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Full Length Research Paper

Nutrient composition of rock phosphate enriched compost from various organic wastes

Sohail Ahmed Qureshi[1], Ambrin Rajput[1*], Mehrunisa Memon[2] and Muhammad Azam Solangi[1]

[1]Agriculture Research Sindh Tandojam, Agriculture Department, Government of Sindh, Pakistan
[2]Sindh Agriculture University Tandojam

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In this study, rock phosphate enriched composts was prepared by mixing rock phosphate with Farm Yard manure (FYM), Poultry manure (PM), Sugar press mud (SPM) with effective microorganism (EM). For this, an experiment was carried out to determine the concentrations of total C, total N, P, K, Fe, Zn, organic matter (%) and C:N ratio of composted manures. Laboratory results of fresh manure data showed that the total N varied in the order: green manure > FYM > poultry manure > pressmud; total P in the order: pressmud > FYM > poultry manure > green manure while total K was in the order: green manure > poultry manure > FYM > preemud. The results showed that the extractability of elements of composted manure revealed that there was a slow reduction in pH (7.34), EC (3.29) and narrowing of C:N ratio (18.32). There was gradual increase in macro (total NPK) and micronutrients (Fe and Zn). Thus, rock phosphate enriched compost could be an alternative and viable technology to utilize low grade rock phosphate .

Keywords: Rock Phosphate; Raw organic material; (FYM, PM, SPM, EM); Compost enriched rock phosphate; Nutrient contents

INTRODUCTION

Application of organic manures as a source of macro and micronutrients and to give humus as a flavonic and humic acid contents in soil and also responsible for improving both the physical and the biological properties of the soil (Abou El-Magd et al., 2006). Compost has ability to improve soil properties by chemically (nutritionally). The usage of waste materials as organic manure has a conomical value, its large disposal creates environmentally threatening operation (Sim and Wu, 2010). Pakistan produces a huge amount of agro-wastes. Farmyard manure (FYM), poultry manure (PM) and pressmud (PM) are very important agro-wastes in the province of Sindh. Pressmud is discarded as a solid waste from sugar mills about 1.2 million tons of PM are produced each year in Pakistan (NFDC, 2004). Much of the research has been conducted on chemical characteristic on fresh and composted manure of Pakistan as well as part of other countries. However, research into the extractability of nutrient elements from fresh and composted manures of different livestock have been insufficiently reported. Pressmud is a rich source of macro and micronutrients, colloidal organic matter, it contains 2.2, 4.4 and 0.8% N, P and K respectively (Anwar et al., 2000) and 2.72% N, 6.20% P_2O_5 and 0.79% K_2O (Mamaril., 2000) Farmyard manure is an excellent source all the plant nutrients needed for crop growth including trace elements. Approximately 70 to 80% of the N, 60 to 85% P and 80 to 90% of K in feed is excreted in the manure (Herbert, 1998). FYM (cow manure) contained 1.87% N, 2.47% P_2O_5 and 2.11% K_2O (Mamaril., 2000). Poultry manure is a source of all the plant macro and micronutrients. It contains approximately 1.1 to 1.5% of the N, 0.8 to 1.3% P and 0.5 to 2.7% of K in feed is excreted in the manure (Gachene and Kimaru, 2003). By comparison, the chicken manure was rich in nutrients and contained 3.23% N, 4.27% P_2O_5 and 2.54% K_2O (Mamaril., 2000) and 2.2% total N, 35.4% organic C by Singh et al. (2003). Antil and Mandeep (2007) analyzed the Poultry manure contained 22.5% organic C, 2.51% N, 1.79% P and 1.13% K.

*Corresponding Author E-mail: ambrin2004@gmail.com

Pressmud contained 37.4% organic C, 3.01 %N, 0.87% P and 0.79% K. Farmyard manure contained 38.5% organic C, 1.16% N, 0.58% P and 1.90% K. Hasanuzzaman, et al (2010) analysed chemical composition of different organic manures. Cowdung contained 36.0% C, 1.48% N, 0.29% P and 0.75% K. Poultry manure contained 29.0% C, 2.19% N, 1.98% P and 0.81% K. Sesbania contained 46.0% C, 2.95% N, 0.26% P and 1.56% K. Rock phosphate has good P content (28-30%) but cannot be directly used as a fertilizer because of its poor release of P for the use of plant (Reddy *et al.,* 2002). Solubility of phosphorus increases with the increase in organic matter content in soil (Khattak, 1996). The organic matter added to soil, on decomposition releases organic acids (i.e. humic acid), thus, hydrogen ions lower soil pH as a result of chelated calcium and magnesium ions. There by enhancing the availability of phosphorus from rock phosphate (Savini *et al*., 2006). Effective microorganism (EM) is a microbial fertilizer, and it is able to increase digest and quality of compost manure. EM created in university of Ryukyus in Okinawa Japan in over 25 years ago. Its function restoration of healthy environment in both soil and water by using three major genera of microorganisms phosphoric bacteria (Rhodopseudomonas), lactic acid bacteria (Lactobaccillus) and yeast (Saccharonmyces) (Higa, 2010).

Composted material has more concentration of nutrients, narrower C : N ratio, free from pathogens and other potential contaminants that cause pollution (Zia et al., 2003; Jimenez and Wang, 2006). However, much of the research into the extractability of nutrient elements from composted manures have been insufficiently reported.

Preethu et al. (2007) analyzed nutrient composition of enrichment of compost manure from blended with other organic wastes coffee pulp (CP), coffee husk (CH) and other additive like forest litter, weeds; coffee effluents, cowdung, rock phosphate, microbial inoculum etc. were used for preparation of this compost. The data revealed that the pH (7.41), total N (2.99%), P (2.45%), K (2.94%) ,C:N ratio (7.25) as well as Cu, Fe, Mn and Zn (14.2, 922.11, 269 and 14.2 in a mature compost in other words the gradual increase in major nutrients, secondary nutrients and micronutrients during the period of composting. Irshad *et al*. (2013) carried out an experiment to compare the concentrations of total C, total N, extractable P, K, Na and B in fresh and composted manures from five animal sources (i.e., buffalo, camel, cow, goat and poultry manure). It was observed that the total C, N extractable K and Na decreased with composting whereas increased the EC, extractable P and B. Satisha and Devarajan (2007) found out that untreated pressmud compost alone gave 13.6 g kg^{-1}N and after composting 15.3 g kg^{-1} N. Naidu *et al.* (2010) reported similar results in his study that that nutrients content like N was higher in microbial enriched compost as compared to the compost alone. Similar results were reported by other scientists (Holden, 1990; Cambardella *et al.* 2003). Naidu *et al*. (2010) found that rock phosphate enriched compost had significantly higher content of total P. Kanwal et al., 2011 prepared rock phosphate enriched composts by mixing rock phosphate with water lettuce (Pistia stratiotes) with and without effective microbes. The data showed that the nutrients availability was enhanced in the compost with the time span. RP-compost had higher total and available P and other nutrient contents in the compost like N, K, Zn and B than normal compost.

The present study was therefore undertaken to explore the possibility of increasing the availability of macro and micro nutrient from low grade rock phosphate incorporated during decomposition of FYM, PM, SPM, green manure with effective microorganisms (EM).

MATERIALS AND METHODS

Site description

Tando Jam is a town and Union Council of Hyderabad District in the Sindh province of Pakistan. It is located at 25°25'60N 68°31'60E and lies about 20 km away from Hyderabad city Pakistan. Agriculture Research Sindh is situated in Tando Jam town at 18 km from Hyderabad, about 200 km from Karachi airport linked with super highway to Hyderabad. The total area covered by the Research is 416.66 acres (1.6862 km^2) including an area of more than 80 acres. The climate in Tandojam is called a desert climate. The average annual temperature in Tando jam is 27.7 °C and average annual rainfall is 171 mm.

Raw material of organic manures

The all basic organic raw materials Farm Yard manure (FYM), Poultry manure (PM), dry leaves and green manure (jantar) from around Tandojam Sugar press mud (SPM) from Mityari Sugar mill and effective microorganism (EM), rock phosphate (RP-compost) were collected from Hyderabad , Sindh Pakistan . Green manure was chopped into small pieces, about 8 to 10 cm in length.

Preparation of rock phosphate enriched compost

The basic organic raw materials used for composting were Farm Yard manure (FYM), Poultry manure (PM), and Sugar press muds (SPM) with effective microorganism (EM), rock phosphate (RP-compost) etc.

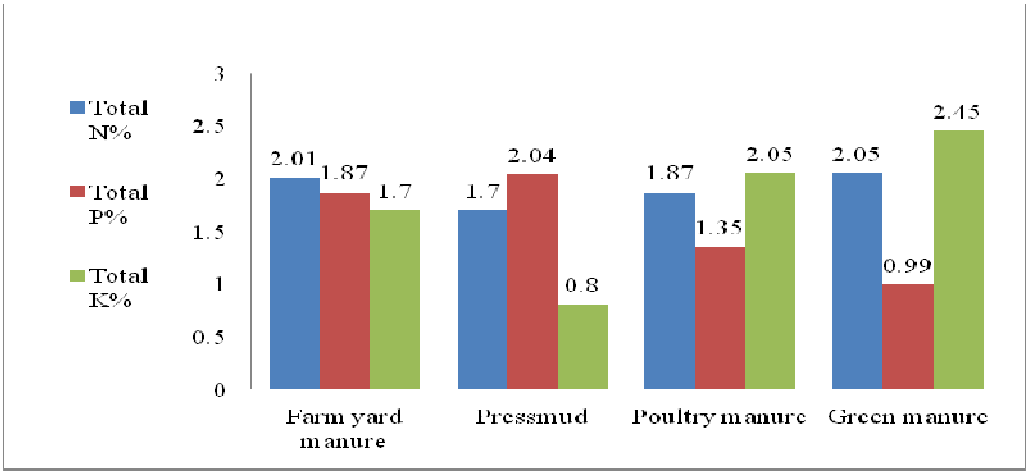

Figure 1. Nutrient content (total NPK) of fresh organic waste (farm yard manure, pressmud, poultry manure and green manure) used for composting

were thoroughly mixed for homogenization enrichment of compost. The compost was prepared from the material in a 1.5 m wide, 1.5 m long and 5 m deep pits lined with polythene sheet to avoid contamination and moister loss. Then, dried plant material crushed and chopped, dry leaves and green manure, rock phosphate, FYM, PM, SPM were spread in the pit one by one in the form of layer at the rate of 100 kg. In all steps, water was sprinkled because it is necessary to maintain the moisture level of 50 to 60% and the surface of the heap was covered with polythene sheet. The compost pile was turned on weekly basis for 12 weeks after recording the temperature. The compost was ready in about 90 days.

Chemical analysis of compost

The composting processes of the pit were prepared in approximately three months. Three replicates of compost sampled were analyzed. Compost samples from pit collected, dried, ground and sieved by passing through sieve and then used for chemical analysis. Samples were oven dried at 70° C and ground to pass through a 20-mesh sieve size.

pH: pH was determined by glass electrode pH meter as described by (Tandon et al., 2005).The position of the electrode was adjusted in the clamp. The electrode was immersed into partly settled solution suspension and pH was measured. The result was reported as soil pH measured in water (sample and water ratio=1:5).

Electrical conductivity: The EC of collected soil samples was determined electrometrically (1:5 sample: water ratio) by a conductivity meter using 0.01 M KCL solution to calibrate the meter following the procedure described by Tandon et al. 2005.

The compost samples were analysed for nitrogen, phosphorus, potassium and micronutrients (Fe and Zn) by the following methods.

Total nitrogen was determined by Kjeldhal's method (Bremner, 1965) where sample was digested with conc. H_2SO_4, and catalyst mixture. Nitrogen in the digest was determined by distillation with 40 % NaOH followed by titration of the distillate trapped in Toshero regent with 0.01 % HCl.

Total Phosphorus was determined on spectrophotometer after developing colour by vanadomolybdo phosphoric acid yellow colour method. The readings were taken at 440 nm wavelength (Cottenie, 1980).

Total Potassium was analysed by Percent emission was recorded following the methods outlined by using Eel Flame photometer (Knudsen et al. 1982).

Micronutrients (Fe and Zn) analysed by using atomic absorption spectrophotometer (Baker and Amacher, 1982).

Total carbon and organic matter content were determined by using procedure reported by (Tandon et al. 2005). Organic matter was determined by loss on ignition method. Five gram sample was taken in pre-weighed the porcelain crucibles which were kept in muffle furnace for 5 hours at 550 ^{0}C. After cooling the crucibles were weighed to determine the loss on ignition.

RESULTS

Among the major nutrients, The analytical data regarding NPK contents of FYM, PM , Poultry manure and green manure showed great variation depending upon the nature of material (Figure 1). Nitrogen contents of FYM, PM, poultry manure and green manure were 1.9, 1.7,

Table 1. Chemical composition of the phosphorus enriched manure after composting

Parameters	Composted phosphate enriched manure
EC (1:5) dSm^{-1}	3.29
pH (1:5)	7.34
Organic matter %	65.34
Total C (%)	37.55
Total N (%)	2.50
Total P (%)	2.89
Total K (%)	1.93
C: N (%)	18.32
Fe (mg kg^{-1})	1012
Zn (mg kg^{-1})	166

1.72 and 2.05 %, respectively. In case of P, PM was the richest source containing 2.2% followed by FYM (1.57%), poultry manure (1.35%) and green manure (0.98%). A different picture emerged for K, which was highest in poultry manure (2.13%) followed by FYM (1.72%). PM was lowest (0.87%) as compared to other two materials. These results compare well with those of Shah (2001) who also reported highest contents of P (1.74 %) in PM and K (2.4 %) in FYM. Theses result were similar by (Mamaril. 2000: Gachene and Kimaru, 2003: Singh *et al*. (2003) and Hasanuzzaman, *et al*. (2010) and Memon *et al.* (2012). 1

The data regarding EC, pH, total organic matter (%), total carbon (%), macro and micronutrient (total N, P, K, Fe and Zn) contents of composted rock phosphate manure are presented in Table 1. The pH of the compost phosphate enriched manure was 7.34 after completion of composting. Analytical data showed that EC (3.29 dS m^{-1}), total organic matter as well as organic carbon content of (65.34 to 37.99 %). The findings are similar by preethu et al. (2007).

Among the major nutrients, total N, P and K (2.5, 2.89 and 1.93%), micronutrients contained highest level of Fe and Zn (1012 and 166 ppm). There was increase in the overall nutrient contents after composting. Total N (2.05 %) of composted manure is equivalent to an increase of 24, 47, 34 and 25 % over fresh FYM, SPM, PM and GM while P increase 55, 42,> 100% over FYM, SPM, PM and GM in case of total K increase 14 and 6 % over FYM and PM while 22% less than GM. Similar results were findings by Preethu *et al.* (2007) and Irshad *et al.(*2012).

DISCUSSION

Kanwal et al. (2011) reported that in acidic soil as well as in alkaline soils decomposition of applied different organic materials released acids or acid forming compounds that reacts with sparingly soluble salts or at least increase their solubility. The carbonic acid and organic acid produced during the decomposition of organic matter solubilized insoluble phosphate in the rock phosphate, resulting in the release of phosphate and calcium into the solution. Thus the preparation of rock phosphate enriched compost is based on the concept of solubilization of insoluble rock phosphate into plant available form during the process of composting (Singh et al., 1982). A combination of phosphate rock with compost has been shown to increase the availability of the phosphorus. Rock phosphate, farmyard manure, poultry manure, pressmud and effective microorganisms being locally available are cheaper sources of nutrient availability with P fertilizer and need to be tested.

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