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Effect of Rice Straw and Lime on Phosphorus and Potassium Mineralization from Cowdung and Poultry Manure under Covered and Uncovered Conditions in the Tropical Environment

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Abstract: A pot study was conducted at greenhouse to measure the P and K mineralization rate from fulvic acid with fresh poultry manure, partially decomposed cowdung, rice straw and lime under covered and uncovered condition. The decomposition period was 90 days. Initially the cowdung contain 127 ppm of fulvic acid P and 2.23 meq /100 g of fulvic acid K whereas the poultry manure contain 378 ppm of fulvic acid P and 13.4 meq /100 g of fulvic acid K. The P and K immobilization takes place after 15 days of decomposition and with the passing of time it increased gradually. The lime addition increased P concentration in cowdung treatments and the highest of 1505 ppm of fulvic acid P was recorded at 75 days of decomposition in the covered cowdung + lime treatment. The addition of rice straw increased K concentration in both cowdung and poultry manure treatments but it decreased the mineralization rate. The highest of 67 meq /100 g of fulvic acid K was mineralized at 75 days of decomposition in the uncovered poultry manure + rice straw treatment. The fulvic acid P mineralization was higher in the covered cowdung and poultry manure treatments. The fulvic acid K mineralization was also high in the covered cowdung treatments but in the poultry manure treatments it was higher in the uncovered treatments.

Key words: Poultry manure, cowdung, phosphorus, potassium, mineralization

INTRODUCTION

Organic fertilizer is essential for maintaining the soil health. Cow dung and poultry manure are excellent sources of soil organic matter as well as phosphorus and potassium. The poultry manure contains about 2.91% of total phosphorus and 2.12% of total potassium (Saha *et al.*, 2003) which is higher than cow dung. Rice is the staple food of most of the tropical countries and phosphorus and potassium are involved in a wide range of plant process from cell division to the development of root system. One ton of economic yield required about 5 Kg of phosphorus (Tandon and Narayan, 1990) and at least 70 Kg of potassium removes from the soil for an average 4.0 t/ha-rice yield (Saleque *et al.*, 1998). The cultivation of high yielding rice varieties increased demand of phosphorus and potassium fertilizer. Kawaguchi and Kyuma (1977) surveyed the extent of phosphorus in the low land rice soils of the tropical Asian countries including Bangladesh and found low in available phosphorus. Phosphorus mineralization is very relative to soil pH, although total phosphorus concentration may be high; the plant available phosphorus may not be higher.

Potassium is the most abundant cation in plants and absorbed in large quantities by roots. Modern high yielding rice verities remove higher amount of Potassium than phosphorus or even nitrogen from the soil (Von Uexkull, 1970). Intensive cropping with modern rice varieties has been responsible for increasing instances of potassium deficiency in soil in many areas of the world (Goswami and Banerjee, 1978). The potassium status of soil is dynamic and is influenced by such factors as soil texture, mineralogy, temperature and pH. Leaching of applied potassium can be significant and seems to be influenced by both soil texture and quantity of water that percolates through the soil profile (Bertsch and Thomas, 1985) Management of phosphorus and potassium besides nitrogen is very important to maximize rice production for food security in rice eating Asian countries. The application of organic fertilizer such as cow dung, poultry manure act as sources of available phosphorus and also improve soil texture and water holding capacity of soil that reduce the leaching loss of potassium. Rice stubble may play an important role in phosphorus and potassium mineralization when organic manure is mixed with rice field.

There are available literatures on the phosphorus and potassium mineralization under control condition that is incubation study but there is no available information about phosphorus and potassium mineralization under natural condition, which is actual need for farmer's nutrient management practices. Considering this, a study was conducted to know the phosphorus and potassium release pattern from some selected organic manure under natural condition.

MATERIALS AND METHODS

A pot experiment was conducted under green house condition at Bangladesh Rice Research Institute, Gazipur. The fresh poultry manure, rice straw, partially decomposed cowdung and lime were used in this study. The rice straw was chopped about one-inch pieces and mixed with poultry manure and cowdung as 1:1 (by volume) to the desired pots. A 25 gm of lime dust were mixed with 1 kg of poultry manure and cowdung. A number of 18 pots were kept in covered condition and other 18 pots were remaining uncovered condition. After separation of fulvic acid from humic acid the available phosphorus and potassium were measured at every 15 days interval.

Phosphorus measurement: The available phosphorus from fulvic acid (NaOH-P) was measured by developing blue color with ascorbic acid –ammonium molybdate vanadate complex and color intensity was measured colorimetrically at 710 nm wavelength in Hitachi-U-1100 spectrophotometer.

Potassium measurement: Exchangeable potassium was determined from fulvic acid by using flame photometer in Hitachi 170-10 Atomic absorption Spectrophotometer according to Black, 1965.

Statistical analysis: The data were analyzed in a factorial design (four factor in RCB) design with three replications using IRRI STAT version 4 software.

Table 1: Analysis of variance for phosphorus concentration in the fulvic acid during decomposition of cowdung and poultry manure under covered and uncovered condition with and without rice straw and lime

Source of variance	df	SS	MSS	F ratio	Prob.
Rep	2	83701.90	41851	0.46	0.638
Treat (CDvs. PM)	1	15215800	15215800	167.00	0.000
Add (control vs. RS vs. Lime)	2	1057210	528603	5.8	0.004
Cover (covered vs. Uncovered)	1	1599190	1599190	17.55	0.000
Date	6	12757600	2126260	23.34	0.000
Treat x add	2	3678770	1839390	20.19	0.000
Treat x cover	1	305362	305362	13.35	0.005
Treat x date	6	4212430	702071	7.71	0.000
Add x cover	2	1205750	602873	6.62	0.002
Add x date	12	12025400	1002110	11.00	0.000
Cover x date	6	2205090	367515	4.03	0.001
Treat x add x cover	2	914268	457134	5.02	0.008
Add x cover x date	12	1732930	144411	1.58	0.1
Treat x add x cover x date	30	5060620	168687	1.85	0.008
Residual	166	15124900	91113.80		

Table 2: Analysis of variance for potassium concentration in the fulvic acid during decomposition of cowdung and poultry manure under covered and uncovered condition with and without rice straw and lime

Source of variance	df	SS	MSS	F ratio	Prob.
Rep	2	31.522	15.761	1.38	0.253
Treat (CD vs. PM)	1	48839.7	48839.7	25.77	0.000
Add (control vs. RS vs. Lime)	2	27.2185	13.6092	21.19	0.006
Cover (covered vs. Uncovered)	1	25.4095	25.4095	2.23	0.133
Date	6	18903.7	3150.62	275.97	0.000
Treat x add	2	1224.90	612.452	53.65	0.000
Treat x cover	1	228.267	228.267	19.99	0.000
Treat x date	6	18931.5	3155.24	276.37	0.000
Add x cover	2	319.059	159.529	13.97	0.000
Add x date	12	10493.6	874.469	76.60	0.000
Cover x date	6	2809.47	468.244	41.01	0.000
Treat x add x cover	2	785.748	392.874	34.41	0.000
Add x cover x date	12	1606.56	133.880	11.73	0.000
Treat x add x cover x date	30	10312.5	343.749	30.11	0.000
Residual	166	1895.17	11.4167		

RESULTS AND DISCUSSION

Phosphorus mineralization: Initially the cowdung contains about 127 ppm and poultry manure contains 378 ppm of fulvic acid phosphorus. The concentration of available phosphorus decreased at 15 days in the both covered and uncovered poultry manure and cowdung treatments (Fig. 1). This might be due to the phosphorus may have utilized in the synthesis of microbial tissues. Gagnon and Simrad (1999) also reported strongly immobilization of phosphorus started from first week in the fresh solids, beef and young dairy manure compost amended soil. After 15 days the concentration of available phosphorus increased in the treatments. The fulvic acid phosphorus concentration was significantly higher in the covered treatments than uncovered treatments. The addition of rice straw decreases phosphorus mineralization rate and the mineralization pattern shows it would need much more time (Fig. 1b). Lime increases phosphorus concentration (~1500 ppm) in the cowdung-covered treatment (Fig. 1c) after 75 days of decomposition where as in the poultry manure treatments it would need more time to reach the peak. The highest of 271 ppm of phosphorus was found at 75 days of decomposition in the covered cowdung treatments where as in the uncovered cowdung treatments it increases slowly and after 90 days of decomposition the highest 162 ppm phosphorus was found. In the poultry manure treatments the highest of 1741 ppm of phosphorus was mineralized at 45 days of decomposition (Fig. 1a). The addition of rice straw and

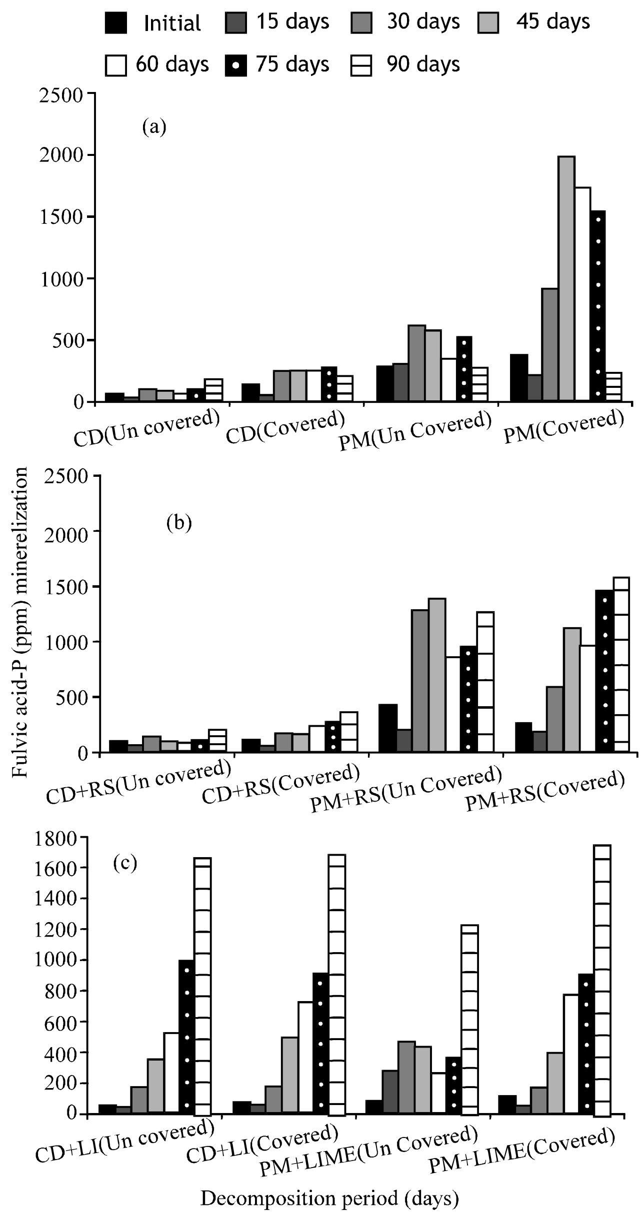

Fig. 1: Effect of rice straw and lime on fulvic acid-P mineralization from cowdung and poultry manure under covered and uncovered condition

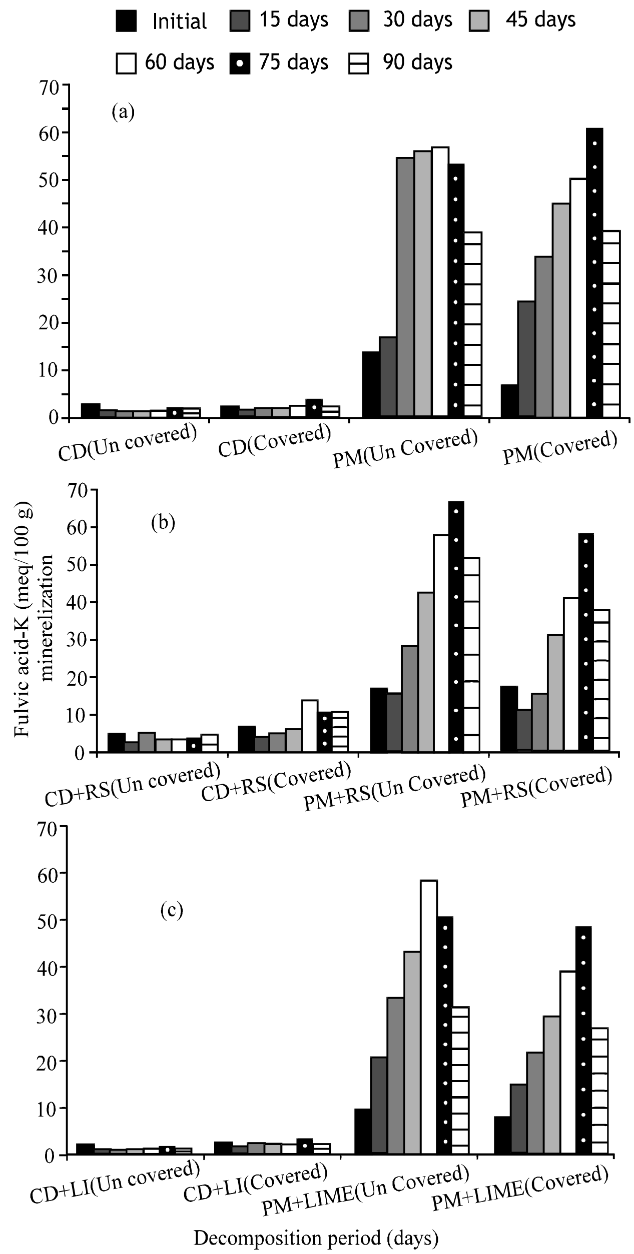

Fig. 2: Effect of rice straw and lime fulvic acid-K mineralization from cowdung and poultry manure under covered and uncovered condition

lime with cowdung and poultry manure made significant differences in fulvic acid phosphorus concentration and was significant at 0.01% level in both covered and uncovered condition during the whole decomposition period (Table 1).

Potassium mineralization: The concentration of fulvic acid potassium was manifold higher in the poultry manure than cowdung treatments. The cowdung contain about 2.23 meq /100 g and poultry manure contain 13.4 meq /100 g of potassium at the initial stage of decomposition (Fig. 2a). The potassium concentration significantly increased in the cowdung and poultry manure when rice straw was added. The highest of 3.6 meq /100 g of fulvic acid potassium was recorded in cowdung treatment but when rice straw was added with cowdung the highest of 14.05 meq /100 g potassium was found (Fig. 2b). In the poultry manure treatment same phenomena observed. The highest of 67 meq/100 g of fulvic acid potassium was recorded in the poultry manure + rice straw treatment where as it was 56 meq /100 g in poultry manure alone. Considering covering in the cowdung covered treatments the fulvic acid potassium concentration was significantly higher than uncovered treatments during the 90 days of decomposition. It is reverse in case of poultry manure treatments. After 15 days of decomposition the potassium immobilization takes place. Mishra *et al.* (2001) also found during decomposition of rice straw carbon and potassium content decreased initially and 79% of the total potassium released within five weeks since its burial in the soil. In the present study the highest potassium mineralization was observed after about 60 days of decomposition. The addition of lime did not made significant difference in fulvic acid potassium concentration (Fig. 2c). The interaction effect within the cowdung and poultry manure, rice straw and lime were significant in covered and uncovered condition at 0.01% level of significance (Table 2). Where as the interaction effect between covering and the treatments were insignificant at the same level of significance.

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