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EFFECT OF ORGANIC MANURES ON SOIL NUTRIENT STATUS IN RAINFED GROUNDNUT GROWN ON AN ALFISOL

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ABSTRACT

A field experiment was conducted to study effect of organic manures on availability of nutrients in groundnut crop (*Arachis hypogaea* L.) at Regional Agricultural Research Station, Tirupati during *kharif*, 2016. The experimental soil was red sandy loam (Typic Haplustalf). The experiment has six treatments each replicated four times in a randomized block design. Surface soil samples at a depth of 15 cm were collected in each treatment and analyzed for chemical properties. Available N, P, K, Ca, Mg and S increased significantly by the application of organic manures at harvest. Highest available nitrogen (236 kg ha^{-1}), phosphorus (61 kg ha^{-1}) and potassium (292 kg ha^{-1}) were observed in FYM, poultry manure and pressmud cake applied treatments, respectively whereas the lowest was observed in control. The highest exchangeable calcium (6.5 cmol (p^{+}) kg^{-1}) and available sulphur (9.4 mg kg^{-1}) were observed in pressmud cake applied treatment. However, FYM applied treatment recorded the highest exchangeable magnesium (4.0 cmol (p^{+}) kg^{-1}). The lowest magnesium and sulphur were observed in RDF treatment. The DTPA extractable micronutrients like Fe, Zn, Cu and Mn also increased significantly with the application of organic manures at harvest. The highest Fe (7.1 mg kg^{-1}), Zn 4.7 (7.1 mg kg^{-1}) and Cu (0.73 mg kg^{-1}) content were recorded in FYM applied treatment followed by poultry manure applied treatment. The lowest Fe, Zn and Cu were recorded in control. From the present study, organic manures viz., FYM or pressmud cake application @ 10 t ha^{-1} was found most effective in maintaining soil health with respect to nutrient status.

KEYWORDS: Organic manures, soil nutrients, soil health

INTRODUCTION

Healthy soil is a requisite for the integrity of terrestrial ecosystems to remain intact and to recover from disturbances such as drought, climate change, pest infestation, pollution and human exploitation through agriculture. Deterioration of soil, and thereby soil health, is of great concern for human, animal and plant health (Wang and Chao, 1995). However, rebuilding soil quality and health through appropriate farming practices may take several years, especially in dryland areas, where limited moisture reduces biomass production and soil biological activity. Thus, the challenge is to identify soil management practices that promote soil organic matter formation and moisture retention, and ensure productivity and profitability for the farmers.

Groundnut being a legume crop, leaves lot of residual fertility which inturn helps the succeeding crop under rainfed farming situations. Further, integration and incorporation of organic manures (farmyard manure, vermicompost etc.) helps to improve soil structure, soil microbial activity and soil moisture conservation, which in turn helps to stabilize the production and productivity of the crops in rainfed farming situations (Lourduraj, 1999). Agricultural practices such as crop rotations, cover crop, reduced or no tillage and proper nutrient management have resulted in increased soil carbon sequestration because of improvement in plant biomass. Among the different agronomic management practices, use of organics is of prime importance under rainfed farming situations (Nagaraj *et al.,* 2001).

Keeping the above aspects in view, an experiment on evaluation of different organic sources on different soil properties and productivity of rainfed groundnut is being conducted since ten years at Regional Agricultural Research Station, Tirupati. So as a part of this, the effect of various organic manures on soil nutrient status and nutrient uptake has been presented and discussed in this paper.

MATERIAL AND METHODS

An experiment on "Evaluation of different organic manures on soil health and productivity of rainfed groundnut (*Arachis hypogaea* L.)" was started in the year, 2007 at Regional Agricultural Research Station, Tirupati,

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Acharya N. G Ranga Agricultural University (Andhra Pradesh). The same experiment was selected for the present study during *kharif,* 2016. The experiment was laid out in Randomized Block Design, replicated four times with six treatments *viz*., T_1 : Control (no fertilizers or manure), T_2 : Recommended dose of fertilizer @ 20 : 40 : 50 N : P_2O_5 : K_2O kg ha^{-1}, T_3 : Vermicompost @ 2.5 t ha^{-1}, T_4 : Poultry manure @ 4 t ha^{-1}, T_5 : Farm yard manure @ 10 t ha-1, T_6 : Press mud cake @ 10 t ha^{-1} replicated four times. Fully decomposed organic manures like vermicompost @ 2.5 t ha^{-1}, farmyard manure @ 10 t ha^{-1}, poultry manure @ 4 t ha^{-1} and press mud cake @ 10 t ha^{-1} were applied to the plots as per the treatments before sowing. Fertilizers *viz*., N @ 20 kg ha^{-1} as urea, P_2O_5 @ 40 kg ha^{-1} as single super phosphate and K_2O @ 50 kg ha^{-1} as murate of potash were applied to the RDF treatment, in lines at a depth of 5 cm in the furrows made with hand hoes 5 cm away from the seed rows. Gypsum @ 500 kg ha^{-1} is applied to all treatments except control at first bloom stage *i.e.* 30 days after sowing. Bold and healthy groundnut kernels of Dharani variety with 95 per cent germination were selected for sowing. The seeds were treated with Dithane M 45 @ 3 g kg^{-1} seed to the control and RDF plots and with *Tricoderma viridae* @ 3 g kg^{-1} seed to the organic manure plots against seed borne diseases. The seeds were hand dibbled in furrows by adopting a spacing of 30 cm × 10 cm and covered with soil and slightly compacted.

Surface soil samples at a depth of 15 cm were collected in each treatment, dried, pounded, mixed and labelled. The soil samples so collected were analysed for chemical properties by using standard procedures. Soil available nitrogen was determined by alkaline permanganate method (Subbiah and Asija, 1956), phosphorus by (Olsen *et al*., 1954) and available potassium by Jackson (1973). Soil exchangeable calcium and magnesium were determined in neutral normal ammonium acetate extract and the contents were determined by following versenate titration method (Vogel, 1978) and was expressed as cmol (p^+) kg^{-1} of soil. Available sulphur was extracted with 0.15 per cent Calcium Chloride solution (Williams and Steinbergs, 1959) and estimated by turbidimetric method and was expressed as mg kg^{-1} of soil. Available micronutrients in soil were extracted with DTPA as (1:2 ratio) developed by Lindsay and Norvell (1978). The contents of micronutrients (DTPA) *viz.,* Fe, Mn, Zn, and Cu were estimated by using Atomic Absorption Spectrophotometer and were expressed as mg kg^{-1} of soil. Data was analysed statistically for test of significance following the Fisher's method of analysis of variance as outlined by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Available nitrogen

Soil available nitrogen at harvest was significantly influenced by the application of different organic manures. Available nitrogen in the soil at harvest ranged from 150 to 236 kg ha^{-1} with an overall mean of 203 kg ha^{-1} (Table 1). Significantly higher available nitrogen was recorded in FYM applied treatment (236 kg ha^{-1}) than control and RDF and was found on par with the pressmud cake applied treatment (231 kg ha^{-1}). The lowest nitrogen content was recorded in control (150 kg ha^{-1}) followed by RDF (175 kg ha^{-1}), vermicompost (210 kg ha^{-1}) and poultry manure applied treatments (213 kg ha^{-1})

The results indicated that available N increased significantly in all the organic manure applied treatments when compared to the RDF and control. Among the treatments, FYM showed significant increase in available nitrogen which was on par with pressmud cake applied treatment. The higher available nitrogen in the FYM treated plots as compared to other treatments might be due to supplying of FYM to the soil which yield highest organic matter that increases N content in soil and its availability (Kamalakumari and Singaram, 1996). The results of present investigation were supported by findings of Ravankar *et al*. (2004) that application of FYM alone significantly increased the available P_2O_5 and available nitrogen content of the soil when compared to the inorganic and other organic manure applied treatments.

Available phosphorus

Available phosphorus in soil at harvest ranged from 30 kg ha^{-1} to 61 kg ha^{-1} with an overall mean of 46.83 kg ha^{-1} (Table 1). The available phosphorus increased with the application of organic manures. Significantly higher available phosphorus was recorded in poultry manure applied treatment (61 kg ha^{-1}) than control and RDF and was found on par with the pressmud cake (58 kg ha-1) and FYM applied treatments (57 kg ha^{-1}). The lowest phosphorus availability was recorded in control (30 kg ha^{-1}) followed by RDF (38 kg ha^{-1}) and vermicompost applied treatments (52 kg ha^{-1}).

Table 1. Effect of application of various organic manures on soil available nitrogen, phosphorous and potassium at harvest of groundnut crop

Treatments	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
Control	150	30	147
RDF @ (20 : 40 : 50 N : P : K kg ha^{-1})	175	38	214
Vermicompost @ 2.5 t ha^{-1}	210	52	215
Poultry manure @ 4 t ha^{-1}	213	61	217
FYM @ 10 t ha^{-1}	236	57	268
Press mud cake @ 10 t ha^{-1}	231	58	292
Mean	203	46.83	214.23
SE.m.±	6.45	1.89	7.63
C.D (P = 0.05)	19.44	5.70	23.00

Table 2. Effect of application of various organic manures on soil exchangeable calcium, magnesium and available sulphur at harvest of groundnut crop

Treatments	Exchangeable Ca (cmol p^+ kg^{-1})	Exchangeable Mg (cmol p^+ kg^{-1})	Available S (mg kg^{-1})
Control	2.6	1.3	5.8
RDF @ (20 : 40 : 50 N : P : K kg ha^{-1})	2.5	1.5	6.1
Vermicompost @ 2.5 t ha^{-1}	4.0	1.8	8.5
Poultry manure @ 4 t ha^{-1}	4.9	2.0	7.3
FYM @ 10 t ha^{-1}	4.4	4.0	8.0
Press mud cake @ 10 t ha^{-1}	6.5	2.9	9.4
Mean	4.15	2.03	7.52
SE.m. ±	0.29	0.12	0.27
C.D (P = 0.05)	0.88	0.37	0.82

The results indicated that P_2O_5 content increased significantly in all the organic manure applied treatments when compared to the RDF and control. The accumulation of considerable amount of available phosphorus might be due to the release of organic acids during microbial decomposition of organic matter which helped in the solubility of native phosphates. Similar results were reported by Ramesh *et al*. (2008).

Available potassium

Available potassium of soil at harvest ranged from 147 kg ha^{-1} to 292 kg ha^{-1} with an overall mean of 214.23 kg ha^{-1} (Table 1). The available potassium increased with the application of organic manures. Significantly higher potassium was recorded in presssmud cake applied treatment (292 kg ha^{-1}) than control and RDF and was found on par with the FYM applied treatment (268 kg ha^{-1}). The lowest available potassium was recorded in control (147 kg ha^{-1}) followed by RDF (214 kg ha^{-1}), vermicompost (215 kg ha^{-1}) and poultry manure applied treatments (217 kg ha^{-1}).

The results indicated that K_2O content increased significantly in all the organic manure applied treatments, when compared to the RDF and control. Among the treatments, pressmud cake showed significant increase in available potassium. The initial potassium content in pressmud cake is higher than in other organic manures and so higher availability of potassium is observed in pressmud cake applied treatment. Similar results were reported by Madhuri *et al*. (2014). The buildup of soil available potassium in the soil might be attributed to greater capacity of organic colloids to hold K ions on the exchange sites as reported by Sheeba and Chellamuthu (1999).

Exchangeable calcium

Significantly higher calcium content was recorded in pressmud cake applied treatment (6.5 cmol (p^+) kg^{-1}) than control and RDF (Table 2). Lowest calcium content was recorded in control (2.6 cmol (p^+) kg^{-1}) followed by RDF (2.5 cmol (p^+) kg^{-1}), vermicompost (4.0 cmol (p^+) kg^{-1}), poultry manure (4.9 cmol (p^+) kg^{-1}) and FYM applied treatments (4.4 cmol (p^+) kg^{-1}). The increase in calcium might be due to the fact that soil organic matter encourages granulation, increases cation exchange capacity (CEC) and enhances the adsorbing power of the soils upto 90 % with producing cations such as Ca^{+2}, Mg^{+2} and K^+ during decomposition (Kumar *et al*., 2017). The results indicated that calcium content increased significantly in all the organic manure applied treatments when compared to the RDF and control. Among the treatments, pressmud cake showed significantly increased the calcium content. The results were in accordance with Sarwar *et al*. (2010) who reported that pressmud cake applied treatment recorded the highest Ca content (158 ppm) in the soil followed by RDF (148 ppm) and the least Ca content was noticed in control (112 ppm).

Exchangeable magnesium

Exchangeable magnesium increased with the application of organic manures. Significantly higher exchangeable magnesium was recorded in FYM applied treatment (4.0 cmol (p^+) kg^{-1}) than control and RDF (Table 2). The lowest magnesium content was recorded in control (1.3 cmol (p^+) kg^{-1}) followed by RDF (1.5 cmol (p^+) kg^{-1}), vermicompost (1.8 cmol (p^+) kg^{-1}), poultry manure (2.0 cmol (p^+) kg^{-1}) and pressmud cake applied treatments (2.9 cmol (p^+) kg^{-1}). The results indicated that exchangeable magnesium increased significantly in all organic manure applied treatments when compared to the RDF and control. Among the treatments, FYM showed significant increase in exchangeable magnesium. The increase in magnesium might be due to the fact that soil organic matter encourages granulation, increases cation exchange capacity (CEC) and enhance the adsorbing power of the soils upto 90 per cent with producing cations such as Ca^{+2}, Mg^{+2} and K^+ during decomposition (Kumar *et al*., 2017).

Available sulphur

The available sulphur increased in the soil with the application of organic manures (Table 2). Significantly higher available sulphur was recorded in pressmud cake applied treatment (9.4 mg kg^{-1}) than control and RDF and was found on par with vermicompost applied treatment (8.5 mg kg^{-1}). The lowest available sulphur was recorded in control (5.8 mg kg^{-1}) followed by RDF (6.1 mg kg^{-1}), poultry manure (7.3 mg kg^{-1}) and FYM applied treatments (8.0 mg kg^{-1}).

The results indicated that available sulphur increased significantly in all the organic manure applied treatments when compared to the RDF and control. Among the treatments, pressmud cake significantly increased available sulphur which was on par with vermicompost applied treatment. The higher value of $SO_4^{2''}$ in the soil treated with pressmud was probable due to high amounts of $SO_4^{2''}$ in the pressmud (Chopra *et al*., 2012).

Table 3. Effect of application of various organic manures on soil DTPA extractable micronutrients at harvest of groundnut crop

Treatments	Fe (mg kg^{-1})	Zn (mg kg^{-1})	Cu (mg kg^{-1})	Mn (mg kg^{-1})
Control	6.0	3.8	0.46	8.2
RDF @ (20 : 40 : 50 N : P : K kg ha^{-1})	6.1	4.0	0.47	8.1
Vermicompost @ 2.5 t ha^{-1}	6.2	3.8	0.62	8.5
Poultry manure @ 4 t ha^{-1}	6.9	4.1	0.69	8.9
FYM @ 10 t ha^{-1}	7.1	4.7	0.73	9.0
Press mud cake @ 10 t ha^{-1}	6.1	4.2	0.65	9.5
Mean	6.08	3.90	0.60	8.05
SE.m. ±	0.07	0.05	0.03	0.11
C.D (P = 0.05)	0.22	0.15	0.08	0.35

DTPA extractable iron

The DTPA iron increased in the soil with the application of organic manures (Table 3). Significantly higher DTPA-Fe was recorded in FYM applied treatment (7.1 mg kg^{-1}) than control and RDF and was found on par with poultry manure applied treatment (6.9 mg kg^{-1}). The lowest DTPA iron was recorded in control (6.0 mg kg^{-1}) followed by RDF (6.1 mg kg^{-1}), pressmud cake (6.1 mg kg^{-1}) and vermicompost applied treatments (6.2 mg kg^{-1}).

The results indicated that DTPA-Fe increased in all the organic manure applied treatments when compared to the RDF and control. Among the treatments, FYM showed significant increase in DTPA-Fe which was on par with poultry manure applied treatment. The increase in extractable DTPA-Fe due to FYM application might be attributed to two reasons; firstly, the direct addition of nutrients to soil through FYM, secondly, due to favorable soil conditions associated with application of FYM (Selvakumari *et al*., 2000).

DTPA extractable zinc

The DTPA-Zn increased in soil with the application of organic manures. Significantly higher DTPA-Fe was recorded in FYM applied treatment (4.7 mg kg^{-1}) which is more than control and RDF (Table 3). The lowest DTPA-Zn was recorded in control (3.8 mg kg^{-1}) followed by vermicompost (3.8 mg kg^{-1}), RDF (4.0 mg kg^{-1}), poultry manure (4.1 mg kg^{-1}) and pressmud cake applied treatments (4.2 mg kg^{-1}).

The DTPA zinc increased in all the organic manures applied treatments when compared to the RDF and control. Among the treatments, FYM showed significant increase in DTPA zinc and this might be due to addition of FYM that might have enhanced the microbial activity in the soil and the consequent release of complex organic substances (chelating agents) which would have prevented Zn from precipitation, fixation, oxidation and leaching (Swarup, 1984).

DTPA extractable copper

The DTPA copper increased in soil with the application of organic manures (Table 3). Significantly higher copper was recorded in FYM applied treatment (0.73 mg kg^{-1}) more than control and RDF and was found on par with poultry manure (0.69 mg kg^{-1}) and pressmud cake applied treatments (0.65 mg kg^{-1}). The lowest DTPA-Cu was recorded in control (0.46 mg kg^{-1}) followed by RDF (0.47 mg kg^{-1}) and vermicompost applied treatments (0.62 mg kg^{-1}).

The DTPA copper increased in all the organic manure applied treatments except vermicompost applied treatment when compared to the RDF and control. Among the treatments, FYM showed significant increase in DTPA-Cu which was on par with poultry manure and pressmud cake applied treatments. The increased availability may be due to the chelation process (Hemalatha, 2013). Fertilization with FYM significantly increased DTPA extractable Cu in the surface layer as compared to NPK fertilization (Agbenin and Felix-Henningsen, 2004).

DTPA extractable manganese

The DTPA Mn increased in the soil with the application of organic manures (Table 3). Significantly higher DTPA Mn was recorded in pressmud cake applied treatment (9.5 mg kg^{-1}) more than control and RDF. The lowest DTPA Mn was recorded in control (8.2 mg kg^{-1}) followed by RDF (8.1 mg kg^{-1}), vermicompost (8.5 mg kg^{-1}), poultry manure (8.9 mg kg^{-1}) and FYM applied (9.0 mg kg^{-1}) treatments. The results indicated that DTPA-Mn increased in all the organic manure applied treatments when compared to the RDF and control. Among the treatments, application of pressmud cake significantly higher in DTPA-Mn in the soil. The DTPA-Mn increased in all organic manure applied treatments when compared with control and ranged from 120 mg kg^{-1} in control to 163 mg kg^{-1} in treatments receiving organic manures (Brown and Cotton, 2011).

It is clear that available nitrogen, exchangeable magnesium, DTPA extractable Fe, Zn and Cu were significantly higher in FYM applied treatment. Parameters like available potassium, exchangeable Ca, available S are significantly higher in pressmud cake applied treatment. Though other treatments also influence some parameters, most of the parameters were significantly influenced by FYM and pressmud cake applied treatments. The study revealed that organic manure application improved the supplying capacity all the essential nutrients in balanced ratio during crop growth. Hence, depending on the availability, any of the organic sources *viz.*, FYM or pressmud cake can be suggested to promote organic farming in rainfed groundnut crop.

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