Alleviating Soil Acidity with Crop Residues

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Summary: Crop residues could be use as a partial substitute for lime in correcting soil acidity, at least in the short term. The effectiveness of such soil organic amendments varied with residue type and mode of preparation (i.e., fresh or ashed). A combination of lime and organic materials is recommended for improving soil fertility and crop growth (and saving money).

Soil acidity, which is characterized by mainly aluminum (Al) toxicity and often calcium (Ca) deficiency, is a serious constraint for crop production in many regions of the world. Soil acidity is traditionally corrected by applications of lime ($CaCO_3$ or $Ca(OH)_2$), which raise soil pH, precipitate Al and provide Ca. However, high rates of lime cannot be afforded because of its high cost relative to the value of some farm products; lime also may not be available in certain regions. Fortunately, recent research has shown that additions of locally available green or animal manures could reduce Al toxicity and increase crop yields.

Given the current strong interest in sustainable agriculture and organic farming, the use of crop residues to alleviate the soil acidity warrants a detailed investigation. Thus, the objective of this study was to quantitatively compare liming effects of two crop residues with those of $Ca(OH)_2$.

The soil used was an acid Ultisol, Paaloa series, collected from a former sugarcane field in Waialua, Oahu. In the unamended state, the soil had a pH of 4.6 and an exchangeable Al of 2.8 meq/100g. Such pH and Al conditions would not be suitable for good crop production. To ensure that Al and/or Ca were only growth limiting factors, other nutrients were blanket-applied (in mg/kg) as follows: 100 N as ammonium nitrate, 50 Mg, 10 Mn, 5 Cu, and 5 Zn as sulfate salts. Phosphorus (P) and potassium (K) were applied at 400 mg P/kg and 503 mg K/kg as KH_2PO_4. Crop residues used as soil amendments were cowpea (*Vigna unguiculata*) leaves and shredded pineapple (*Ananas comosus*) crown. There were six treatments: (1) control (only blanket fertilizers added), (2) 6 meq/100g $Ca(OH)_2$, (3) 10g/kg fresh cowpea (about 15 tons per hectare), (4) ashed cowpea at rate equivalent to (3) [10g of fresh cowpea was ashed at 350 ^{o}C for 4 hours then added to 1 kg soil], (5) 10g/kg fresh pineapple, (6) ashed pineapple at rate equivalent to (5). Fresh crop residues and their ashed counterparts were used to separate the effects of Al complexation by organic molecules derived from the residues from their direct nutritional contributions. The test crop was *Desmodium intortum* cv. Greenleaf, which is a forage legume highly sensitive to Al toxicity.

The experiment was installed in a greenhouse, with a randomized complete block design having 3 replications per treatment. The test plants were grown for 6 weeks after transplanting. Soil pH, exchangeable Al, soil-solution Al, and many other elements were measured at transplanting and at harvest when shoot dry weight was also taken.

Table 1. Soil properties and shoot dry matter of *Desmodium intortum* legume as affected by lime or crop residue amendments.

Treatment	pH	Exchangeable Al	Soil-solution Al	Shoot Dry weight	
		meq/100g	µmole/L	g/pot	%
Control	4.60	2.78	21.49	3.73	34.1
$Ca(OH)_2$	5.32	0.10	2.23	7.34	67.1
Ashed pineapple	4.78	1.63	10.00	5.49	50.2
Fresh pineapple	5.01	1.16	4.68	8.31	76.0
Ashed cowpea	4.75	1.11	8.98	5.95	54.4
Fresh cowpea	5.11	0.61	1.23	10.93	100

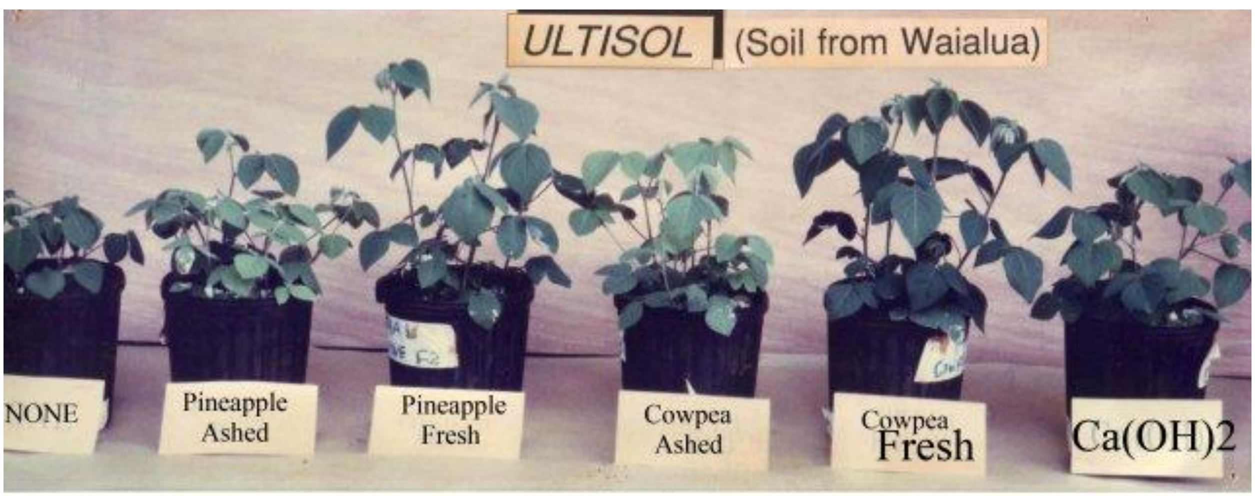

Figure 1. *Desmodium intortum* growth as affected by lime and crop residue amendments.

As Figure 1 and numbers in Table 1 can attest, soil amendments with crop residues, particularly with the fresh cowpea leaves, produced growth even better than the lime treatment and nearly three times that of the control. It should also be noted that soil pH was increased slightly by the organic amendments; and the fresh residue treatments were more effective than their ashed counterparts. In fact, good growth was likely brought about by Al-organic interactions, resulting in lowered exchangeable Al, and much lowered Al activity in the soil solution. It is soil-solution Al that controls the Al toxicity (or a lack of it) to crops and is the main culprit of soil acidity problems.