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Effect of organic inputs on chemical properties of soil under certified organic farms in Nagpur district

AP Sawant, Ommala D Kuchanwar, Neha K Chopde, Hina A Raghorte, Padmaja H Kausadikar and NG Sarnaik

AP Sawant
Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Amravati Road, Nagpur, Maharashtra, India

Ommala D Kuchanwar
Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Amravati Road, Nagpur, Maharashtra, India

Neha K Chopde
Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Amravati Road, Nagpur, Maharashtra, India

Hina A Raghorte
Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Amravati Road, Nagpur, Maharashtra, India

Padmaja H Kausadikar
Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Amravati Road, Nagpur, Maharashtra, India

NG Sarnaik
Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Amravati Road, Nagpur, Maharashtra, India

Correspondence
Ommala D Kuchanwar
Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Amravati Road, Nagpur, Maharashtra, India

Abstract
The field investigation in relation to "Effect of organic inputs on chemical properties of soil under certified organic farms in Nagpur district" was carried out during kharif - rabi season of 2017 - 18 at the certified organic farmer's fields of Nagpur district. Soil samples of 0-20 cm depth were collected randomly after the harvest of crops from six locations viz., Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan of Nagpur district were selected. The certified organic farmers applying FYM @ 2.5 to 10 t ha^{-1}, Ghanjivamrut 500 kg ha^{-1} and Jivamrut 500 lit ha^{-1} from last 7 to 17 years for different crops. The results revealed that soil pH was reduced and electrical conductivity of soil (0.215 to 0.316 dS m^{-1}) remained almost unchanged due to incorporation of organic and inorganic sources. The application of organic inputs increased organic carbon by 2.47 to 46.48% and maximum available N content of soil by 2.08 to 44.18% over the application of fertilizers alone. The available P content of soil after harvesting of crops varied from 15.26 to 30.00 kg ha^{-1} and comes under medium to high range categories. The application of organic sources from 7 to 17 years decreased soil available potassium by 1.26 to 11.95% over inorganic. The variation in available sulphur (11.03 to 14.61 mg kg^{-1}) was observed and it found low to moderately high amount in all locations. Correlation matrix observed that N, K, Cu and Mn maintained positive relationship with the yield of mandarin crops. Whereas EC, OC and N were positively correlated with yield of rice crop.

Keywords: Organic inputs, soil chemical properties, FYM

Introduction
Organic farming was practiced in India since thousands of years. In traditional India, the entire agriculture was practiced using organic techniques, where nutrient, pesticides, etc. were obtained from plant and animal products.
Soil organic matter (SOM) has been called "the most complex and least understood component of soils". Simply put, soil organic matter is any soil material that comes from the tissues of organisms (plants, animals, or microorganisms) that are currently or were once living. Soil organic matter is rich in nutrients such as nitrogen (N), phosphorus (P), sulfur (S), and micronutrients, and is comprised of approximately 50% carbon (C). of soil health. Organically rich soil helps to increase availability of nutrients and micro-nutrients.
A large percentage of the earth's active carbon (C) is deposited in soil organic matter (SOM), and its cycling rate is tightly linked to nitrogen availability in natural and managed ecosystems (Gardenas *et al*., 2011) [6]. Addition of organic amendments could represent important strategy to protect agricultural land from excessive soil resources exploitation and to maintain soil fertility. Soil organic matter is key component because it Influence soil physical, chemical and biological properties that defined soil productivity and quality (Doran and Parkin 1994) [5].

Materials and methods
The field investigation was conducted during kharif-rabi season of 2017-2018 at the certified farmer's fields (organic field) of Nagpur district. Survey and samples were taken on organic and in the vicinity of organic farms (farmer's field) from Kalmeshwar, Saoner and Mauda tehsil of Nagpur district.
A soil sample of (0-20 cm) depth, the soil samples were dried in shade and gently grind with mortar and pestle and sieved through 2 mm sieve and for determination of organic carbon grind soil samples were passed through 0.5 mm sieve.

These samples were stored in polythene bags and were subsequently analyzed for pH, EC (Jackson, 1973) [7], organic carbon (wet oxidation method given by Walkley and Black 1934) [21], available N(alkaline permanganate method given by Subbiah and Asija, 1956) [19], P by Olsen's method using spectrophotometer (Olsen and Sommer, 1982) [11]., K by neutral ammonium acetate solution and determined using flame photometer (Jackson, 1973) [7], S by turbidimetric method given by Chesnin and Yien (1951) [2] and micronutrients (Fe, Mn, Zn and Cu) DTPA (Diethylene triamine penta acetic acid) (0.005 M) extractable (1:2, soil: DTPA), Fe, Mn, Zn and Cu were determined as per the procedure outlined by Lindsay and Norvell (1978) [10] using Atomic Absorption Spectrophotometer.

Results and discussion

Soil pH (Soil reaction)

Result revealed that Soil pH was influenced by the continuous incorporation of various organic nutrients (solid or liquid) sources for various crops presented at different locations since 7 to 17 years. The value of soil pH varied from 7.02 to 8.12 under different sources of organics applied at different locations which indicate the soil of study area was neutral to moderately alkaline in soil reaction (table 1).

Results revealed that the incorporation of organic sources in term of solid and liquid continuously reduced the soil pH in the locations could be ascribed to the acidifying effect of nitrogen and organic acid produced during the decomposition of organic materials. Similar results were coated by Singh *et al.* (2015) [16], that the application of pressmud were found more effective than application of FYM in reducing soil pH in the soil after the harvest of rice and wheat.

Electrical Conductivity (dS m^{-1})

The values of electrical conductivity of soil ranged between 0.215 to 0.316 dS m^{-1} with the use of organic and inorganic fertilizers among the locations. The EC of soil remained almost unchanged by the action of organic sources which is under permissible limit (<1 dSm^{-1}). Similar observation were repeated by Rathod *et at.* (2003) [13] that organic inputs in the form of FYM at 5 t ha^{-1} lowers electrical conductivity of the soil.

Organic carbon (g kg^{-1})

The results obtained of soil organic carbon as influenced by various organic source is presented in table-1. The soil organic varied from 4.28 to 7.81 g kg^{-1} in the field treated with various organic sources and chemical fertilizers alone. When the continuous use of ghanjivamrut @ 500 kg ha^{-1} to tomato crop from 10 years at Selu locations recorded the highest organic carbon content in soil (7.81 g kg^{-1}) which may be attributed to highest contribution of organic carbon to the soil in the form of solid source. Similarly also Chhibba (2010) [4] reported that, the incorporation of crop residues and FYM alone or in combination with green manuring significantly increases the organic carbon content.

Available nitrogen of soil (kg ha^{-1})

The available nitrogen content in soil after harvest of crop is presented in table-2. The data indicated that, the available nitrogen in soil varied from 189.00 to 349.44 kg ha^{-1}. The application of organic inputs from 7 to 17 years resulted in maximum available N content of soil by 2.08 to 44.18 per cent over the application of inorganic fertilizer alone. The maximum increase of available N (44.18%) is recorded in soybean crop where Jivamrut @ 500 lit ha^{-1} was applied. The increase in available N content of soil might be attributed to the more N fixation in soil on account of higher microbial population, leaving to better mineralization of organic N with other nutrient application. Sharma *et al*., (2013) [14] observed that, available N status in soil increased with application of organic sources along with fertilizers.

Available phosphorus of soil (kg ha^{-1})

The available phosphorus content of soil after harvest of crops varied from 15.26 to 30.00 kg ha^{-1} under the application of organic and inorganic fertilizers. In the present study, there was decreased in available phosphorous content in soil with the use of organic inputs upto 37-43 per cent over the application of chemical fertilizers alone. Balanced inorganic fertilizer and crop residues helps in increasing the phosphorous content in solution and solubelization of native soil phosphorous. Chesti and Ali (2012) [3] revealed that, soil available P recorded an increased between 16 to 24 per cent due to application of 30 to 60 kg P_2O_5 ha^{-1}, respectively.

The build-up of available P with the application of inorganic fertilizer and crop residue was ascribed to the release of organic acid, during decomposition which in turn helped in releasing native phosphorous through solubalizing action of the acids and thus reduces the P fixing capacity of soil which ultimately helps in release of sufficient quantity of plant available phosphorous (Sharma and Subehia, 2014) [15].

Available potassium of soil (kg ha^{-1})

The data on available potassium in soil after harvest of crop is presented in table-2. The magnitude of available K ranged from 337.62 to 431.06 kg ha^{-1}. The data further revealed that, the application of inorganic fertilizers alone (NPK) recorded an increased in available K content in soil by 1.26 to 11.95 per cent. The increasing available K in soil due to addition of organic sources may be ascribed to the reduction of K fixation and released of K due to interaction of organic material with clays besides the direct K addition in the soil (Subehia and Sepehya, 2012) [20].

Available sulphur of soil (kg ha^{-1})

Sulphur is considered as fourth major nutrient for plant growth. The data regarding the available sulphur in the soil is presented in table 2. The variation of available S was observed between the continuous use of organic sources and inorganic inputs applied. The higher amount of available S was recorded due to application of inorganic fertilizer than the use of organic source alone. It may be due to inorganic fertilizer containing sulphur and incorporation of organic carbon content in soil. The increased in available sulphur might be due to addition of 18:18:10 and 18:46 which content about 18 kg N and 46 kg P. Patel and Das (2009) reported that, total S (0.32%) was obtained with sample of FYM.

Micronutrients status in soils as influenced by organic sources

The results revealed that the status of DTPA extractable Zn, Fe, Mn and Cu ranged between 0.48 to 0.72, 6.33 to 8.82, 4.21 to 7.83 and 2.65 to 4.51 mg kg^{-1} respectively when the application of organic sources and chemical fertilizer alone among the different locations. The Zn status of these locations comes under low to medium in range Wide variation in proportion of Zn deficit soil sample within locations which is related with soil texture, pH, organic matter of soil. It is apparent that availability of Fe increased with increasing in organic matter content in the soils and increased the solubility of Fe. The DTPA extractable iron status of all the locations found medium in range 4.5 to 18.0 mg kg^{-1} as stated by Patil *et al.* 2004 [12]. Kharche (2013) [9] reported that, the application of FYM significantly increased availability of micro-nutrient over rest of treatments probably due to decomposition of FYM.

Correlation matrix between various soil properties and yield of crops.

From the data presented in table 3, the fruit yield of Nagpur mandarin was significantly and positively correlated with available N (r =0.546*), available K (r = 532*) and negatively correlated with EC (r = -0.026) under different management practices. Earlier studied demonstrated the similar positive correlation of soil available N and P with fruit yield of Nagpur mandarin reported by (Srivastava and Singh, 2001) [17]. Organic carbon (r =0.804**) were positively and significantly correlated with available N (r=0.546*), where the N was positively correlated with K (r = 0.536*). Srivastava (2013) [18] resulted an positively significant correlation with available N, Fe, Zn, Mn, and B with fruit yield of Nagpur mandarin.

Correlation of micronutrients with yield of Nagpur mandarin

From the data presented in table-4. The fruit yield of Nagpur mandarin was significantly and positively correlated with Mn (r =0.578*) and Cu (r = 0.771**). Similar findings were reported by Srivastava (2013) [81] that, fruit yield of Nagpur mandarin positively and significantly correlated with Fe, Mn and B.

Correlation matrix between various soil properties and yield of Rice

From the data of correlation, the electrical conductivity, organic carbon and available nitrogen were positively correlated with yield of rice crop (table-5). Similar observations were reported by Ahmed *et al.* (2014) [1] that, the grain yield of rice had significant correlation with organic carbon, available N, P, and K. Data showed that, Zn and Fe were negatively correlated with yield of rice crop (table -6). The Fe was negatively correlated with Mn. Correlation matrix of different variables showed that there was strong positive relationship between content of micronutrients (Zn, Mn, Cu and Fe content) each other but their relation with grain yield was fairly negatively correlated with the application of farmyard manure and nitrogen as reported by Kalfe and Sharma (2015) [8].

Table 1: Effect of various organic sources on soil pH and EC of soil at harvest of different crops

Location		Crops	Source	Soil pH Soil: water ratio (1:2.5)	EC, dS m^{-1}	OC (g kg^{-1})
Selu	1)	Mandarin ^{e}	Organic	7.69	6.79	0.292
	2)	Mandarin	Fertilizer	7.98	5.80	0.279
	3)	Tomato ^{e}	Organic	7.85	7.81	0.315
	4)	Tomato	Fertilizer	8.03	5.98	0.289
Kalmeshwar	1)	Fenugreek+ Spinach ^{d}	Organic	7.74	7.11	0.276
	2)	Inorganic	Fertilizer	8.12	5.84	0.312
Gangner	1)	Mandarin ^{e}	Organic	7.65	6.87	0.311
	2)	Mandarin	Fertilizer	7.85	5.13	0.297
	3)	Rice ^{b}	Organic	7.02	4.96	0.278
	4)	Soybean ^{d}	Organic	7.35	7.09	0.287
	5)	Inorganic	Fertilizer	7.78	4.84	0.240
Saoner	1)	Pigeonpea ^{c}	Organic	7.72	6.39	0.257
	2)	Pigeonpea	Fertilizer	7.94	6.11	0.267
	3)	Wheat ^{a}	Organic	7.47	6.58	0.326
	4)	Sweet orange ^{e}	Organic	7.89	6.22	0.295
	5)	Inorganic	Fertilizer	8.01	5.30	0.263
Chacher	1)	Rice ^{b}	Organic	7.10	4.58	0.293
	2)	Rice	Fertilizer	7.25	4.28	0.281
	3)	Mandarin ^{e}	Organic	7.45	6.29	0.312
	4)	Soybean ^{c}	Organic	7.35	6.56	0.243
	5)	Inorganic	Fertilizer	7.49	5.80	0.249
Chinchbhavan	1)	Mandarin ^{e}	Organic	7.68	6.57	0.308
	2)	Sorghum (Maldandi) ^{b}	Organic	7.42	6.09	0.254
	3)	Onion ^{a}	Organic	7.29	7.15	0.245
	4)	Inorganic	Fertilizer	7.85	5.46	0.303

a = 10 t FYM ha^{-1}, *b* = 5 t FYM ha^{-1}, *c* = 2.5 t FYM ha^{-1}, *d* = Jivamrut @ 500 lit ha^{-1}, *e* = Ghanjivamrut @ 500 kg ha^{-1}

Table 2: Effect of organic sources on fertility status of soil after harvest of different crops

Location		Crops	Source	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	Available S (mg kg^{-1})
Selu	1)	Mandarin ^{e}	Organic	301.50	398.32	13.32	19.20
	2)	Mandarin	Fertilizer	260.42	415.28	14.57	22.60
	3)	Tomato ^{e}	Organic	349.44	382.61	13.89	21.20
	4)	Tomato	Fertilizer	264.91	430.02	14.61	28.64
Kalmeshwar	1)	Fenugreek+ Spinach ^{d}	Organic	319.44	378.16	12.99	15.26
	2)	Inorganic	Fertilizer	261.00	405.19	14.02	20.34
Gangner	1)	Mandarin ^{e}	Organic	305.32	405.38	12.69	18.98
	2)	Mandarin	Fertilizer	229.50	428.93	12.83	24.36
	3)	Rice ^{b}	Organic	220.50	394.24	11.93	20.58

	4)	Soybean [d]	Organic	313.60	385.13	12.29	22.34
	5)	Inorganic	Fertilizer	216.00	419.56	12.81	26.46
Saoner	1)	Pigeonpea [c]	Organic	282.87	394.69	11.63	20.74
	2)	Pigeonpea	Fertilizer	273.89	421.32	12.19	27.74
	3)	Wheat [a]	Organic	291.20	403.14	11.92	19.35
	4)	Sweet orange [e]	Organic	277.76	356.11	12.02	18.77
	5)	Inorganic	Fertilizer	238.50	398.57	12.42	30.00
Chacher	1)	Rice [b]	Organic	202.50	375.32	11.03	21.64
	2)	Rice	Fertilizer	189.00	381.45	12.07	27.43
	3)	Mandarin [e]	Organic	279.00	351.92	11.56	18.36
	4)	Soybean [c]	Organic	292.50	337.62	12.15	20.24
	5)	Inorganic	Fertilizer	261.00	359.18	12.86	24.23
Chinchbhavan	1)	Mandarin [e]	Organic	292.50	409.12	12.69	20.17
	2)	Sorghum (Maldandi) [b]	Organic	270.00	401.33	11.14	16.27
	3)	Onion [a]	Organic	318.08	379.51	13.08	19.94
	4)	Inorganic	Fertilizer	243.00	431.06	12.64	22.86

a = 10 t FYM ha^{-1}, *b* = 5 t FYM ha^{-1}, *c* = 2.5 t FYM ha^{-1}, *d* = Jivamrut @ 500 lit ha^{-1}, *e* = Ghanjivamrut @ 500 kg ha^{-1}

Table 3: Effect of various organic sources on micronutrients status of soil at harvest of different crops

Location		**Crops**	**Source**	**Zn (mg kg^{-1})**	**Fe (mg kg^{-1})**	**Mn (mg kg^{-1})**	**Cu (mg kg^{-1})**
Selu	1)	Mandarin [e]	Organic	0.59	7.25	6.54	3.23
	2)	Mandarin	Fertilizer	0.58	6.33	4.93	4.32
	3)	Tomato [e]	Organic	0.72	7.89	7.81	3.51
	4)	Tomato	Fertilizer	0.67	7.63	6.23	4.27
Kalmeshwar	1)	Fenugreek+ Spinach [d]	Organic	0.62	8.07	6.31	3.71
	2)	Inorganic	Fertilizer	0.52	7.86	4.85	2.81
Gangner	1)	Mandarin [e]	Organic	0.63	8.11	6.91	4.41
	2)	Mandarin	Fertilizer	0.72	8.05	5.53	4.51
	3)	Rice [b]	Organic	0.67	7.34	6.21	2.67
	4)	Soybean [d]	Organic	0.61	7.74	6.73	2.92
	5)	Inorganic	Fertilizer	0.51	6.97	5.43	2.65
Saoner	1)	Pigeonpea [c]	Organic	0.53	8.21	6.47	3.56
	2)	Pigeonpea	Fertilizer	0.62	8.13	5.43	2.92
	3)	Wheat [a]	Organic	0.51	7.61	7.83	3.42
	4)	Sweet orange [e]	Organic	0.61	7.92	5.64	3.59
	5)	Inorganic	Fertilizer	0.63	7.33	6.43	3.99
Chacher	1)	Rice [b]	Organic	0.58	7.46	4.32	3.99
	2)	Rice	Fertilizer	0.64	7.63	4.93	3.91
	3)	Mandarin [e]	Organic	0.64	7.99	6.68	3.53
	4)	Soybean [c]	Organic	0.53	7.51	6.53	2.82
	5)	Inorganic	Fertilizer	0.63	6.87	4.21	3.53
Chinchbhavan	1)	Mandarin [e]	Organic	0.64	7.89	6.68	3.53
	2)	Sorghum (Maldandi) [b]	Organic	0.53	7.64	6.54	3.86
	3)	Onion [a]	Organic	0.57	8.82	7.78	3.78
	4)	Inorganic	Fertilizer	0.48	6.38	5.21	3.73

a = 10 t FYM ha^{-1}, *b* = 5 t FYM ha^{-1}, *c* = 2.5 t FYM ha^{-1}, *d* = Jivamrut @ 500 lit ha^{-1}, *e* = Ghanjivamrut @ 500 kg ha^{-1}

Table 4: Correlation of different chemical properties of soil with yield of Nagpur mandarin

	Yield t ha^{-1}	**pH**	**EC dSm^{-1}**	**O.C g kg^{-1}**	**N kg ha^{-1}**	**P kg ha^{-1}**	**K kg ha^{-1}**
Yield t ha^{-1}	1						
pH	0.451	1					
EC dSm^{-1}	-0.026	-0.111	1				
O.C g kg^{-1}	0.163	-0.405	0.119	1			
N kg ha^{-1}	0.546*	-0.100	0.172	0.804**	1		
P kg ha^{-1}	0.273	0.144	0.012	0.090	0.293	1	
K kg ha^{-1}	0.532*	0.144	-0.116	0.361	0.536*	0.352	1

**significant at 1% level *significant at 5% level

Table 5: Correlation of micronutrients with yield of Nagpur mandarin

	Yield t ha^{-1}	**Zn (mg kg^{-1})**	**Fe (mg kg^{-1})**	**Mn (mg kg^{-1})**	**Cu (mg kg^{-1})**
Yield t ha^{-1}	1				
Zn (mg kg^{-1})	0.120	1			
Fe (mg kg^{-1})	0.204	-0.494	1		
Mn (mg kg^{-1})	0.578*	0.450	-0.016	1	
Cu (mg kg^{-1})	0.771**	0.183	-0.060	0.435	1

**significant at 1% level *significant at 5% levels

Table 6: Correlation matrix between the properties of soils and yield of rice

	Yield t ha^{-1}	**pH**	**EC dSm^{-1}**	**OC g kg^{-1}**	**N kg ha^{-1}**	**P kg ha^{-1}**	**K kg ha^{-1}**
Yield t ha^{-1}	1						
pH	0.354	1					
EC dSm^{-1}	0.420*	0.218	1				
OC g kg^{-1}	0.602**	0.295	0.370	1			
N kg ha^{-1}	0.587**	0.254	0.399*	0.897**	1		
P kg ha^{-1}	-0.057	-0.291	-0.022	0.117	0.202	1	
K kg ha^{-1}	-0.531	-0.391	-0.341	-0.477	-0.397	-0.205	1
S Mg kg^{-1}	-0.358	0.020	-0.169	-0.109	-0.026	0.015	0.348

**Significant at 1% level *Significant at 5% level

Table 7: Correlation between micronutrients and yield of rice

	Yield t ha^{-1}	**Zn**	**Fe**	**Mn**	**Cu**
Yield t ha^{-1}	**1**				
Zn	-0.243	1			
Fe	-0.074	-0.222	1		
Mn	0.110	0.208	-0.368	1	
Cu	0.124	-0.107	0.334	-0.182	1

**Significant at 1% level *Significant at 5% level

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