Impact Of Poultry Manure And Agricultural Lime On Acidic Soil Of Fiji

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ABSTRACT

The objective of this study is to prove whether Poultry Manure (PM) is a suitable organic alternative to Lime Stone (LS) to neutralize acidic soil in Fiji. A greenhouse experiment was conducted to compare the effects of poultry manure and agricultural Lime on soil fertility on selected chemical properties of an acidic soil series of Fiji. The pots received seven treatments, an unamended control, 5.0, 7.5 and 1.0Mg/ha-1 PM and lime. All treatments were replicated three times and were arranged in the greenhouse in the randomized design. The pots received 200 mL water continually for four weeks. The results indicated that the application of PM increased the soil pH, %N, exchangeable Ca, Mg, K and P levels amended soil compared to $CaCO_3$. The study clearly demonstrate that the fertility of acidic soil can be corrected by either ($CaCO_3$) or PM addition. It is evident that PM maybe used as an alternative to $CaCO_3$. The conventional liming materials such as calcium carbonate are not only scarce and expensive. There is needed to focus on development of locally adapted indigenous and sustainable way of managing soil acidity.

KEYWORDS: Crop, acidity, poultry, soil, lime.

INTRODUCTION

One of the major factors which is responsible for the discrimination of natural crops and which is also responsible for the dispersal of flora and fauna is known as Soil acidity. The acidity of soil distinguishes between the property and quality of the soil. One should be aware of the normal soil pH as it is a crucial aspect in the management and production of the crop from the soil. Uncertainly, soil pH is enumerated by ions of aluminum (Al^{3+}) and hydrogen (H^{+}). The amount of H+ ions found in soil refers to how much acidic that soil is and it can be due to acid-forming elements found in that particular soil (Fageria, Baligar, and Li, 2008). It's all equivalent to high aluminum (Al), hydrogen (H), manganese (Mn), and iron (Fe) noxiousness in plant roots. Sometimes it also depends on the deficiencies of certain elements in the plant like deficiencies of K, P, and (Ca) among others (Giller, 2001). If a soil has a low amount of Fe and Al oxides, so it means that phosphorous deficiency is present in the soil (Kanyanjua et al., 2002) which also has some impact on the negativity of soil fertility and productivity (Muindil et al., 2016). Nutrients present in plants such as phosphorous, potassium, and nitrogen can decrease the acidity of the soil. If soil is more acidic than the normal amount, that means phosphorous is present in soil and is used as a limited nutrient by the soil (Harun, Benson and Benjamin, 2015). The decline in the pH of soil stimulates the presence of phytotoxicity substances like Mn and Al resulting in acidic soil infertility thus limiting crop production (Proietti et al., 2015). The harmful effects faced by plants are due to the high pH of the soil and due to toxic nutrients present in soil like calcium, magnesium, and phosphorous (Obi and Ekperigin, 2001). Acidity of soil does not let the plants grow in areas which has higher humidity range as there are some lethal amounts of aluminum (Al) and manganese (Mn), calcium (Ca), magnesium (Mg), potassium (K) and possibly phosphorus (P) present.

Soils present in Fiji are already weathered, oxidic, have high acidity amount, and contains kaolin tin minerals (Morrison and Asghar, 1992).

A possibility of lessening adverse effects of acid soil is the use of carbon-based manure. In 1993, there were information about the accumulation of organic manure to acid soil could avoid Al toxicity (Mattson and Hester, 1933). This was later inveterate by a total of surveys demonstrating a considerable decrease in exchangeable Al ions by organic manure to very acid soils. The increase in pH of highly weathered acid soil due to organic manure additions has also been reported (Hue, Fox and McCall, 1987). The decay harvests of biological manure (i.e., anions of organic acids) can also evidently lessen P adsorption by acidic dirt.

Efficacy of fertilizers of phosphorous can rise up it they are combine with organic elements with components like green manures or animal waste (Hue, Craddock and Adams, 1986). Organic materials benefits soil and plant by:

- Supplying plant nutrients upon decomposition.
- Increase nutrient retention via increased CES.
- Improving soil structure, aggregation and aeration
- Increasing water holding capacity of the soil.
- Increasing biological activity of the soil.
- Decreasing soil erosion and water run –off by increasing infiltration.
- Regulating soil temperature.

It has been shown that addition of organic materials (e.g. green manure, crop residues and animal waste) to acid soil are good amendments with respect to enhancing soil fertility and reducing soil acidity (Ashgar and Kanehiro, 1980).

Furthermore, only selected agriculture markets have the commercially available liming material. It is expensive as well. So, poultry manure is used is used in replacement of liming materials.

Poultry manure is used in replacement of liming minerals as poultry manure has a capability of determining soil pH as it contains some concentration of calcium carbonate. Along with it, some amounts of limestone are also found. 1% ground limestone is found in turkey feed whereas 7 to 10% is found in layer and breeder ratios. When this manure is consumed by birds and passed on with their

feces in litter so it becomes part of the manure. A questionnaire was conducted of Albama feces which depicted repeated poultry broiler litter which had a pH of 6.3 (±0.1). The fields of latter had 5.8(±0.1) pH (Kafle and Sharma, 2015). A study was proposed by Hue in which he worked on manure of chicken and reported that it was effective in increasing the pH of soil. It was due to organic anions. Chicken manure also had the ability of detoxify toxic minerals like Al when pH of soil increased (manures of hen contains 15 to 18% amount of calcium carbonate. Hen manure can also be beneficial in increasing the soil pH as it has ability to convert nitrogen. The aim of this research was to work on an experiment consisting of greenhouse by comparing lime and poultry manure on soil of Fiji.

MATERIALS AND METHODS:

Study area

This study was carried out at Fiji national university and this research was completed during February-May, 2015.

Soil collection and preparation: The amount of soil collected from RA farm of Fiji was 50kg for the pot trail. soil collected from the topsoil (0-20cm depth) over the selected field site, and air dry spreading it thinly on plastic sheet. Large soils were broken down into thinner particles before it was ready to be weighed for treatments.

Soil properties: Organic matters were evaluated in the greenhouse, by the usage of the acid RA soil. In the unamended condition, the constraints of a soil were tested and it was found that Ra soil has pH 5.0 with total carbon and nitrogen content 2.44% and 0.31% respectively. Electrical conductivity was measured to be 0.05 milli siemens per centimeter and Olsen available phosphorous is 2.29 mg/kg. Exchangeable ions of Ca, Mg and K were found to be 3.89, 3.02 and 0.31 milliequivalents per 100 grams respectively.

Treatment and Soil Sampling: The pots received 7 treatments, an unamended control, 5.0, 7.5 and 10 Mg

Ha^{-1} lime ($CaCO_3$) or (12.1, 18.1 and 24.2g lime per 3kg soil), and 5.0, 7.5 and 10 Mg Ha^{-1} of poultry manure (PM) or (12.1 ,18.1 and 24.2 g of poultry manure). Each one was then repeated for more three times and then the pots were kept in the greenhouse.
After this they were left unattended for approx. four weeks. Only watering of the plants was maintained

Chemical analysis of soils: For the chemical analysis, soil was taken from 0-20cm depth from the ground. They were cleaned and then run through a 0.02mm sieve. Then it was mix with 10g soil mixed with 50ml of pure water. After 30 minutes pH of soil was measured. Organic C was determined by the Walkley – Black dichromate method (Mucheru-Muna et al., 2014) total N of the strained soils was examined using the semi micro Kjedhal method. 1M ammonium acetate with a mixture of strontium and cesium (Sr/Cr) was determined by Ca and K. Phosphorous present in soil was removed by using the method of sodium bicarbonate ($NaHCO_3$) (Mehlich, 1953) and manganese present in soil was removed by diethylenetriamine Penta–acidic acid (DTPA) (Abdulsalam et al., 2011) solution and its pH was 7.3

RESULTS

A rock present in the atmosphere of earth which is made up of high levels of calcium carbonate (97.5%) and some other essential elements like Ca and Mg as 31.2 and 0.3% respectively is known as Limestone. The efficiency of soil is based on its size, purity and chemical composition. The granularity (600µ) % of strained and retained found to be 98% and 2% respectively. Soil acidity was neutralizing when calcium ions absorbed H ions. 0.2% of moisture content was seen in already prepared lime.

Already prepared nitrogen (N) fertilizer can be replaced by using poultry manure as it contains some important nutrients and components which are responsible for production of crop with relatively normal pH of 7.5. In poultry manure the content of moisture and nutrient are depended on each other hence analysis conducted in

laboratory should be used to find out level of N and nutrient in the material to be applied. The analysis of poultry manure shows C, N, K, Ca, Mg, Fe, Mn, Cu, Zn as 48.9%. 2.73%, 1.63%, 9.03%, 0.68%, 19.37%, 5.54%, 45%, 3.99% respectively with electrical conductivity of 15.5 mS/cm.

The soil pH in water was 5.0. **Table 1** shows the soil physical and chemical properties after poultry manure and lime application. After analyzing the data, it can be said that pH value was increased by the addition of lime and poultry manure, total carbon and nitrogen was also increased in the soil whereas the available phosphorous was decreased after addition of the poultry manure. It was due that poultry manure has other nutrient components which help in the composition of the soil fertility in short period of time. In the PM modifies soil, phosphorous was seen in high content. K levels also got higher when poultry manure was added comparison to the $CaCO_3$. Cations were increased and acids were reduced when manure of poultry was added.

DISCUSSION

Treatments with lime and fertilizer, sole or joined had a huge expansion in soil pH which expanded the accessibility of soil supplements. Use of joined lime, excrement and compost lime had the most noteworthy stover and grain yield contrasted with those with sole excrement, manure, or lime. This demonstrates that liming is a compelling strategy for improving soil causticity and offers a superior choice for expanding crop yields in debased soils of focal Fiji. Financial returns were fundamentally impacted by communication of lime, compost. The expansion in the dirt pH because of the use of compost in addition to lime could be ascribed to increment in soil replaceable Mg^{2+} accordingly expanding its accessibility in the dirt through mineralization of the fertilizer and lime disintegration in the dirt. Also, decrease of the dirt pH diminished the Al3+ and H+ content in the dirt in this manner upgrading the accessibility of the Mg^{2+} to the dirt. Organic modifications have humid elements with an attachment

of other groups like carboxyl or phenolic group that occur during decomposition. These corroborate with the findings of Tan et al (Tan et al., 1971) who reported similar findings on increase of soil available Mg on the application of lime combined with manure (Sims, 1986; Mokolobate, 2001)

CONCLUSION

The results from this research clearly demonstrated that acid soil infertility can be corrected by poultry manure or lime, additions. The organic amendments (PM) could supply, in addition to liming effects (increased soil pH and exchangeable Ca), considering amount of nutrients (particularly, P and K) to crop which may in turn result in good yield.

Poultry manure is more beneficial compared to commercial lime in a sense that it is cheap and locally available, it improves the soil conditions both chemical and physical properties and enhance soil biology. Poultry manure is a good soil amendment source and also provide good supplement of available nutrients for plant uptake for growth and development. It supports the 3R concepts of which were introduced by Ministry of Environment and Organic Growers Association.

"CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

ACKNOWLEDGMENTS

The authors gratefully acknowledge Mr. Ami Sharma, the Principal Research officer - Chemistry for allowing and doing research analysis at Koronivia laboratory, Fiji. This research work is originally done at Fiji National University, FIJI.

SIGNIFICANCE STATEMENT

This study will help researcher to uncover the scientific knowledge on how lime, manure and fertilizer affect soil properties, and profitability in the central highlands of Fiji. This would be helpful to smallholder farmers who have small sizes of land and have difficulties in managing

acidic soils. Such information will also enable the extension service providers to advise farmers on the most appropriate integrated soil fertility management to increase yield.

DATA AVAILABILITY STATEMENT

The analysis data used to support the findings of this study are available from the corresponding author upon request as it belongs to the author findings and research work."

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Table 1. Data showing the amended soil with Poultry Manure and Lime

Treatments	**pH (water)**	**Ec (mS/cm)**	**Total C (%)**	**Total N (%)**	**Olsen available P (mg/kg)**	**Exchangeable**		
						Ca	**Mg**	**K**
						(me/100g)		
Soil QC	6.6	0.03	1.67	11.35	6.34	-	6.22	0.23
Soil QC	6.2	0.03	1.84	14.49	6.65	-	6.51	0.28
Control	5.3	0.05	2.44	0.31	2.29	3.89	3.02	0.13
PM TMT 1	5.6	0.13	3.09	0.31	9.38	5.93	3.30	0.28
PM TMT 2	5.7	0.14	2.84	0.33	19.09	8.42	3.55	0.36
PM TMT 3	6.5	0.13	2.96	0.29	24.98	8.68	3.29	0.51
Lime TMT 1	6.7	0.08	2.97	0.30	3.74	18.85	3.13	0.12
Lime TMT 2	6.9	0.11	3.29	0.31	2.85	58.32	2.80	0.11
Lime TMT 3	7.0	0.14	2.77	0.27	1.80	73.35	2.86	0.11

QC = Quality control; Ec = electrical conductivity; (mS/cm) = milli siemens per centimeter