recommendations (without plant or site considerations).**Soil phosphorus recommendations**

Soil test results (ppm)	Heavy soils	Light soils (pounds P ₂ O ₅ per acre)	A'ā land
0 – 12.5	620–890	2140–2630	370–420
12.5 – 25	360–620	1660–2140	310–370
25 – 35	160–360	1270–1660	260–310
35 – 50	0–160	680–1270	190–260
50 – 60	0	290–680	150–190
60 – 80	0	0–290	60–150
80 – 100	0	0	0–60

Soil potassium recommendations

Soil test results (ppm) (ppm)	Heavy soils	Light soils (pounds K ₂ O per acre)	A'ā land
0 – 50	290–360	360–430	650–720
50 – 100	220–290	290–360	580–650
100 – 150	140–220	220–290	510–580
150 – 200	70–140	140–220	430–510
200 – 250	0–70	70–140	360–430
250 – 300	0	0–70	290–360
300 – 350	0	0	220–290
350 – 400	0	0	140–220
400 – 450	0	0	70–140
450 – 500	0	0	0–70

Notes: Soil test results are parts per million (ppm); however, the equivalent units mg/kg or mg/liter are preferred. Heavy soils have a bulk density of about 1 g per cubic centimeter. Light soils have a bulk density of about 0.5 g/cc. A'ā lands have young soils derived from a'ā lava and are typical of the Puna region of the island of Hawaii. (Data provided by R. Uchida, CTAHR Agricultural Diagnostic Service Center)

When soil levels of a nutrient are “very high,” it is an indicator of the likelihood of problems due to nutrient imbalances; it also suggests the possibility of environmental pollution from the field. Such levels may be the result of overapplication of fertilizers or excessive amounts of sewage or animal waste, and in such cases the fertilizer program should be revised, and the nutrient in excess should be withheld until its level declines.

On the other hand, when soil measurements are categorized as “very low” or “low,” the recommendation is usually to add nutrients. The term “very low” suggests that in addition to a simple addition of the specific nutrient, there should be a change in the fertilization program (for existing farms) or a major correction of the extremely low nutrient levels (in the case of newly farmed land).