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Comparative effects of filter cake and agricultural lime as liming material under marginal soil conditions of CSU-Piat

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Abstract

Soil acidity is one of the most important factors affecting crop growth and, ultimately, yield and profitability. Soil pH directly affects the life and growth of plants because it affects the availability of all plant nutrients. This problem can be corrected with the use of lime. The study aimed to determine the effects of filter cake and agricultural lime as liming materials under marginal soil conditions of CSU-Piat. The pH value after application ranged from 5.27 to 7.03 as compared to the initial pH value ranging from 5.0 to 5.03. All the treatments recorded higher soil pH values as compared to the initial soil. Among the two limes tested, agricultural lime ($CaCO_3$) can be comparable to filter cake since they did not differ significantly from each other in most of the data gathered. Organic matter content of the post-harvest soils varied from 0.94 – 1.22% which is considerably higher than the initial value of 28%. Available P content in the post-harvest soils ranged from 2.57 to 3.24 ppm. The P availability in soil was highly pH-dependent, while a tremendous increase in the K content was recorded from 26.66 – 38.88 ppm. Dolomite ($CaCO_3$) and filter cake as sources of lime can be used to reduce the acidity level and raise the pH level of soils since they do not differ significantly from each other. The filter cake is recommended as an alternative source of lime in marginal soil.

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Introduction

Soil acidity is a major environmental and economic concern. Acidic soils cause significant losses in production and where the choice of crops is restricted to acid tolerant species and varieties, profitable market opportunities may be reduced. Various liming materials can be used to neutralize the soil acidity, i.e., agricultural lime ($CaCO_3$) and filter cake. The main effects of filter cake on soil properties will be increased nitrogen, phosphorus, and calcium concentrations, increased cation exchange capacity (CEC), and reduced concentrations of exchangeable aluminum (Al 3+), which is toxic to plants (Korndorfer *et al.*, 1997). Beneficial effects on physical and biological soil properties are also observed. Thus, due to its characteristics, the filter cake can play a fundamental role in agricultural production in the maintenance of soil fertility (as liming) and as a soil conditioner (Rosetto *et al.*, 2008).

Lands with marginal soil have received wide attention for their potential to increase food security and support bio-energy production (Tillman *et al.*, 2006; Food and Agriculture Organization (FAO), 2008; Robertson *et al.,* 2008). The cultivation of marginal lands is inevitable because of the shortage of prime agricultural lands in densely populated regions and increasing food demand due to the increasing world population, especially in developing countries (FAO, 2008).

Marginal soil has a soil pH ranging from 6.0 to 7.0, but in Cagayan State University – Piat Campus, such soil series has a pH that ranges from 4.5 to 5.5 which is extremely acidic for upland rice production. Thus, soil management (liming) is necessary to enhance yield performance and increase farm profitability. This also involves maintaining the soil in good physical condition and fertility status and influencing the biological aspect of the soil to attain maximum benefits (Hampstead *et al.*, 1997). Moreover, to enhance and sustain aerobic rice production in lands with marginal soil, the development of appropriate technologies is indispensable.

Generally, the study aimed to evaluate the effects of filter cake and agricultural lime under marginal soil conditions of CSU-Piat. Specifically, it aimed to: determine the effects of filter cake and agricultural lime on the chemical characteristics of the soil.

Materials and methods

Experimental site

The study was conducted in a well-drained, non-puddled rainfed upland under Bago series soil of CSU-Piat, Cagayan Valley. The field has been planted previously with high-value vegetables. The experimental area is exactly located at 17°48' 4.1" North, 121°30'31.3" East.

Soil sampling

Soil samples were collected in every treatment in the field with a 1 kg soil sample per hole. The soil samples were mixed, air-dried and a 1 kg refined soil sample was taken and submitted to the Cagayan Valley Integrated Agricultural Laboratory (CVIAL) at Tuguegarao City for nutrient analysis.

Land preparation

The experimental area was thoroughly prepared (dry preparation) using the conventional system of land preparation, i.e., 2 times plowing at one (1) week interval to give ample time for the weeds and weed seeds to decompose. Each plowing was followed by harrowing to pulverize the soil to attain a good soil tilth for better growth and development.

Experimental layout and design

An area of 54 meters x 14 meters as experimental plots was laid out following the randomization procedure of the Randomized Complete Block Design (RCBD).

Each block was further subdivided into 3 plots with a dimension of 4m x 3m and the distance between blocks was 1m as alleyways.

Liming application

The lime was applied at the designated treatments for 4 weeks before sowing following the recommended rate of 2 tons per hectare for agricultural lime and 3 tons per hectare for filter cake.

Seed sowing

The experimental area was planted with aerobic rice, where seeds were drilled manually at the rate of 80 kg/hectare or equivalent to 9.6 grams of seeds per furrow.

Data gathered

Soil pH: Soil samples were collected and determined before and after the conduct of the study to determine the pH.

Nutrient composition: The nutrient analysis was determined before and after the conduct of the study, particularly on the organic matter (N), phosphorus and potassium.

Results and discussion

Soil pH before and after harvest

The application of lime caused an increasing effect on the pH of the soil after harvest (Table 1). The pH value after application ranged from 5.27 to 7.03 as compared to the initial pH value ranging from 5.0 – to 5.03. All the treatments recorded higher soil pH values as compared to the initial soil.

This means that dolomite ($CaCO_3$) and filter cake are effective in increasing the soil pH. Improvement of the pH may be one of the overall impacts of lime application which will reduce soil acidity by changing some of the H+ ions into water and carbon dioxide (CO_2). The results support previous findings showing that lime is effective in alleviating soil acidity (Venkatesh *et al.*, 2002; Chang and Sung, 2004; Cifu *et al.*, 2004; Caires *et al.*, 2005).

Table 1. Effect of lime on soil pH before and after the study.

Treatments	Before	After
T1	5.1	5.27
T2	5.0	7.03
T3	5.0	6.6
Result	ns	*
CV (%)	1.98	6.73

ns = not significant
** = significant @ 1%*
*** = highly significant @ 5%*

Nutrient composition of the soil before and after application

The organic matter content of the post-harvest soils slightly increased due to the application of fertilizers, while results were reversed in most cases when vermicompost was applied in every treatment (Table 2). Organic matter content of the post-harvest soils varied from 0.94 – 1.22% which is considerably higher than the initial value of 28%. It was observed that organic matter content tends to increase in soils treated with liming materials.

The results in Table 2 indicated that the use of lime had a considerable change in available P content of the post-harvest soils due to the different treatments. Available P content in the post-harvest soils ranged from 2.57 to 3.24 ppm. The P availability in soil was highly pH-dependent. In acid soils, the P availability decreased due to precipitation of P with insoluble Fe- and Al Phosphates. This result agrees well with other findings, indicating that liming improves soil extracted P availability (Haynes, 1982; Caires *et al.*, 2005).

Exchangeable K content in the post-harvest soils ranged from 26.66 – 38.88 ppm soil (Table 2) which were influenced by the application of lime. Results also indicated that exchangeable K content was higher in soils treated with filter cake and dolomite ($CaCO_3$) compared to control (No Lime). The available forms of K in soil are affected by liming. This result supports the study conducted by Kumar *et al.* (2010) who reported that liming has a positive influence on the exchangeable and reserved form of K and it may disturb the K balance in soil by increasing pH which leads to increased microbial activity in acid soil. Liming generally increases K fixation in soil, though liming soils of acidic reaction increased the cumulative release of potassium over an unlimed system (Ghosh *et al.*, 2001).

Table 2. Characteristics of the soil after harvesting the rice crop.

Treatments	N (%)		P, ppm		K, ppm	
	Before	After	Before	After	Before	After
T1	0.95	1.0	3.0	1.68	26.67	23.33
T2	1.07	1.34	1.6	2.53	23.33	41.66
T3	0.81	1.31	3.13	5.5	30	51.67
Result	ns	*	ns	*	ns	*
CV (%)	2.41	7.79	3.01	2.92	1.53	2.01

ns = not significant
** = significant @ 1%*
*** = highly significant @ 5%*

Conclusions and recommendation

Based on the result of the study, the following conclusions were drawn: The agricultural lime/dolomite ($CaCO_3$) and filter cake as sources of lime can be used to reduce the acidity level and raise the pH level of soils since they did not differ significantly to each other. Liming in combination with appropriate fertilizer application would make acid sulfate soils suitable for aerobic rice cultivation. The use of filter cake is recommended as alternative lime under marginal soil conditions of CSU-Piat.

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