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Phosphorus availability as influenced by different organic manure in a red soil amended and time of incubation

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Abstract
A laboratory incubation experiment to investigate at the effects on phosphorus release of the addition of organic manures to red soil. Organic manure was added at the different rate. After the incubation, P values in control and amended soils were used for phosphorus availability and by a extraction procedure. The relative contribution of available phosphorus indicating that organic manure increased P in the red soil. In soils amended with different organic manures. A phosphorus mineralization study was conducted in net house Department of soil science and agriculture chemistry Institute of Agricultural Sciences Banaras Hindu University, Varanasi-221005, (U.P.), India 2013-14.Five organic manure FYM, oilcake, poultry manure Pig manure and rice straw in a wide range of C/N and C/P ratio. Were added to the soil sample at the rate of 4, 40, 80 t ha^{-1}.The sample were incubated for 2, 72, 168, 336, 480, 1440, 2160 hours at constant temperature and moisture. The extractable P was determined after the each incubation period. The extractable P calculated in mg kg^{-1}. Mineralization of P comparison between the unamended soil and amended soil with organic manures.

Keywords: Organic manure, P mineralization, incubation. environmental risk

Introduction

Phosphorus (P) is essential to all known life forms because it is a key element in many physiological and biochemical processes. A component of every cell in all living organisms, phosphorus is indispensable and cannot be replaced by any other element. Phosphorus occurs in complex DNA and RNA structures which hold and translate genetic information and so control all living processes in plants, animals and man. It is an essential component of the energy transport system in all cells. The element phosphorus does not occur by itself in nature. It is always combined with other elements to form phosphates. Phosphates can be very complex and more than one form of phosphate will be found in soils, water, plants, animals and man. In this booklet, therefore, the word "phosphorus" will be used in the text rather than identifying the particular phosphate but, in most cases, numerical values will be given as P_2O_5 (2.29 kg P_2O_5 is equivalent to 1.0 kg P). The release of organically and inorganically bound nutrients such as P, which can then be utilized by plants, is particularly important in agriculture. For optimal crop nutrition, replenishment of P-depleted soil is affected predominately by the release of P from clay minerals and organic matter. The release rate of adsorbed P directly affects the P supply to plants and may have a significant impact on surface and ground water quality. Soil organic matter is a vital parameter in maintaining adequate levels of P. The use of organic materials for soil fertility management has many advantages, particularly in arid and semi-arid regions where soil organic matter rapidly depletes and its availability is limited because of erratic and low rainfall distribution. Different organic residues are produced in large amounts in Iran. Crop residues and fruit and vegetable waste are cheap and easily accessible organic residues whose application to agricultural soil could improve soil fertility. However, they may also influence the distribution of P between different fractions (Hooda *et al.* 2001) [18]. Organic amendments supply nutrients and replenish the soil organic matter (OM) pool. According to several studies, organic materials improve soil chemical, physical and biological properties and thereby contribute to the maintenance of overall soil fertility and productivity (Topoliantz *et al*., 2005, Bhogal *et al*., 2011) [19, 20].

Materials and Methods

An incubation experiment was conducted with three organic manures namely FYM, oilcake, poultry manure, pig manure and rice straw. The FYM was obtained from the Department of Animal Husbandry and Dairying, of the Institute of Agricultural Sciences, BHU, Varanasi; oilcake was obtained from the oil mill located at Lalpur, Mirzamurad, Varanasi and pig manure were collected from State Government Piggery Farm, Shahanshahpur, Varanasi. The organic manures were dried at room temperature and ground to pass through 2 mm sieve. Air dried ground (less than 2 mm) samples of organic manures were analysed for total C, H and N by a CHN analyzer (Thermo Finnigan). Sample were digested in diacid (nitric acid and perchloric acid) and the total P in the digest was measured by the ammonium molybdate-vanadate yellow colour method. The C/N and C/P ratios were calculated from total C, total N and total P data. The pH was measured by a glass electrode pH meter using distilled water in the ration 1:5. The soil used in the experiment was an red soil, which was obtained from Agricultural Research Farm of the Institute of Agricultural Sciences, BHU, Varanasi. Bulk soil samples from 0-15 cm depth were collected and the soil was air-dried and passed through a 2 mm sieve before analysis. The pH of soil was measured in 1:2.5 (soil: water suspension) after equilibrating for 30 minutes, with the help of glass electrode digital electrode pH meter. Soil suspension was allowed to settle till supernatant become clear. Electrical conductivity was measured with the help of EC meter and expressed as dS m^{-1}. CEC of soil was determined by sodium saturation method using sodium acetate (NaOAC pH 8.2). Particle size analyses was done using a hydrometer as described by Bouyoucous (1927) [10]. The water holding capacity of the soils were measured using Keen- Rackzowski box (Black, 1965) [14]. Organic carbon in soil was estimated by chromic acid wet digestion, followed by titrimetric measurement of unreacted dichromate (Walkley and Black, 1934) [15]. The calcium carbonate (%) of soil was determined using rapid titration method given by Puri (1930) [9]. Available nitrogen content of soil was determined by alkaline permanganate method (Subbia and Asija, 1956) [1], available phosphorus content by Olsen's method (Olsen, 1954) [11] and available potassium content by extraction using 1 N ammonium acetate and analysed by flame photometer. Exchangeable Ca and Mg was extracted in 1 N ammonium acetate and measured by EDTA titration. Total organic carbon content was determined by using the method of Yeoman and Bremmer (1988) [13], total phosphorus by digesting the soil in nitric-perchloric acid mixture and determining the colour developed. The fractions of P fractionation were measured as outlined in Page *et al.* (1982) [12].

The incubation study was carried out in plastic pots wherein 1 kg soil was thoroughly mixed with organic manure @ 0, 4, 40 and 80 t ha^{-1} equivalent to 0, 2, 20, and 40 g kg^{-1} on dry weight basis and incubated for 2, 72, 168, 336, 480, 1440, and 2160 hours at 25 °C. Appropriate amount of water was added to bring the soil to the estimated field capacity and the samples were kept moist by adding distilled water as needed. After the specified time intervals, samples were taken and air dried before analysis and sub-samples were analyzed for Olsen- P (Olsen and Sommers 1982) [12]. All incubation experiments were carried out in triplicate.

Results and Discussion

Characteristics of Soil and Organic manures

A soil incubation experiment was conducted for 2160 hours with three different soils and five different manures in completely randomized design with three replication in the net house of the Department. The soils were chosen so as to represent major red soil of India. The salient soil properties are presented in Table 1. The soil were yellow brown (red soil) to brown in colours and the clay contents 25.6% (red soil) and consequentially the textural class varied from sandy loam. The water holding capacity was low in red soil (34.2%). The soil were slightly acidic (red soil; 6.25) and low in salt content (0.021 dS m^{-1}). The soil had little calcium carbonate (0.12%) and varied in organic carbon from 5.6. Consequently the CEC of the soil 15.87 (C mol (p+) kg^{-1}). The available nitrogen content of all the soils were in the low category (144 kg ha^{-1}); and available potassium was 301.8 kg ha^{-1} Exchangeable calcium and magnesium was 5.8 and 5.87 meq/100g soil also.

Organic manures used in the study were FYM, poultry manure, pig manure, rice straw and oilcake. The chemical composition of the manures is presented in Table 2. The manures had an acidic range of pH (5.4 -6.8 units). The total C, H and N was analyzed by CHNS analyzer and total P by wet digestion. The manures varied in their carbon and hydrogen content from 22.4 to 40.3% and 3.44 - 5.78% with rice straw and oilcake showing higher C and H content. The total N content also varied widely from 0.66 to 6.43% with lowest N content in rice straw and higher in oilcake. FYM poultry manure and pig manure had similar N contents. Total P content also varied widely between 0.09 and 1.69 %. Poultry manure had higher P content (1.69%) followed by pig manure (1.27%), oilcake (0.96%) FYM (0.38%) and rice straw (0.09%). The C/N ratio varied from 6.2 to 52.7; narrow C/N ratio was found in oilcake and wide ratio in rice straw. FYM, poultry manure and pig manure had similar C/N ratios. Wide variation in C/P ratio was also noted. Poultry and pig manure had narrow C/P ratio (13.2 and 18.8 respectively), oilcake and FYM had intermediate ratio (41.9 and 69.4 respectively) and rice straw had highest C/P ratio (391.6).

Mineralization of P from organic manures in red soils

It was found that the net P mineralized in red soils also increased with increasing time interval but did not attain a study value within the time period of incubation (Table 3); but the rate of P mineralization decreased with increase in the time period of incubation. The net P mineralized increased from 0.2 mg kg^{-1} to 2.4 mg kg^{-1} in case of 4 t ha^{-1} application of FYM, whereas the increase was 0.4 to 2.6 mg kg^{-1} on application of 40 t ha^{-1} and 0.5 to 3.1 mg kg^{-1} in case of 80 t ha^{-1} FYM application thus the increase in P mineralization was 5.7 times, 3.1 times and 3.9 times between 2 and 2160 hrs of incubation for 4, 40 and 80 t ha^{-1} application rate respectively. Similarly the net P mineralized increased from 0.1 mg kg^{-1} to 2.7 mg kg^{-1}; 0.2 to 3.7 mg kg^{-1} and 0.9 to 3.9 mg kg^{-1} on application of 4, 40 and 80 t ha^{-1} of oilcake. This increase was 26, 17.5 and 3.3 times for 4, 40 and 80 t ha^{-1}. The net mineralization of P from poultry manure. was from 0.2 to 1.6 mg kg^{-1} for 4 t ha^{-1} and the corresponding values for 40 and 80 t ha^{-1} application rate was from 0.2 to 2.8 mg kg^{-1} and 0.3 to 3.0 mg kg^{-1}. The increase in mineralization between the beginning and end of incubation was 7 times, 14 times and 2.7 times respectively for 4, 40 and 80 t ha^{-1} application rate. Phosphorus mineralization from pig manure is presented in and the data reveals that the mineralization increased from 0.2 to 5.2 mg P kg^{-1} in case of 4 t ha^{-1} application rate (an increase of 25 times); whereas the increase was from 0.7 to 6.1 mg kg^{-1} in case of 40 t ha^{-1} (an increase of 7.71 times) and 1.3 to 6.8 mg kg^{-1} (an increase of 4.23 times). perusal of reveals that mineralization was rapid in the initial stage of mineralization up to 336 hrs and decreased thereafter. Thus rapid increase in rate of mineralization in poultry manure is probably because of low C/P ratio (13.2) and high P content (1.69% P). In case of pig manure the net P mineralized increased from 0.2 to 5.2 mg kg^{-1} in case of 4 t ha^{-1} addition of pig manure and from 0.7 to 6.1 t ha^{-1} in case of 40 t ha^{-1} application rate and from 1.3 to 6.8 t ha^{-1} in case of 80 t ha^{-1} application rate. This increase was 25 times, 7.71 times and 4.23 times respectively for 4, 40 and 80 t ha^{-1} application rate perusal of rveals that although the C/P ratio was low (18.8) and total P content was high (1.27% P), the mineralization pattern was quite different from poultry manure and 81.3%, 73.9% and 72.1% total P mineralized was within 2 hrs. of the incubation study. The mineralization of rice straw increased from 0.2 to 3.8 mg kg^{-1} and 0.3 to 3.9 mg kg^{-1} and 0.7 to 4.3 mg kg^{-1} in case of of 4, 40 and 80 t ha^{-1} rice straw application rate. Rice straw had the lowest total P content and the highest C/P ratio (391.6) amongst all the studied manures. This increase was 18 times, 12 times and 3.6 times respectively for 4, 40 and 80 t ha^{-1} application rate perusal of Perusal of reveals that the net P mineralization also increased throughout the period of incubation. All manures amended soil result shoes in Table 3 and (Fig 1, 2, 3).

Table 1: Initial properties of soil under study

Properties	Value
pH	6.25
EC (dS/m)	0.02
CEC (cmol (p+) kg^{-1})	15.8
Texture (%)	
Sand	46.3
Silt	26.2
Clay	25.6
Water holding capacity (%)	34.2
Oxidisable Organic carbon (g kg^{-1})	5.6
Calcium carbonate (%)	0.12
Available (kg ha^{-1})	
N	144.1
P_2O_5	11.1
K_2O	301.8
Exchangeable (cmol (p+) kg^{-1})	
Ca	5.8
Mg	5.8

Table 2: Characteristics of organic manures under study

Organic manures	pH		Total			Ratio	
		C	H	N	P	C/N C/P	
				(%)			
FYM	6.8	26.39	3.44	1.77	0.38	14.8	69.4
Oil cake	5.6	40.31	5.78	6.43	0.96	6.2	41.9
Poultry manure	6.7	22.42	3.67	1.96	1.69	11.3	13.2
Pig manure	6.2	23.88	3.72	1.73	1.27	13.7	18.8
Rice straw	5.4	35.24	5.67	0.66	0.09	52.7	391.6
Range	5.4 - 6.8	22.42 - 40.31	3.44 - 5.78	0.66 - 6.43	0.09 - 1.69	6.2 - 52.7	13.2 - 391.6

Table 3: Extractable P (mg kg^{-1}) in a red soil as influenced by organic manure addition and time of incubation

Manures	Application Rate	Incubation period (hr.)						
	(t ha^{-1})	2	72	168	336	480	1440	2160
FYM	4	0.2*	0.3	0.4	0.6	1.5	1.6	2.4
	40	0.4	0.5	0.6	0.7	1.6	2.0	2.6
	80	0.5	0.6	0.7	1.0	2.1	2.5	3.1
Oilcake	4	0.1	0.3	0.6	0.6	1.5	1.7	2.7
	40	0.2	0.3	0.6	0.7	1.7	1.9	3.7
	80	0.9	1.0	0.9	1.4	1.9	2.1	3.9
Poultry manure	4	0.2	0.4	0.4	0.5	0.7	1.2	1.6
	40	0.2	0.6	1.0	1.4	1.5	1.8	2.8
	80	0.3	1.0	1.5	1.7	1.9	2.3	3.0
Pig manure	4	0.2	0.3	0.5	0.9	1.7	2.9	5.2
	40	0.7	0.9	1.2	1.5	2.5	3.7	6.1
	80	1.3	1.3	1.5	2.1	2.7	3.8	6.8
Rice straw	4	0.2	0.3	0.3	0.6	1.4	2.0	3.8
	40	0.3	0.4	0.5	0.9	2.1	2.4	3.9
	80	0.7	0.8	0.9	1.3	2.5	3.1	4.3

* Average of three replication.

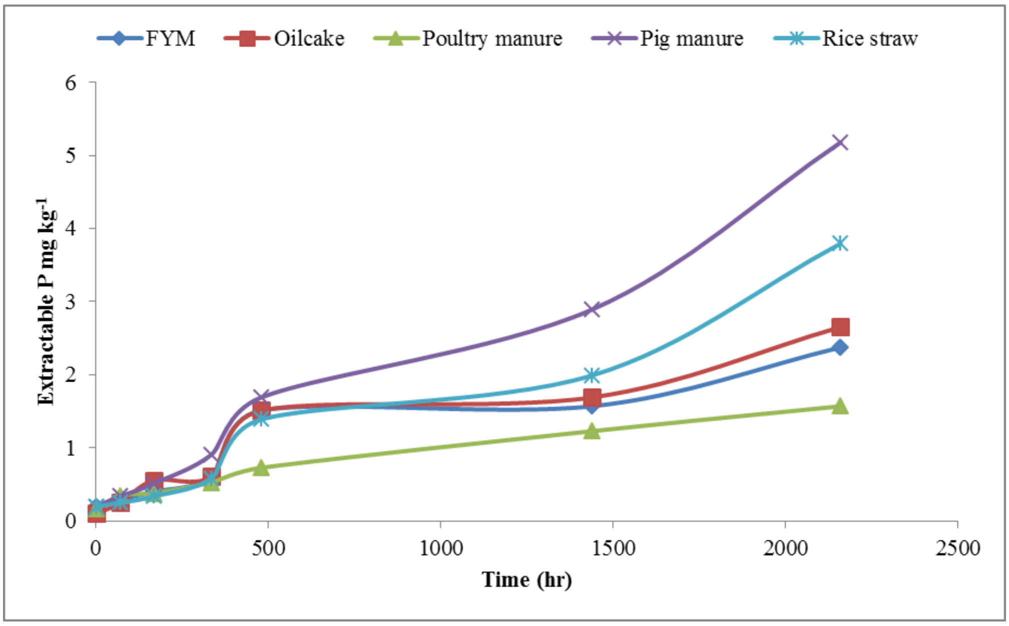

Fig 1: Net P mineralization of different organic manure in a red soil amended @ 4 t ha^{-1}

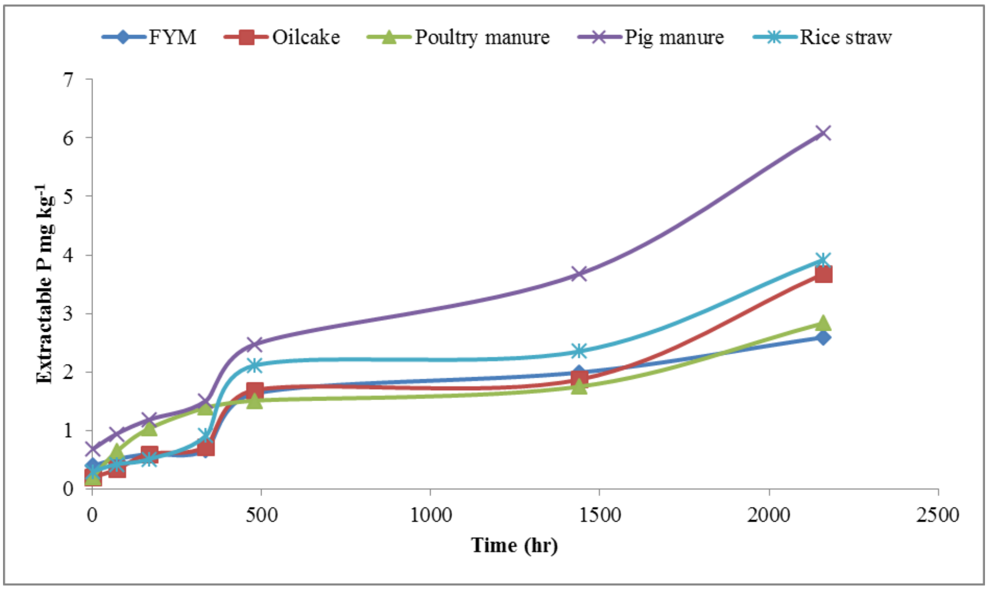

Fig 2: Net P mineralization of different organic manure in a red soil amended @ 40 t ha^{-1}

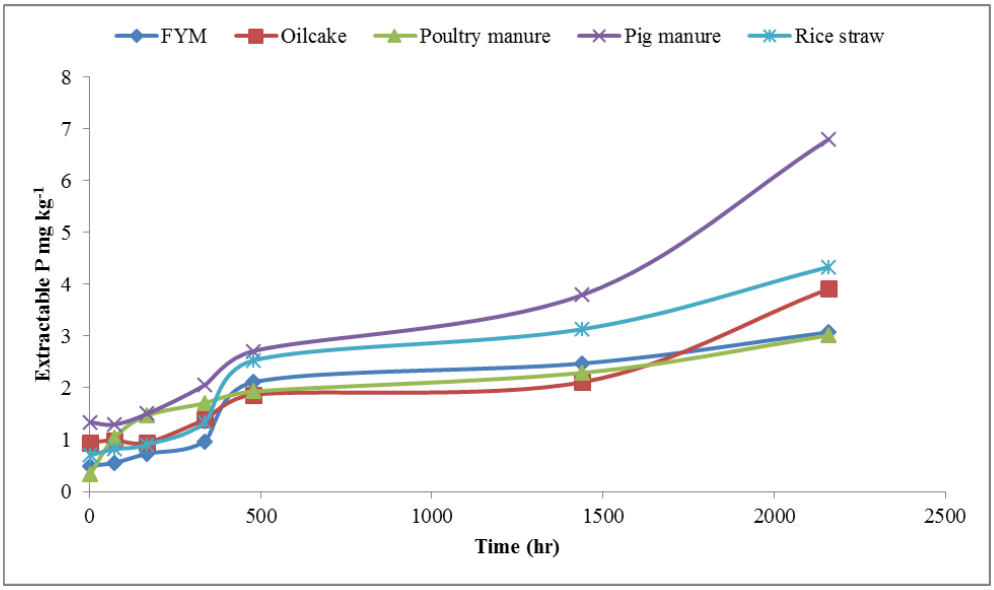

Fig 3: Net P mineralization of different organic manure in a red soil amended @ 80 t ha^{-1}

Conclusion

From the study it can be concluded that addition of the five organic manures. The application of organic manures to improve the physical chemical and biological properties of soil. To maintain sustainability of soil and control environmental fate. The environmental point of view organic manure to reduce the leaching and eutrafication of phosphorus in soil. The C/N ratio of higher in rice straw as compared with others amended manures. In case of C/P ratio higher in rice straw as compared with others manures. The extractable phosphorus will be increase in all manure according to higher dose and incubation period. The view of this investigation on mineralization to application of organic manures to improve phosphorus availability at favorable climate and microbial activity also. Higher mineralization at higher application of organic manures. Organic manure to improve fertility status and control environmental fate in case.

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