

## Nutrient retention capacity of biochar

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### Summary

Highly weathered soils, mainly Oxisols and Ultisols, in the tropics, including those in Hawaii, are poor in nutrients due to leaching and therefore hardly support good crop growth. Biochar reportedly has a great capacity to retain nutrients due to its numerous small pores and large surface area/charge. Our research showed that nutrients from compost when mixed with biochar added to a Hawaiian Ultisol (Leilehua series) and an Oxisol (Wahiawa series) were retained longer and became more efficient, enhancing Chinese cabbage (pak choi) growth, especially in the Ultisol.

### Introduction

Highly weathered soils are poor in nutrients because of leaching. The loss of nutrients not only increases cost of plant production, but also causes the environmental problems, such as algal bloom and water and soil pollution.

Biochar is believed to have high nutrient retention capacity. Such nutrient retention capacity is attributed to high surface area, porosity, and surface charge. For example, NH<sub>4</sub>-N adsorption is due to cation exchange on the surface functional (phenolic and carboxylic) groups of biochar and physical entrapment in biochar's porous structure.

Selected properties	Leilehua Ultisol	Wahiawa Oxisol	Lactree wood	Hilo mixed wood	Vermi-compost	Thermo-compost
pH (H <sub>2</sub> O)	4.5	5.6	9.2	9.5	7.2	8.3
EC (dS/m)	0.08	0.13	1.93	2.42	2.28	3.23
CEC (cmolc/kg)	16.8	12.1	18	14.7	44.8	44.5
N (%)	0.21	0.15	0.4	0.5	1.42	1.9
P (mg/kg)	1.95	51.52	600	900	14800	1700
K (mg/kg)	49.15	140.7	3300	4700	13700	400
Ca (mg/kg)	111.84	715.88	31300	16000	21100	23900
Mg (mg/kg)	53.93	232.6	1300	2200	3600	3600
Fe (mg/kg)	98.14	63.95	684	12259	2408	8345
Mn (mg/kg)	11.41	805.8	55	154	606	239
Al (mg/kg)	-	-	448	9767	1832	9933
Exch. Al (cmolc/kg)	2.16	0.17	-	-	-	-

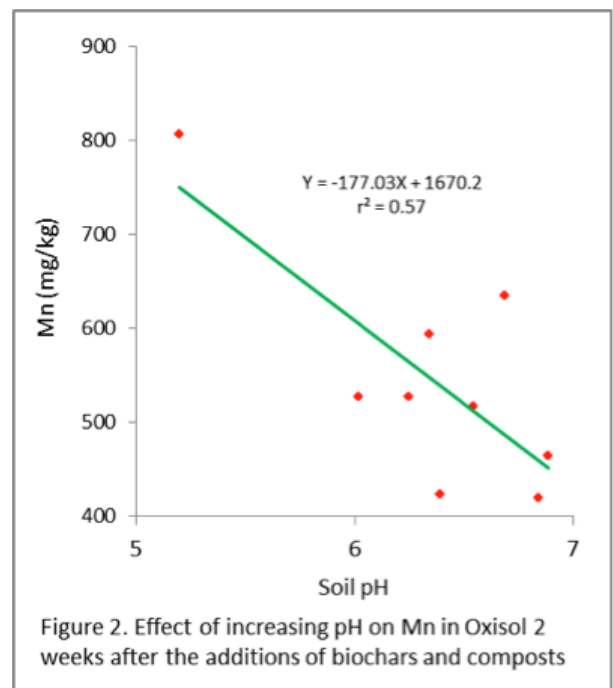
**Materials and methods:**

The Leilehua Ultisol and Wahiawa Oxisol were collected from Oahu, Hawaii, are highly weathered tropical acid soils. The vermicompost and regular thermocompost were also collected from local market in Honolulu, Hawaii. The lac tree wood (*Schleichera oleosa*) biochar produced at 500-600oC and the Hilo mixed wood biochar produced at 300-400oC were collected from West Java, Indonesia and Hilo, Hawaii, USA, respectively. The selected properties of soils, biochars and composts were listed in table 1.



**Results**

Our research showed that the addition of lac tree and Hilo biochars in combination with composts both at 2% to a Ultisol (Leilehua series) and an Oxisol (Wahiawa series) of Hawaii significantly increased soil pH, EC, P and K, cabbage shoot and total fresh and dry matter in both soils; Ca and Mg uptake in the Wahiawa soil; and Fe uptake in the Leilehua soil. Pak choi (*Brassica rapa*) growth in the Ultisol amended with the lac tree biochar in combination with vermicompost was almost twice as that of amended with lime and vermicompost at the same rate (Figure 1). Soil pH was increased by one unit on average, and the EC was increased from 0.35 to 0.47 dS/m and 0.30 to 0.37 dS/m in the Ultisol and Oxisol, respectively. Exchangeable aluminum was decreased from 2.16 cmolc/kg to vir-



tually zero in the high-Al Ultisol. Mehlich-3 extractable Mn and Fe in the high-Mn Oxisol decreased from 806 and 64 to 360 and 37 mg/kg, respectively (Figure 2). Thus, the enhanced cabbage growth in the Leilehua Ultisol was attributed to the increase of plant nutrients and the improvement of acid soil productivity by the additions of biochar and compost. The sufficiency of nutrients in the plant tissues, with exception of N and K, for the pak choi growth both in the first and the second plantings indicated an improvement of nutrients supply and retention in those highly weathered soils by the added biochars and composts.

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