Environment & Ecology 36 (1) : 170—174, January—March 2018
Website : environmentandecology.com ISSN 0970-0420

Effect of Fermented Solid and Liquid Poultry Manure on Soil Properties under Groundnut Cropping System

V. Sathya, M. Maheswari, P. Doraisamy

Received 2 August 2017 ; Accepted 5 September 2017 ; Published on 25 September 2017

Abstract Organic farming is a sustainable form of agriculture which uses only organic inputs for the supply of nutrients. Among the various organic sources, poultry litter contains richamount of plant nutrients. However, the nutritional value of unprocessed poultry litter deteriorates rapidly. Therefore an investigation was undertaken to assess the possibility of utilizing the processed poultry litter through soil application, which could offer the double benefits of safe disposal of the waste and its effective recycling of nutrients for agricultural production. Among the different treatments, the combined application of inorganic fertilizers and solid fermented poultry manure application significantly increased the soil pH, EC and organic carbon. It also enhances the availability of macronutrients in soil with groundnut crop.

Keywords Poultry manure, Groundnut, Soil properties, Nutrient availability, Organic carbon.

Introduction

Growing awareness of health and environmental issues associated with the intensive use of chemical inputs has led to interest in alternate forms of agriculture in the world. Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment. The chemical intensive agriculture that followed the green revolution is causing heavy pollution of our food, drinking water and air. Though the life expectancy has improved, the quality of life has substantially deteriorated. Nowadays variety of organic sources is available which can be effectively utilized in organic agriculture. Among the different sources, poultry waste is the important one for its rich nutrient content. Poultry population is increasing every year leaving large amount of poultry refuse. The poultry population in India is 489 million and the manure availability is estimated to be 12.1 million tonnes. Nutrient values of poultry manure vary considerably depending upon the conditions under which it is processed. Poultry manure contains about 3–5% nitrogen, 1.5–3.5% phosphorus, 1.5–3.0% potassium and micro nutrients at considerable amount. Poultry manure application improves soil retention and uptake of plant nutrients. Therefore the aim of the present study is to investigate the impact of poultry manure on the physico-chemical properties of soil.

Materials and Methods

Subhashri Bioenergies Pvt Ltd located in Goundampalayam, Thiruchengode produce organic manures from poultry litter by the following process. First step is the anaerobic digestion of poultry litter. The slurry from anaerobic digesters after biomethanation is de-

V. Sathya*, M. Maheswari, P. Doraisamy
Department of Environmental Sciences, TNAU, Coimbatore 641003, India
e-mail: sathyavelu1987@gmail.com
*Correspondence

Table 1. Characteristics of solid and liquid fermented poultry manure.

Characteristics	Solid fermented poultry manure	Liquid fermented poultry manure
Color	Dark brown	Black
Odor	No odor	No odor
Moisture content (%)	23.0	–
Bulk density (mg m^{-3})	0.74	–
Particle density (mg m^{-1})	1.11	–
pH	7.30	7.60
EC (dS m^{-1})	1.31	1.39
C:N ratio	6.96	8.40
Organic carbon (%)	17.4	16.8
Total nitrogen (%)	2.50	2.00
Total phosphorus (%)	2.00	1.50
Total potassium (%)	2.00	1.50
Sodium (%)	1.20	1.86
Total calcium (%)	0.48	0.54
Total magnesium (%)	0.28	0.32
Copper (mg L^{-1})	96.0	104
Manganese (mg L^{-1})	185	135
Iron (mg L^{-1})	250	252
Zinc (mg L^{-1})	196	189

watered then, the solids are composted aerobically and enriched with microbial inoculum. The product thus obtained is a solid fermented poultry manure and the liquid obtained through dewatering of slurry was enriched with microbial inoculum and humic acid and used as liquid fermented poultry manure. The solid and liquid fermented poultry manures for the study were obtained from SubashriBioenergies Pvt Ltd. Then the samples were analyzed for their properties (Table 1). The composite soil samples were collected from the field before the conduct of Thiruchengode, Namakkal district and analyzed for initial characteristics (Table 2). Field experiment was conducted with groundnut (VRI 2) as a test crop in Thiruchencode, Namakkal district, Tamilnadu to study

Table 2. Initial characteristics of experimental field soil with groundnut.

Chemical properties	Values
pH (1:2.5 soil water suspension)	7.20
EC (dSm^{-1}) (1:2.5 soil water suspension)	0.35
Organic carbon (%)	0.50
Available N (kg ha^{-1})	103
Available P (kg ha^{-1})	22.4
Available K (kg ha^{-1})	218
Exchangeable Ca (cmol (p^+) kg^{-1})	0.86
Exchangeable Mg (cmol (p^+) kg^{-1})	4.57
Exchangeable Na (cmol (p^+) kg^{-1})	2.12

the impact of solid and liquid poultry manure on the soil properties. Since, nitrogen is considered to be the most important nutrient for improving the productivity of the crops ; the treatments were based on the nitrogen requirement of crops. The treatments were allotted to each plot by following the random principle to minimize the experimental error. The application of solid and liquid fermented poultry manure is based on the treatment details given below. The soil samples were collected at four different stages of crop such as 30, 60, 90 days after sowing (DAS) and post-harvest stage and analyzed for various soil properties like soil pH, soil EC, soil organic carbon, available macronutrients and exchangeable cations.

Treatment details for
groundnut field trial

T_1-Recommended dose of fertilizer (17:34:54 kg of NPK / ha), T_2-80% N through solid fermented poultry manure (544 kg ha^{-1})+ 20% N through liquid fermented poultry manure (170 L ha^{-1}), T_3-50% N through solid fermented poultry manure (340 kg ha^{-1})+ 50% N through inorganic fertilizers, T_4-75% N through solid fermented poultry manure (510 kg ha^{-1})+ 25% N through inorganic fertilizers, T_5-90% N through solid fermented poultry manure (612 kg ha^{-1})+ 10% N through inorganic fertilizers, T_6-100% N through solid fermented poultry manure (680 kg ha^{-1}).

Results and Discussion

Field trial was conducted at the farmer's field located in Thiruchengode, Namakkal district with groundnut

Table 3. Effect of solid and liquid fermented poultry manure on soil at various stages of groundnut.

Treatments/ Stages	pH				
	S_1	S_2	S_3	S_4	Mean
T_1	7.21	7.22	7.39	7.28	7.27
T_2	7.61	7.61	7.52	7.41	7.53
T_3	8.28	8.28	8.18	8.02	8.19
T_4	8.10	8.10	7.88	7.62	7.92
T_5	7.52	7.95	7.82	7.68	7.74
T_6	7.54	7.61	7.52	7.54	7.55
Mean	7.70	7.79	7.72	7.60	7.70

	SEd	CD (0.05)
T	0.060	0.120
S	0.049	0.098
T × S	0.121	0.240

S_1: 30 DAS; S_2:60 DAS; S_3: 90 DAS; S_4 : Post harvest

Table 4. Effect of solid and liquid fermented poultry manure on soil EC at various stages of groundnut.

Treatments/ Stages	EC (dSm^{-1})				
	S_1	S_2	S_3	S_4	Mean
T_1	0.38	0.4	0.39	0.39	0.39
T_2	0.42	0.35	0.3	0.24	0.32
T_3	0.68	0.52	0.48	0.40	0.52
T_4	0.67	0.55	0.50	0.42	0.53
T_5	0.4	0.37	0.32	0.29	0.34
T_6	0.36	0.44	0.38	0.32	0.37
Mean	7.49	0.44	0.40	0.34	0.41

	SEd	CD (0.05)
T	0.003	0.007
S	0.003	0.0056
T × S	0.007	0.014

S_1: 30 DAS; S_2:60 DAS; S_3: 90 DAS; S_4 : Post harvest

to assess the impact of various doses of solid and liquid fermented poultry manure on soil characteristics. The results obtained from the field trials are briefly discussed.

Soil pH

The application of solid and liquid fermented poultry manure significantly influenced the soil pH (Table 3). The maximum pH of 8.19 was registered in the treatment which received solid fermented poultry manure @ 340 kg ha^{-1} along with inorganic fertilizers in the groundnut field. Substantial pH increase with increasing application rate of poultry manure was observed by Dikinya and Mufwanzala [1]. The mechanism responsible for this increase in soil pH is ion exchange reactions which occur when terminal OH^- of Al or Fe^{2+} hydroxyl oxides are replaced by organic anions which are decomposed products of the manure such as malate, citrate and tartrate [1]. Similarly, increased pH was observed with combined application of poultry manure and chemical fertilizers [2].

Soil EC

The EC of the soil significantly varied due to the application of solid and liquid fermented poultry manure (Table 4). The maximum EC of 0.53 dS m^{-1} was observed in the treatment which received combined application of inorganic fertilizers and solid poultry manure @ 510 kg ha^{-1} for groundnut. The salts present in the poultry manure might have increased the EC of the soil. The increase in EC with the application rate of poultry manure in all soil types was reported by Dikinya and Mufwanzala [1] and they also observed the maximum EC of 13.42 dS m^{-1} in verticluvisol at 40% poultry manure application. Further evidence is obtained from the report of Davis et al. [3] who showed a position correlation between the EC and application of poultry manure.

Soil organic carbon

A remarkable increase of organic carbon due to the application of poultry manure was observed in the present investigation (Fig. 1). The highest organic carbon content of 0.59% were observed in the treatment that received solid fermented poultry manure @ 680 kg ha^{-1} for groundnut. The organic fertilization allowed significant increases in the soil organic matter content due to the fact that the manure amendments to soil provide the nutritive elements by mineralization. This type of increase in organic carbon due to poultry manure application was reported by Agbede et al. [4] who showed that the poultry manure tended to improve soil organic carbon compared with NPK

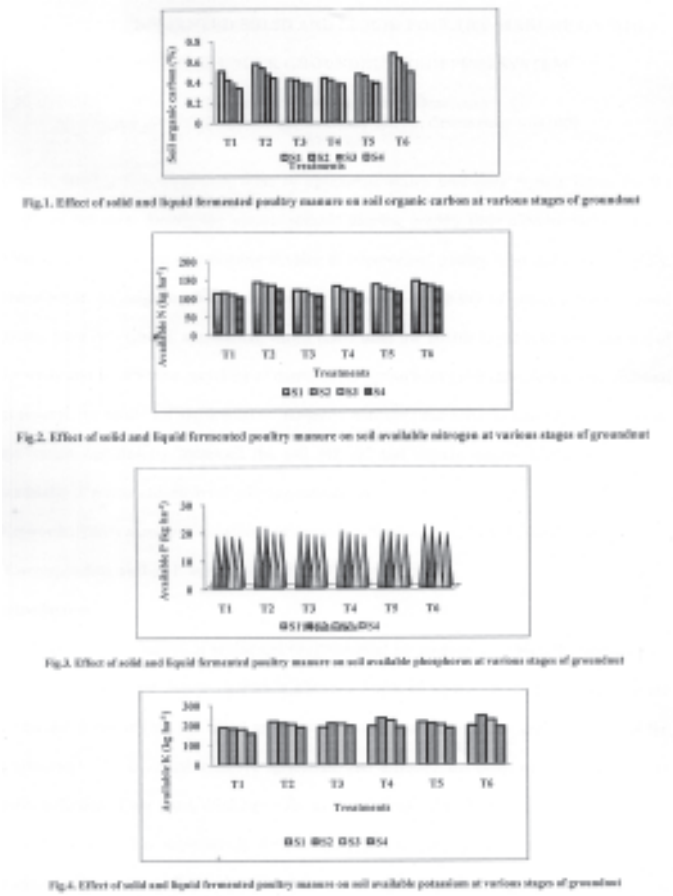

Fig. 1. Effect of solid and liquid fermented poultry manure on soil organic carbon at various stages of groundnut. **Fig. 2.** Effect of solid and liquid fermented poultry manure on soil available nitrogen at various stages of groundnut. **Fig. 3.** Effect of solid and liquid fermented poultry manure on soil available phosphorus at various stages of groundnut. **Fig. 4.** Effect of solid and liquid fermented poultry manure on soil available potassium at various stages of groundnut.

fertilizers. Yadvinder-singh et al. [5] also showed that 17% increase of soil organic carbon due to poultry litter addition.

Available macronutrients

The significant change in soil available macronutrients was observed due to the application of solid and liquid fermented poultry manure (Figs 2, 3, 4). In groundnut grown soil, the treatment that received solid fermented poultry manure @ 680 kg ha^{-1} regis tered the maximum soil available N, P and K content of 137, 20.3 and 217 kg ha^{-1} respectively. The improvement of other physical and chemical properties of soil due to the poultry manure application might be the reason for the increased nutrient status. The available N, P and K in the post harvest soil were higher in the treatments that received composted poultry manure was reported by Amanullah et al. [6]. Earlier it was found that the application of poultry manure to soil increased soil N and P content. Yadvinder-Singh et al. [5] showed that 73% increase

of P and 24% increase of K due to poultry litter application. The available N, P and K in the post-harvest soil were higher in treatments that received CPM either alone or with FYM followed by PM + FYM, PM and FYM. All the organic manorial treatments registered higher available N, P and K than no manuring. The higher NPK of the post-harvest soil due to poultry manure might be due to its higher nutrients content [7]. The available macronutrients showed a decreasing trend from initial to post harvest stage and it might be due to the higher crop uptake [7].

Conclusion

There are several ways in which poultry manure can be collected and processed. The most important way is collecting through caged system and processing by composting. Commonly two types of composting are followed such as aerobic and anaerobic methods of composting. Besides the value addition of poultry litter through composting, biomethanation of poultry waste for energy production is a viable solution for energy crisis in near future. The present study suggests that the application of poultry manure enhanced the mineralization process which increased the availability of nutrients in the soil. The land application of solid fermented poultry manure as a source of plant nutrients enhanced the soil health and organic crop production.

References

1. Dikinya O, Mufwanzala N (2010) Chicken manure-enhanced soil fertility and productivity: Effects of application rates. J Soil Sci Environ Manag 1 : 46—54.
2. Ullah MS, Islam MS, Islam MA, Haque T (2008) Effects of organic manures and chemical fertilizers on the yield of brinjal and soil properties. J Bangladesh Agric Univ 6 : 271—276.
3. Davis AS, Jacobs DF, Wightman KE (2006) Organic matter amendment of fallow forest tree seedling nursery soils influences soil properties and biomass of sorghum cover crop. Purdue Univ, West Lafayette.
4. Agbede TM, Ojeniyi SO, Adeyemo AJ (2008) Effect of poultry manure on soil physical and chemical properties, growth and grain yield of sorghum in southwest, Nigeria. Am Eur J Sustain Agric 2 : 72—77.
5. Yadvinder-Singh RK, Gupta HS, Thind B, Singh V, Singh G, Singh J (2009) Poultry litter as a nitrogen and phosphorus source for the rice-wheat cropping system. Ladha Biol Fertil Soils 45 : 701—710.
6. Amanullah MM, Somasundaram E, Vaiyapuri K, Sathyamoorthi K (2007) Poultry manure to crops: A review. Agric Rev 28 : 216—222.
7. Amanullah MM, Somasundaram E, Alagesan A, Vaiyapuri K (2007) Influence of fertilizer and organic manures on the yield and quality of cassava (*Manihot esculenta* Crantz.). Int J Agric Sci 3 : 181—186.