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Tracer Studies on Sulphur Availability to Groundnut and Residual Crop From Different Sources

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ABSTRACT

Pot culture experiment was conducted using ^{35}S tracer to quantify plant available sulphur to main and residual crop in terms of ‘A’ values. Farmyard manure, poultry manure, vermi compost and sewage sludge were compared with the single superphosphate, all at 75 kg S ha^{-1}. These with control were replicated four times in CRD. Activity of ^{35}S sulphur in groundnut and soil sulphur were analyzed. Poultry manure increased sulphur availability and uptake by groundnut. Sdfs and Sdff was high in Poultry manure and Single superphosphate respectively. ‘A’ values were highest in poultry manure.

1. Introduction

There is a growing deficiency of secondary and micronutrients due to intensive cropping coupled with continuous use of high analysis fertilizers. The limiting secondary and micronutrients need to be applied along with NPK fertilizers for achieving desired productivity.

Soil fertility can be maintained and improved with the application nutrient sources. But with the use of inorganic chemical fertilizer alone the fertility cannot be improved and maintained. There are several sources of plant nutrients like organic manures, crop residues, industrial wastes etc are locally available. Sole application of any cannot meet the increasing nutrient demands for agriculture. To achieve sustainability in production, there is a need to integrate both organic and inorganic sources of nutrients. Patel and Patel (2003) examined the residual effect of integrated nutrient management on performance of succeeding bajra crop grown on a loamy sand. Before integrating nutrient sources, there is a need to quantify the fertilizer replacement value of different organic sources. Such an integration of nutrient sources will enhance the nutritional use efficiencies [4] besides maintaining soil fertility, so that effective and viable integrated nutrient packages can be formulated for different cropping systems under varied agro-ecosystems.

In plants, sulfur is essential for nitrogen-fixing nodules on legumes, and necessary in the formation of chlorophyll. Plants use sulfur in the processes of producing proteins, amino acids, enzymes and vitamins. Sulfur also helps the plants resistance to disease, aids in growth, and in seed formation. Though sulphur is a secondary macronutrient in reality, plants need sulfur in about the same quantity as phosphorus. Field scale deficiencies of sulphur in soils and plants are becoming increasingly important. When a soil is deficient in sulphur, and this deficiency is not rectified, then the full potential of a crop variety cannot be realized regardless of the optimum supply of other nutrients and adoption of improved seeds or top class husbandry practices.

Sulphur deficiency is mostly reported in coarse textured soils, in soils having low organic matter, in sites away from industrial activity associated with the emission of sulphur containing gases, in high rainfall areas, in crop rotations involving pulses and oilseeds and due to continuous use of sulphur free fertilizers. Sulphur improves crop yields, oil percentage in oilseeds, plant proteins, etc. The oil content of sesame was higher with S application as compared to treatments without S application [9].

Information on the exact quantity of sulphur rendered available to crops from the applied manures is scanty. Further, precise information on the residual quantity of soil available sulphur from the applied manures that is made over to a subsequent crop is also not available. Such precise informations could be obtained only with the aid of tracer techniques.

Against this backdrop, the present investigation was contemplated using tracer techniques, to quantify the plant available sulphur in soil from the organic manures and that is made over to a residual crop in terms of ‘A’ values, by soil labeling techniques.

2. Materials and methods

The soil used in the present study was loamy sand in texture with the composition of 15.5, 6.5 and 78.0 percent clay, silt and sand respectively. The contents of available nitrogen, phosphorus, potassium, sulphur and organic carbon were 261.8, 8.70, 191.0 kg ha-1, 8.07 mg kg-1 and 6.3 g kg-1respectively. The sulphur content of organic manures used was 1.10, 2.56, 0.96 and 1.51 percent in farmyard manure, poultry manure, vermicompost and sewage sludge respectively.

The processed soil samples were filled in earthen pots, lined with polythene sheets, at the rate of 8 kg soil per pot.

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There were four organic sources (farmyard manure, poultry manure, vermicompost and sewage sludge) evaluated in comparison with the standard inorganic source of single superphosphate.

All the treatments being equal on S basis (@ 75 kgS ha^{-1}). The six treatments, including a no-S (control) were replicated four times in a completely randomized design.

Seeds of groundnut (VRI 2) were sown in each pot. After germination, from a stock solution of carrier-free ^{35}S, 5 mL was added to each of the 24 pots to give an activity level of 13.37 MBq per pot. The instantaneous specific activity was determined as per standard procedures and calculations [2]. Plant analysis for ^{35}S activity and nutrient contents and post-harvest soil analysis was carried out after groundnut.

3. Results and Discussion

Soil sulphur availability

The results revealed that the application of sulphur sources significantly increased the sulphur availability in post-harvest soil (Table 1). The treatment might directly and indirectly increase the sulphur availability in soil. Besides this organic manure reacts with native nutrients present in soil and thereby formation of soluble forms of sulphur. It was confirmed that organic sources can supply adequate amount of sulphur to crops [3]. Among different sulphur sources poultry manure increased the available nutrient content than other sources. The increase due to the addition of poultry manure can be attributed to the high content of these nutrients in the manure. This result corroborate with the findings of [12].

Table 1. Effect of sulphur sources on post-harvest soil sulphur availability(mg kg^{-1}).

Sulphur sources	Available S
Control	7.1f
Farmyard manure	45.4b
Poultry manure	48.2a
Vermicompost	35.6d
Sewage sludge	38.9c
Superphosphate	29.8e

Nutrient content and uptake in groundnut

Sulphur application was observed to improve the nutrient uptake in groundnut plant parts (table 2). Sulphur fertilization improved over all nutritional environments of the rhizosphere as well as the plant system and ultimately the plant metabolism, and photosynthetic activity resulting into better growth and development of cluster bean [6]. Thereby the nutrient uptake gets increased due to better crop growth.

Present sulphur derived from fertilizer (%Sdff) , Present sulphur derived from soil (%Sdfs), and 'A' value.

Application of organic manure regulates the supply of sulphur to plants due to the amount of residue which influences microbial activity in soil, and will affect S mineralization and immobilization. This finding was confirmed by the results obtained by Santosh Sahay, *et al.* (2005) in wheat. Among the sulphur sources poultry manure increased the nutrient uptake than other sources.

This might be due to that, the poultry manure might be the best source of nutrients than other sources. Poultry manure proved to the best source of organic manure amongst all the organic manure sources tried in bitter gourd [7].

Table 2. Effect of sulphur sources on sulphur content (%) and uptake (mg pot^{-1}) in groundnut.

Sulphur Sources	Plant Sulphur					
	Root		Shoot		Kernel	
	Content	Uptake	Content	Uptake	Content	Uptake
Control	0.17e	8.5d	0.19e	40.8c	0.15d	15.4e
Farmyard manure	0.47a	26.4b	0.45a	114a	0.36a	61.0b
Poultry manure	0.47a	32.8a	0.47a	119a	0.38a	94.2a
Vermicompost	0.28c	16.7c	0.33c	70.0b	0.21c	29.0d
Sewage sludge	0.32b	19.5c	0.41b	116a	0.35b	65.6b
Superphosphate	0.24d	14.7c	0.29d	67.5b	0.35b	49.5c

The statistical analysis of radio assay data for sulphur derived from fertilizer revealed that %Sdff in root, shoot and kernel was higher in single superphosphate treatment (12.16, 29.59 and 58.64 respectively) and highest %Sdfs was recorded in poultry manure treatment (95.19, 88.43 and 71.78 respectively) (table 3). This may be due to the residual effect of poultry manure on nutrient availability. Poultry manure application increased the residual soil nutrient and organic matter [5]. The 'A' value was lower in single superphosphate treatment than other organic sources. Among the organic sources poultry manure recorded higher 'A' value in root, shoot and kernel (66.91, 25.97 and 8.72 respectively) and was comparable with sewage sludge in kernel (7.98). Among the organic sources farmyard manure recorded the second best 'A' value in root, shoot and kernel (55.05, 19.82 and 6.44 respectively). This indicates the increased availability of native sulphur from poultry manure. Poultry manure could be used to better sustain soil nutrient availability [1]. The beneficial effect of organic manure on nutrient availability may be attributed to the supply of nutrients through mineralization and improvement of physical and physico – chemical properties of soil [10].

There was a positive and significant correlation between the 'A' values and kernel yield ($r = 0.68^{**}$).

Table 4. Effect of sulphur sources on the 'A' value (mg $100g^{-1}$soil) in groundnut.

Sulphur sources	Root	Shoot	Kernel
Poultry manure	66.91a	25.97a	8.72a
Farmyard Manure	55.05b	19.82b	6.44b
Vermicompost	35.53c	11.64d	4.43c
Sewage sludge	36.25c	15.11c	7.98ab
Single superphosphate	24.45d	8.04e	2.41d

4. Conclusion

Among the sulphur sources tried, poultry manure was the best source in increasing the nutrient uptake, post- harvest soil sulphur availability, %Sdfs, 'A' value in groundnut.

Table 3. Effect of sulphur sources on % Sdff and %Sdfs in groundnut.

Sulphur sources	Root		Shoot		Kernel	
	% Sdff	%Sdfs	% Sdff	%Sdfs	% Sdff	%Sdfs
Poultry-manure	4.81d	95.19a	11.57e	88.43a	28.22d	71.78a
Farmyard Manure	5.84c	94.16a	14.64d	85.36 b	34.44c	65.56 b
Vermi-compost	8.69b	91.31ab	22.56b	77.44d	43.73b	56.27c
Sewage-sludge	8.53b	91.47ab	18.41c	81.59c	30.77cd	71.23a
Super-phosphate	12.16 a	87.84b	29.59a	70.41e	58.64a	41.36d

S: Sulphur, PM: Poultry manure, FYM: Farmyard Manure, VC: Vermicompost, SS: Sewage sludge, SSP: Superphosphate

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