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Residual Effect of Phosphorus from Organic Manures in Sunflower – Assessment Using Radio Tracer Technique

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Abstract: Quantification of plant available phosphorus to the residual crop of sunflower in maize – sunflower cropping sequence from organic manures namely farmyard manure (FYM), poultry manure (PM), Bio compost (BC) and pressmud (Pr.m) was carried out through radiotracer technique using ^{32}P. Poultry manure recorded the highest value (42.68 %) with respect to phosphorus derived from source. Farmyard manure as a source of phosphorus was statistically superior to other treatments in A value (12.89) indicating more availability of phosphorus from soil in this treatment.

Key words: Organic manures, residual effect, ^{32}P, sunflower, phosphorus, % pdff, A value

INTRODUCTION

Phosphorus (P) in plants performs unique function of energy transfer via formation of pyrophosphate bond. Phosphorus compounds (ADP and ATP) act as energy currency within the plants and involve in wide range of plant processes from permitting cell division and development of good root system. The availability of phosphate in soils is often limited by fixation reactions, which convert the monophosphate ion into various insoluble forms. The importance of organic manures in the soil has been recognized for centuries as the key to soil fertility and productivity. Organic manures, favourable by product of farming and allied industries contribute to plant growth through their favourable effect on physical, chemical and biological properties of soil. The availability of soil phosphate is enhanced by addition of organic manures, due to chelation of polyvalent cations by organic acids and other decay products.

Though, information is available on the conjunctive use of organic manures and inorganic fertilizers for improving soil fertility and crop yields, direct quantification of plant available phosphorus rendered available to the crops (main and residual benefits) from organic manures is scant. Precise information on the quantity of soil available phosphorus from applied manure can be obtained only with the aid of radio tracer technique. A value technique [2] which is often used to measure amount of available nutrients in different soils or fertilizers can also be used to measure indirectly the availability of nutrient from sources that cannot be labeled conveniently [8] With this background, this study was carried out to determine the plant available P in soil from four organic sources on equal P basis with inorganic source of phosphorus namely, Single Super Phosphate (SSP) in the main crop (maize) and residual crop (sunflower). The effect of the treatments on the biomass yield was also studied. The results obtained pertaining to the residual crop of sunflower is discussed in this paper.

MATERIALS AND METHODS

A green house experiment was conducted during 2005-06 at Tamil Nadu Agricultural University, Coimbatore with maize as main crop and sunflower as the residual crop to determine the plant available P in soil from four organic sources of P by ^{32}P labeling technique. One of the dominant soil series of Tamil Nadu, namely Irugur (*Typic haplustalf*) was used for the study. The initial characteristics of the soil are given in Table 1. Organic manures namely, Farm Yard Manure (FYM), Poultry Manure (PM), Bio compost (BC) and Pressmud (Pr.m) were tried as a source of phosphorus. These organics were compared with standard source namely, Single Super Phosphate (SSP). Totally there were six treatments (four organic manures, SSP and control) and four replicates, totally 24 pots. A second set of 24 pots identical with the first set in all aspects but without ^{32}P labeling was maintained to study the effect of treatments on the residual crop sunflower. The experimental soil was filled in earthen pots @ 10 kg pot^{-1}, lined with polythene sheets. The experiment was laid out in a completely randomized block design.

Organic sources of P and SSP as per the treatment were applied to each pot on equal P basis to the main crop

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Table 1: Initial soil characteristics

Parameters	Value
1.Physical properties	
Sand (%)	64.91
Silt (%)	11.26
Clay (%)	21.83
Texture	Sandy clay loam
2.Physico chemical properties	
pH	7.8
EC (dSm^{-1})	0.42
3. Chemical properties	
Organic carbon (%)	0.24
KMnO4 – N (kg ha^{-1})	242
Olsen's – P (kg ha^{-1})	13.20
NN NH_4OAc – K (kg ha^{-1})	746

Table 2: Chemical composition of the organic manures

Organic source	Nitrogen (%)	Phosphorus (%)	Potassium (%)
FYM	0.46	0.18	1.32
Poultry manure	1.08	0.80	1.28
Bio compost	0.76	1.32	0.90
Pressmud	0.82	0.48	1.98

of maize (31.2 mg pot^{-1}) and mixed with soil. The chemical composition of the organic manures used in the experiment is furnished in Table 2. The treatments received P application only for the main crop (maize). The radiotracer ^{32}P ($T1/_2$ – 14.3 days E max: 1.71 M_{ev}) obtained as orthophosphoric acid in dilute HCl medium from the Board of Radiation and Isotope Technology (BRIT), Mumbai was used for the study. After the harvest of the first crop, the second set of pots were given with 5 ml of ^{32}P from the stock solution of carrier free ^{32}P to give an activity level of 10 MBq pot^{-1}. The instantaneous specific activity was determined as per the standard procedure [1].

Basal application of nitrogen as urea and potassium as muriate of potash were given commonly to all the 48 pots. Routine cultural practices were followed in raising the crop. After the harvest, the grain and stalk samples were processed and subjected to radio assay. The phosphorus in the triacid extract of the plant sample was precipitated as magnesium pyrophosphate by the method outlined by McKenzie and Dean[5]. The Radioactivity in the precipitate was estimated in an end window type a Geiger Muller counter.

Interpretation of Radio Assay Data:

$$Bq = dps = \frac{\text{Corrected count rate per second}}{\text{Efficiency (\%)}} \times 100$$

$$\text{Specific activity} = \frac{\text{Corrected count rate per second}}{\text{(dps / mg) P content in sample (mg)}} \times 100$$

$$\%\ pd\ ff = \frac{\text{Specific activity of plant sample}}{\text{Specific activity of standard}} \times 100$$

(% Pdff – Per cent phosphorus in plant derived from fertilizer. Here, it refers to Per cent phosphorus derived from organic source)

Pdfs = Phosphorus in the plant derived from soil = 100 - % pdff

$$\text{A value} = \frac{\%\ \text{pdfs}}{\%\ \text{pdff}} \times \text{P applied (mg p/ 100g soil)}$$

The data obtained were statistically analyzed to establish the significance of observed variation in a completely randomized block design following the procedure outlined by Steel and Torrie [9].

RESULTS AND DISCUSSIONS

Grain Yield: There was significant increase in sunflower grain yield due to the application of organic manures (Table 3). Poultry manure recorded the highest grain yield than other treatments. This was in line with the findings of Jama *et al.* [3] who reported that grain yields for manures at least equaled or sometimes exceeded the yields when P was applied as inorganic source. The residual effect of composted poultry manure on the residual crop of maize in groundnut-maize sequence was also reported by Reddy *et al.* [6].

Per Cent Phosphorus Derived from Source (% Pdff): The different sources of organics tried had a significant effect on the per cent phosphorus derived from source in sunflower. The mean values ranged from 17.53 – 42.68 per cent (Table 3). The % Pdff in maize was more in organic source applied pots and less in superphosphate applied pots. This was obviously due to greater residual availability and release of P from organic sources as compared to superphosphate. FYM, pressmud and biocompost recorded 22.53, 20.05 and 19.66 % Pdff. Obviously, organic manures released over a period of time P in amounts sufficient to meet the needs of sunflower grown in succession to maize. This resulted in higher P in maize derived from organic sources than SSP. This is in line with the observations of Sangeetha Mohanty *et al* [7] who observed higher % Pdff in poultry manure applied treatments in the residual crop of maize in groundnut - maize sequence.

Per Cent Phosphorus Derived from Soil (% pdfs): There were significant differences in the treatments with respect to the % Pdfs in sunflower. The highest % pdfs was due to SSP (Table 3). This trend of result was quite reverse to the trend observed with %Pdff.

Table 3: Per cent Phosphorus Derived from Source (% pdff), Per cent Phosphorus Derived from soil (% pdfs) and A value in Sunflower as Influenced by Sources of Phosphorus

Phosphorus source	Sunflower grain yield (g pot $^{-1}$)	Per cent Phosphorus		
		Derived from Source (%pdff)	Derived from Soil (%pdfs)	A value
Control	2.77	-	-	-
FYM	4.95	22.53	77.47	12.89
Poultry manure	6.00	42.68	57.32	11.08
Bio compost	5.05	19.66	80.34	9.55
Pressmud	4.95	20.05	79.95	7.80
SSP	4.15	17.53	82.47	10.49
CD (0.05%)	1.75	6.95	6..95	

A Value: According to Larsen[4], A value is a measure of plant available nutrient consequent to the application of fertilizer, in this case manure. Unlike the chemical extraction methods, A value measures the dynamics of phosphorus under growing plants. High A value of 21.13 was observed in SSP applied treatment as compared to the organic manure treatments (Table 3). This could be related to the fact that % Pdfs was high in this treatment compared to organic sources.

CONCLUSION

In maize-sunflower cropping sequence, for the residual crop of sunflower the per cent phosphorus derived from source was high with poultry manure (42.68%). A value recorded was high with FYM and PM applied treatments. Hence, emphasis has to be given on the decomposition time and mineralization of organic manures.

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