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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'a 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 Hawaii[1].

Soil property	Unit	Heavy soils[2]	Light soils[2]	A'a 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	

[1]These 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.
[2]Bulk density of heavy soils = ~1.0 g/cm^3, light soils = ~ 0.5 g/cm^3.
[3]Measured as paste in distilled water. The desirable level of pH varies among crops. EC = electrical conductivity.
[4]Extracted with the Modified Truog Method (0.01 *M* H_2SO_4 + 0.02 *M* $(NH_4)_2SO_4$ with soil:solution ratio of 1:100).
[5]Extracted with neutral 1 *M* ammonium acetate with soil:solution ratio of 1:20.
[6]Ca 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]	
N	%	3.0	4.5	2.6	4.0	3.5	4.5	3.0	4.5
P	%	0.30	0.70	0.25	0.50	0.4	1.0	0.25	0.75
K	%	1.5	4.0	1.5	3.0	2.8	4.5	3.0	5.0
Ca	%	1.5	2.5	0.3	0.8	1.8	4.0	2.0	3.0
Mg	%	0.20	0.80	0.3	0.8	0.4	1.2	0.40	0.60
S	%	0.15	0.40	0.16	0.50	0.30	1.0	0.40	1.2
Fe	ppm	50	300	50	250	50	300	100	200
Mn	ppm	50	300	35	200	50	400	40	250
Zn	ppm	20	200	35	100	25	300	20	50
Cu	ppm	5	30	6	20	8	20	5	20
B	ppm	30	75	10	25	30	100	25	100
		Chinese cabbage[1]		Lettuce[1,6]		Kikuyugrass[2]		Bermudagrass[1,5]	
N	%	3.5	4.0	2.5	4.0	2.5	3.0	4.0	6.0
P	%	0.40	0.60	0.40	0.60	0.20	0.30	0.20	0.60
K	%	4.5	7.5	4.0	7.5	2.0	3.0	1.0	3.0
Ca	%	2.0	6.0	1.5	2.3	0.25	0.40	15	1.0
Mg	%	0.30	0.70	0.36	0.50	0.25	0.40	0.20	0.60
S	%	(0.50	1.0)[2]	(0.25	0.50)[3]	0.20	0.30	0.20	0.50
Fe	ppm	40	200	50	200	75	300	50	350
Mn	ppm	25	200	25	150	50	300	25	300
Zn	ppm	20	200	25	150	25	150	20	250
Cu	ppm	5	25	7	25	10	25	5	50
B	ppm	60	100	23	50	10	25	6	30
		Banana[1,3]		Papaya[1]		Coffee[1,4]		Macadamia[1,2,4]	
N	%	2.6	4.0	1.0	2.5	2.5	3.5	1.5	2.5
P	%	0.2	0.4	0.20	0.40	0.15	0.30	0.07	0.12
K	%	3.0	5.0	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
Mg	%	0.25	0.80	0.40	1.2	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
Fe	ppm	80	200	25	100	75	300	30	300
Mn	ppm	200	1000	20	150	50	500	30	1000
Zn	ppm	20	200	15	40	15	150	15	50
Cu	ppm	6	25	4	10	10	30	5	10
B	ppm	10	50	20	50	25	75	40	80

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

[1]Beans: 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.

[2]Corn: 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.

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

[4]N.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.

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

Extension Series no. 025.

[6]Vegetables 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.