Asian Soil Research Journal

1(1): 1-8, 2018; Article no.ASRJ.41037

Effect of Organic Nutrient Management on Soil Physical and Chemical Properties in South Gujarat Condition

Khuwaja Safiullah[1*], Mahammad Akbar Ansari[1] and Sadiq Hotak[1]

[1]Department of Soil Science and Agricultural Chemistry, N.M.C.A., Navsari Agricultural University, Navsari, Gujarat, India.

Authors' contributions

This work was carried out in collaboration between all authors. Author KS collected the materials, managed the statistical analysis and wrote the paper. Author MAA searched and helped in review literature and correction. Author SH revised and helped in management of the paper.

Article Information

DOI: 10.9734/ASRJ/2018/v1i1620
Editor(s):
(1) Ademir de Oliveira Ferreira, Professor, Dynamics of Organic Matter in Soil Systems Management, University of Northern Paraná, Rua Tibúrcio Pedro Ferreira, Ponta Grossa, Paraná, Brazil.
Reviewers:
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Complete Peer review History: http://www.sciencedomain.org/review-history/24525

Original Research Article

Received 27th February 2018
Accepted 3rd May 2018
Published 8th May 2018

ABSTRACT

A field experiment was conducted to study the effect of organic nutrient on soil properties. During *rabi* season of 2016-17 at Organic Farm (F block), Aspee College of Horticulture and Forestry Research Station, Navsari Agricultural University, Navsari Gujarat. The experiment was laid out in a Factorial Randomizes Block Design, comprising fifteen treatment combinations. The results indicated that significantly higher organic carbon content (1.22 %), available Nitrogen (229.52 kgN/ha), phosphorus, P_2O_5 (106.51 kgP/ha), potassium, K_2O (599.60 kgK/ha) and Zinc (0.61 mgZn/kg) were found with the treatment O_1 **(100 % Nadep compost**) and at par with O_2 whereas, treatment O_2 (**75 % Nadep compost**) registered significantly higher DTPA-Fe (15.35 mgFe/kg) and Manganese (17.27 mgMn/kg). No significant effect of different levels of Nadep compost was observed on pH, electric conductivity (EC), copper, DTPA-Cu and soil physical properties. Application of liquid organic manure failed to generate any significant effect on soil physic-chemical properties.

**Corresponding author: E-mail: khuja.safi@gmail.com;*

Keywords: Soil properties; organic manure; physic-chemical and macro and micronutrients.

1. INTRODUCTION

Organic farming is a production system, which avoids or largely excludes the use of synthetically compounded fertilisers, pesticides and growth regulators. Organic farming is becoming an increasingly important aspect of environmentally sound sustainable agriculture.

Improving and maintaining soil quality for enhancing and sustaining agricultural production is of utmost importance for India's food and nutritional security. Though India is a food surplus nation at present with about 231.5 million tones food grain production per annum, it will require about 4-5 million tones additional food grains every year if the trend in rising population persists [1].

Organic materials hold a great promise due to local availability as a source of multiple nutrients and ability to improve soil characteristics. In this context, it is worth to study the nutrient management options through organics. The use of organics plays a major role in maintaining soil health due to building up of soil organic matter, beneficial microbes. To sustain the soil fertility and crop productivity, the role of solid organic manures *viz*. Nadep compost, bio compost, vermicompost and fermented liquid organic manures mainly *Jeevamrut*, *Panchagavya*, *Sanjeevak*, *Amrut pani*, bio-digester liquid and cow urine etc., are very important. The value of organic materials as fertilizers and soil conditioners is often misunderstood and has been the source of some controversy. The simplest and most common means of estimating the value of organic amendments is by assessing the current market value of the potentially available plant nutrients they contain. Usually, this is done regarding their macronutrient content *i.e.,* N, P and K. However, many organic materials contain other components which can contribute significantly to increased crop yields, including organic matter, secondary and micronutrients. In some cases, the organic matter fraction of a particular material may be of higher value than its total nutrient content because of the beneficial effect of organic matter on soil physical, chemical properties and soil productivity so in the present to find the effect of organic nutrient management on soil properties.

2. MATERIALS AND METHODS

An experiment was conducted during the year rabi 2016-17 at Organic Farm (F block), Aspee College of Horticulture and Forestry Research Station, Navsari Agricultural University, Navsari. The soil at 30 cm depth of the experimental field was alkaline in reaction (pH=7.82), medium in salt and DTPA-Zn content (0.55 mg/kg), high in organic carbon (1.03 %), available P_2O_5 95.30 kg/ha, K_2O 582 kg/ha, DTPA-Fe 14.24 mg/kg, DTPA-Mn 13.96 mg/kg DTPA-Cu 2.68 mg/kg and deficient in available N content (196 kg/ha). The experiment was laid out in a Factorial Randomizes Block Design, comprising fifteen treatment combinations, three levels of Nadep compost (O1: 100% 25 t/ha through Nadep compost O2: 75% 20 t/ha through Nadep compost and O3: 50% 10/ha through Nadep compost) applied two days before sowing and

Table 1. Methods followed for soil analysis

Parameters		Methods	References
A. Soil physical parameter			
i	WSA	Wet sieving	[2]
ii	Bulk density	Clod method	[2]
B. Soil chemical and Fertility parameters			
i	pH	Potentiometric,	[3]
ii	EC	Conductometric	[3]
iii	Organic carbon	Wet oxidation	[3]
iv	Available N	Alkaline permanganate method	[4]
v	Available P_2O_5	Spectrophotometric (0.5M $NaHCO_3$, pH 8.5)	[5]
vi	Available K_2O	Flame photometric (Neutral N NH_4OAc)	[3]
vii	DTPA-extractable Fe, Zn, Mn, Cu	Atomic absorption Spectro photometer method (DTPA)	[6]

Table 2. Chemical composition of Nadep compost

Manures	OC	N	P	K	Fe	Mn	Zn	Cu	C:N ratio
	(%)		(%)		(mg/kg)				
Nadep compost	23.44	1.23	0.92	1.09	1017	35.42	53.17	29.16	9.06

Table 3. Chemical composition of liquid organic manures

Liquid organic manures	N	P	K	Fe	Mn	Zn	Cu
	%			mg/l			
Jeevamrut	0.70	0.016	0.122	282	10.70	4.32	1.58
Amrut pani	0.40	0.015	0.252	15.35	3.32	2.96	0.52
Panch gavya	1.10	0.08	0.50	217	286	27	41
Sanjeevak	1.03	0.04	0.50	12.98	3.20	0.92	0.18

five types of liquid organic manures (L0: control-no liquid manure, L1: Jeevamrut @ 600 L/ha, L2: Amrut pani @ 600 L/ha, L3: Panch gavya @ 600 L/ha and L4: Sanjeevak @ 600 L/ha which were repeated three times with irrigation at sowing time, knee stage and silking. The observations recorded were tabulated, analyzed as per the methods described by [7] and interpreted herein.

3. RESULTS

3.1 Major Nutrients

3.1.1 Available nitrogen

Soil available nitrogen content in soil was significantly affected by application of Nadep compost at different rates (Table 4). The results on soil available nitrogen was found significantly higher (229.52 kg/ha) with solid organic treatment O_1, receiving 100% RDN through Nadep compost and remained at par with treatments O_2 (222.64 kg/ha). Simultaneously, the lowest available nitrogen (196.26 kg/ha) was observed in treatment O_3, receiving only 50% RDN through Nadep compost.

3.1.2 Available phosphorus

Soil available phosphorus status was significantly affected with applied different rates of solid organics (Table 4). Significantly higher available phosphorus (106.51 kg/ha) was recorded with treatment O_1, receiving 100% RDN through Nadep compost and remained at par with treatments O_2. In contrast, significantly the lowest available phosphorus (98.56 kg/ha) was recorded under the treatment receiving 50% RDN through Nadep compost (O_3).

3.1.3 Available potash

The status of available potash was also significantly affected with application of different rates of solid organics (Table 4). Treatment receiving 100% RDN through Nadep compost (O_1) resulted in significantly higher available potash (599.60 kg/ha) in soil and remained at par with treatments O_2. On the contrary, the lowest available potash content (554.27 kg/ha) was recorded under the treatment receiving 50% RDN through Nadep compost (O_3).

On the other hand, application of different liquid organics did not exert any significant effect on status of available, P_2O_5 and K_2O (Table 4). Although, application of *Jeevamrut* @ 600 L/ha recorded slightly higher content of available K_2O (594.00 kg/ha) in comparison to other applied liquid manures.

3.2 DTPA Extractable Micronutrient

3.2.1 Iron

DTPA-Fe status was significantly affected with different rates of applied solid organics (Table 4). Significantly higher DTPA-Fe (15.35 mg/kg) was recorded with application of 75 % RDN through Nadep compost (O_2) and remained at par with treatments O_1, receiving 100% RDN through Nadep compost. In contrast, the lowest DTPA-Fe (13.63 mg/kg) was recorded under the treatment receiving 50 % RDN through Nadep compost (O_3).

Table 4. Effect of solid and liquid organics on chemical soil properties

Treatments	pH $_{1:2.5}$	EC $_{1:2.5}$ (dS/m)	SOC (%)	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)	Fe (g/ha)	Mn (g/ha)	Zn (g/ha)	Cu (g/ha)
Solid organic manure (O)										
O_1	7.74	0.65	1.22	229.52	106.51	599.60	15.34	16.42	0.61	2.70
O_2	7.77	0.66	1.19	222.64	106.49	595.87	15.35	17.27	0.59	2.63
O_3	7.81	0.68	1.08	196.26	98.56	554.27	13.63	14.62	0.49	2.50
S. Em. ±	**0.07**	**0.01**	**0.03**	**6.64**	**2.00**	**12.74**	**0.50**	**0.71**	**0.02**	**0.06**
CD @ 5 %	**NS**	**NS**	**0.09**	**19.24**	**5.78**	**36.91**	**1.44**	**2.04**	**0.06**	**NS**
Liquid organic manure (L)										
L_0	7.80	0.67	1.14	207.22	102.75	577.22	14.41	15.55	0.53	2.57
L_1	7.75	0.66	1.15	226.03	103.83	594.00	15.26	17.28	0.61	2.64
L_2	7.77	0.66	1.16	221.41	103.28	581.89	14.74	15.93	0.59	2.63
L_3	7.76	0.67	1.16	207.70	104.41	577.67	15.17	15.41	0.57	2.66
L_4	7.79	0.66	1.16	218.33	105.01	585.44	14.28	16.34	0.56	2.55
S. Em. ±	**0.09**	**0.02**	**0.04**	**8.58**	**2.58**	**16.45**	**0.64**	**0.91**	**0.03**	**0.08**
CD @ 5 %	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction (O x L)										
S. Em. ±	**0.14**	**0.03**	**0.07**	**14.85**	**4.47**	**28.49**	**1.11**	**1.58**	**0.04**	**0.14**
CD @ 5 %	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV %	**3.51**	**7.84**	**10.08**	**11.91**	**7.45**	**8.46**	**13.02**	**10.42**	**13.30**	**9.18**
Initial	**7.82**	**0.70**	**1.12**	**196**	**95.3**	**582**	**14.24**	**13.96**	**0.55**	**2.68**

3.2.2 Manganese

In case of DTPA-Mn, the effect of applied different rates of solid organics (O) was found significant on DTPA-Mn content in soil (Table 4). Significantly higher DTPA-Mn (17.27 mg/kg) was also recorded with application of 75% RDN through Nadep compost (O_2) and remained at par with treatments O_1, receiving 100% RDN through Nadep compost. In contrast, the lowest DTPA-Mn (14.62 mg/kg) was recorded under the treatment receiving 50% RDN through Nadep compost (O_3).

3.2.3 Zinc

DTPA-Zn content was significantly affected with different rate of solid organics (Table 4). The application of 100% RDN through Nadep compost (O_1) registered significantly higher DTPA-Zn (0.61 mg/kg) and being at par with treatments O_2. While, the lowest DTPA-Zn (0.49 mg/kg) was recorded under the treatment receiving 50 % RDN through Nadep compost (O_3).

3.2.4 Copper

The application of different rates of Nadep compost, soil application different liquid organics and interaction (O X L) did not show any significant effect on DTPA-Cu. However, in case of solid organics, application of 100% RDN through Nadep compost (O_1) and in case of liquid organics, application of *Panch gavya* @ 600 L/ha (L_3) recorded slightly higher DTPA-Cu, 2.70 mg/kg and 2.66 mg/kg, respectively.

Further, application of different liquid organics did not exert significant effect on DTPA- Fe, Mn, and Zn (Table 4). Even though, application of *Jeevamrut* @ 600 L/ha recorded slightly higher content of available DTPA- Fe, Mn, and Zn in comparison to other applied liquid manures.

The interactions (O x L) also failed to exert any significant effect on macro and micro nutrient (Table 4).

3.3 Soil Physical Properties

The results on soil physical properties *viz*. soil bulk density, and water stable aggregates showed non significant effect with different rates of Nadep compost and soil application of different liquid organics (Table 5).

3.3.1 Bulk density

The results on bulk density showed nonsignificant effect on bulk density of experimental soil (Table 5). Application of 100% RDN through Nadep compost (O_1) recorded minimum bulk density (1.40 Mg/m^3) as compared to remaining rates of Nadep compost and initial bulk density of experimental soil (1.50 Mg/m^3).

Table 5. Effect of solid and liquid organics on soil physical properties

Treatments	BD (Mg/m^3)	Water stable aggregate (%)	
		0.5 - 1.0 mm	> 1.0 mm
Solid organic manure (O)			
O_1	1.40	28.90	52.78
O_2	1.41	29.17	51.04
O_3	1.49	28.40	49.88
S. Em. ±	**0.03**	**0.96**	**1.45**
CD @ 5 %	**NS**	**NS**	**NS**
Liquid organic manure (L)			
L_0	1.51	28.54	50.01
L_1	1.42	29.40	52.32
L_2	1.45	29.52	50.98
L_3	1.43	27.84	52.46
L_4	1.36	28.81	50.41
S. Em. ±	**0.04**	**1.25**	**1.87**
CD @ 5 %	**NS**	**NS**	**NS**
Interaction (O x L)			
S. Em. ±	**0.07**	**2.14**	**3.24**
CD @ 5 %	**NS**	**NS**	**NS**
CV %	**8.2**	**12.92**	**10.95**
Initial	**1.50**	**30.16**	**48.20**

Besides, application of different liquid organics also showed non significant effect on bulk density of experimental soil (Table 5). Soil application of *Sanjeevak* @ 600 L/ha (L_4) recorded minimum bulk density (1.36 Mg/m^3) followed by treatment L_1 (1.42 Mg/m^3).

3.3.2 Water stable aggregate

Application of different levels of Nadep compost showed non significant effect on water stable aggregates of experimental soil (Table 5). But, among the different rates of Nadep compost, application of 100% RDN through Nadep compost (O_1) generated slightly more >1.00mm size WSA (52.78%) while, treatment receiving 75% RDN through Nadep compost (O_2) recorded maximum 0.50-1.00mm size WSA (29.17%) in compare to other remaining treatments.

Here also, soil applied liquid organic manure application did not show any significant effect on WSA (Table 5). However, application of *Amrutpani* @ 600 L/ha (L_2) showed slightly higher 0.50 to 1.00mm size WSA (29.52%) and application of *Panch gavya* @ 600 L/ha (L_3) slightly higher > 1.00mm size WSA (52.46%).

The interaction (O x L) failed to exert any significant effect on water stable aggregates (Table 5).

4. DISCUSSION

4.1 Soil Chemical Properties

Generally nutrient supplementation in form of organics significantly influenced soil chemical, physical and biological properties of soil. Moreover, this was possible due to the better root growth and subsequent decomposition of these residues by the higher microbial population with addition of Nadep compost (100% RDN). [8] noticed an increase in organic carbon content of soil due to continuous addition of FYM. Similarly, [9] observed higher content of organic matter in soil due to application of FYM and vermicompost after the harvest of wheat crop and was attributed to addition of more biomass. These observations are in agreement with the findings of [10,11,12].

4.2 Soil Fertility Parameters

In order to judge the impact of different organics on fertility status of experimental soil, availability of major (N, P_2O_5 and K_2O) and cationic micronutrients (DTPA extractable Fe, Mn, Zn and Cu) were recorded and presented in (Table 4). Perceptible increase in availability of N, P_2O_5, K_2O and DTPA-Fe, Mn and Zn might be due to (i) addition of nutrient rich Nadep compost (1.23% N, 0.92% P, 1.09% K, 1017 mg/kg Fe, 35.42 mg/kg Mn, 53.17 mg/kg Zn and 29.16 mg/kg Cu) (ii) application of 100% and 75% RDN through Nadep compost in treatments O_1 and O_2 (iii) organics ability to interact with metal, metal oxides, hydroxides, clay minerals to form metallo-organic complexes and act as ion exchanger and store house of nutrients (iv) solubilizing effect of organic manures on fixed native forms of nutrients in soil and (v) inclusion of organics increased adsorptive power of soil for cations and anions and retard fixation. A report by with vermicompost and with FYM. Significant increase in the available macro nutrients content in treatment with application of Nadep compost @ 100% RDN due to the beneficial effect of organic manures in releasing Macro nutreints as well as the interaction of organic matter with clay and direct addition of available pool of the soil [13-19].

4.3 Soil Physical Properties

No significant changes were observed for physical parameters *viz*. bulk density and water stable aggregate under the influence of applied different rates of Nadep compost (Table 5). Addition of organic manures improves the soil physical properties is a well-documented and scientifically proven fact but here such non-significant effect was quite acceptable as physical properties of soil remain unchanged in short course of time, hence non-significant result was anticipated. Similar results were reported by [20-23].

4.4 Liquid Organics on Soil Properties

No significant effect of different soil applied liquid organic manure was observed on soil chemical properties, fertility parameters and physical properties under study (Tables 4 and 5) hence, results for soil properties are not discussed in different heads this chapter but discussed under only one head. Non significant effect of different liquid organics might be due to (i) Liquid organics are fast decomposing organics; released nutrients. Similar results for soil chemical, fertility and physical properties were reported by [24-28] with soil application of different liquid organics.

5. CONCLUSION

The organic nutrient management improves organic carbon, micro and macronutrients by addition of 100 to 75% RDN Nadep compost, also building the soil productive. Organic nutrient management it does not effect on soil physical properties in one-year application.

No significant effect of different soil-applied liquid organic manure was observed on soil physical and chemical properties.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/24525