

Adequate Nutrient Levels in Soils and Plants in Hawaii (General Guide)

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This fact sheet presents a practical guide to the soil fertility status (Table 1) and sufficiency ranges for nutrients in tissues (Table 2) of some crops grown in Hawaii. This information is useful for targeting fertilizer application levels for sustained agricultural production and protecting our environment from pollution resulting from overapplications.

Soils of Hawaii are divided into three main groups: “heavy” soils developed from alluvial or volcanic rocks, “light” soils developed from volcanic ash, and a’ua lava land, predominantly composed of broken lava rocks mixed with some fine soil particles and organic matter. These groups were selected to simplify diagnosis, because soil bulk density, clay mineralogy, and other pertinent soil characteristics affecting soil fertility are relatively similar within each group but substantially different among the groups.

Table 1. Soil analysis levels generally considered adequate for three broad soil bulk density categories in Hawaii¹.

Soil property	Unit	Heavy soils ²	Light soils ²	A’ua land
Acidity ³	pH	5.8 – 6.2	5.8 – 6.2	5.5 – 6.2
Phosphorus ⁴	P (ppm)	25 – 35	50 – 85	80 – 100
Potassium ⁵	K (ppm)	200 – 300	200 – 400	400 – 600
Calcium ^{5,6}	Ca (ppm)	1500 – 2000	3000 – 4000	1500 – 2000
Magnesium ^{5,6}	Mg (ppm)	300 – 400	600 – 800	300 – 400
Salinity ³	EC (mmhos/cm)	< 3.0	< 3.0	

¹These levels 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 a very low bulk density may respond to higher levels of soil-available nutrients.

²Bulk density of heavy soils = ~1.0 g/cm³, light soils = ~ 0.5 g/cm³.

³Measured as paste in distilled water. The desirable level of pH varies among crops. EC = electrical conductivity.

⁴Extracted with the Modified Truog Method (0.01 M H₂SO₄ + 0.02 M (NH₄)₂SO₄ with soil:solution ratio of 1:100).

⁵Extracted with neutral 1 M ammonium acetate with soil:solution ratio of 1:20.

⁶Ca and Mg are generally in the ratio 5:1.

*Replaces Agronomy & Soil Science Fact Sheet no. 3, 10/17/94.

Table 2. Suggested “sufficiency” nutrient levels in tissues of selected crops.

Nutrient	Unit	Crop																							
		Beans ^{1,2,6}		Corn ^{1,2}		Cucumber ^{1,6}		Tomato ^{1,6}		Chinese cabbage ¹		Lettuce ^{1,6}		Kikuyugrass ²		Bermudagrass ^{1,5}									
N	%	3.0	–	4.5	2.6	–	4.0	3.5	–	4.5	3.0	–	4.5	3.5	–	4.0	2.5	–	3.0	4.0	–	6.0			
P	%	0.30	–	0.70	0.25	–	0.50	0.4	–	1.0	0.25	–	0.75	0.20	–	0.30	0.20	–	0.30	0.20	–	0.60			
K	%	1.5	–	4.0	1.5	–	3.0	2.8	–	4.5	3.0	–	5.0	4.5	–	7.5	2.0	–	3.0	1.0	–	3.0			
Ca	%	1.5	–	2.5	0.3	–	0.8	1.8	–	4.0	2.0	–	3.0	2.0	–	6.0	0.25	–	0.40	15	–	1.0			
Mg	%	0.20	–	0.80	0.3	–	0.8	0.4	–	1.2	0.40	–	0.60	0.30	–	0.50	0.25	–	0.40	0.20	–	0.60			
S	%	0.15	–	0.40	0.16	–	0.50	0.30	–	1.0	0.40	–	1.2	(0.50	–	1.0) ²	0.20	–	0.30	0.20	–	0.50			
Fe	ppm	50	–	300	50	–	250	50	–	300	100	–	200	40	–	200	75	–	300	50	–	350			
Mn	ppm	50	–	300	35	–	200	50	–	400	40	–	250	25	–	200	50	–	300	25	–	300			
Zn	ppm	20	–	200	35	–	100	25	–	300	20	–	50	20	–	200	25	–	150	20	–	250			
Cu	ppm	5	–	30	6	–	20	8	–	20	5	–	20	5	–	25	10	–	25	5	–	50			
B	ppm	30	–	75	10	–	25	30	–	100	25	–	100	60	–	100	10	–	25	6	–	30			
N	%	2.6	–	4.0	1.0	–	2.5	2.5	–	3.5	1.5	–	2.5	2.6	–	4.0	1.0	–	2.5	2.5	–	3.5			
P	%	0.2	–	0.4	0.20	–	0.40	0.15	–	0.30	0.07	–	0.12	0.2	–	0.4	0.20	–	0.40	0.15	–	0.30			
K	%	3.0	–	5.0	3.0	–	5.0	2.0	–	3.0	0.50	–	1.5	3.0	–	5.0	2.0	–	3.0	0.50	–	1.5			
Ca	%	0.4	–	0.8	1.0	–	3.0	0.8	–	1.6	0.50	–	1.0	0.4	–	0.8	0.8	–	1.6	0.50	–	1.0			
Mg	%	0.25	–	0.80	0.40	–	1.2	0.30	–	0.50	0.08	–	0.15	0.25	–	0.80	0.30	–	0.50	0.08	–	0.15			
S	%	0.20	–	0.80	(0.30	–	0.80) ³	0.20	–	0.40	0.15	–	0.30	0.20	–	0.80	(0.30	–	0.80) ³	0.20	–	0.40	0.15	–	0.30
Fe	ppm	80	–	200	25	–	100	75	–	300	30	–	300	80	–	200	25	–	100	75	–	300			
Mn	ppm	200	–	1000	20	–	150	50	–	500	30	–	1000	200	–	1000	20	–	150	50	–	500			
Zn	ppm	20	–	200	15	–	40	15	–	150	15	–	50	20	–	200	15	–	40	15	–	150			
Cu	ppm	6	–	25	4	–	10	10	–	30	5	–	10	6	–	25	4	–	10	10	–	30			
B	ppm	10	–	50	20	–	50	25	–	75	40	–	80	10	–	50	20	–	50	25	–	75			

Crop index tissues and sources from which critical-level data were adapted:

¹Beans: uppermost, most recently fully developed trifoliate leaf. Coffee: 4th pair of leaves back from growing tip. Cucumber: leafblades with midribs, 5th leaf from tip, at pre-fruit stage. Lettuce: pre-heading wrapper leaves. Papaya: petiole from most recently mature leaf. Tomato: compound leaves adjacent to top inflorescence at pre-fruit stage. J.B. Jones, Jr., B. Wolf, and H.A. Mills (1991) Plant analysis handbook. Micro-macro Publishing Inc., Athens, GA.

²Corn: whole ear-leaf at early tasseling. Chinese cabbage: fully mature wrapper leaf. Macadamia: recently fully mature leaf. Kikuyugrass: terminal growth to include 5th–6th leaf. Y.N. Tamimi and D.T. Matsuyama, unpublished.

³Banana: strips from middle of 3rd leaf. Reuter and Robinson (1968) Plant analysis. Inkata Press, Australia.

⁴N.V. Hue, unpublished; Fox and Hue, 1989, J. Plant Nutr.; Hue and Nakamura (1988) J. Plant Nutr.; Hue, Fox, and McCall (1988) J. Plant Nutr.

⁵Bermudagrass (mostly Tifgreen and Tifdwarf for putting greens): leaf clippings. C.L. Murdoch, E.N. Okazaki, and D.T. Shigeta (1983) HITAHR Research

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⁶Vegetables grown under tropical/subtropical conditions. Fox, R.L., and H. Valenzuela (1992) In: IFA World fertilizer use manual. International Fertilizer Industry Association. p. 293–337.