International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(3): 14-18

Received: 07-03-2021
Accepted: 09-04-2021

Umakant V Thawale
PG Students of Soil Science & Agricultural Chemistry, College of Agriculture, Nagpur, Maharashtra, India

Ommala D Kuchanwar
Professor (CAS) of Soil Science & Agricultural Chemistry, College of Agriculture, Nagpur, Maharashtra, India

Neha Chopde
Associate Professor of Horticulture, College of Agriculture, Sonapur, Gadchiroli, Maharashtra, India

Kajal D Bhoyar
Ph.D. Scholar of Soil Science & Agricultural Chemistry College of Agriculture, Nagpur, Maharashtra, India

Padmaja H Kausadikar
Assistant Professor of Soil Science & Agricultural Chemistry, College of Agriculture, Nagpur, Maharashtra, India

Tushar K Nakade
Senior Research Associate (SRA) of Soil Science & Agricultural Chemistry, College of Agriculture, Nagpur, Maharashtra, India

Nishigandha Mairan
Assistant Professor of Botany, Institute of Science, Nagpur, Maharashtra, India

Kirtimala R Gopal
Soil Science & Agricultural Chemistry Section, College of Agriculture, Nagpur, Maharashtra, India

Corresponding Author:
Ommala D Kuchanwar
Professor (CAS) of Soil Science & Agricultural Chemistry, College of Agriculture, Nagpur, Maharashtra, India

Impact of organic inputs on fertility status of soil under certified organic farms in Nagpur district

Umakant V Thawale, Ommala D Kuchanwar, Neha Chopde, Kajal D Bhoyar, Padmaja H Kausadikar, Tushar K Nakade, Nishigandha Mairan and Kirtimala R Gopal

Abstract
The field investigation in relation to "Impact of organic inputs on fertility status of under certified organic farms in Nagpur district" was carried out during Kharif-rabi season of 2019 - 20 at the certified organic farmer's fields of Nagpur district to assess the soil properties, quality and yield of different crops as influenced by various organic resources. 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 for recording various observations and collected plant samples for quality parameters. 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 9 to 19 years for different crops. The results revealed that soil pH was reduced due to continuous application of various organic sources to field. However, electrical conductivity of soil (0.289 to 0.479 dS m^{-1}) remained almost unchanged due to incorporation of organic and inorganic sources. The application of organic inputs increased organic carbon by 5.95 to 55.32 per cent at different locations over fertilizer applied field. The application of organic sources from 9 to 19 years resulted in maximum available N content of soil by 13.50 to 63.35 per cent over the application of fertilizers alone. The available P content of soil after harvesting of crops varied from 12.55 to 25.25 kg ha^{-1} and comes under medium to high range categories. The application of organic sources from 9 to 19 years increase soil available potassium by 2.12 to 13.58 per cent over inorganic. The magnitude of available K ranged from 319.45 to 474.34 kg ha^{-1}. The available sulphur ranged from 10.64 to 15.38 mg kg^{-1} i.e. marginal to adequate. The variation in available sulphur (10.67 to 15.67 mg kg^{-1}) was observed and it found low to moderately high amount in all locations. The use of FYM, manurial liquid and solid organic source was found useful in maintaining the available micro-nutrient status of soil over the continuous use of fertilizer. The status of DTPA extractable micronutrients Zn, Fe, Mn and Cu (mg kg-1) range from 0.52 to 0.70, 3.69 to 8.75, 4.08 to 7.87 and 2.55 to 4.89 respectively when the use of organic and inorganic sources.

Keywords: organic, fertility, certified organic farms

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) [5]. 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) [4].

Materials and Methods

The field investigation was conducted during kharif-rabi season of 2019-2020 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 tahsil 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) [6], organic carbon (wet oxidation method given by Walkley and Black 1934 [19], available N (alkaline permanganate method given by Subbiah and Asija, (1956) [17], P by Olsen's method using spectrophotometer (Olsen's and Sommer, 1982) [9]., K by neutral ammonium acetate solution and determined using flame photometer (Jackson, 1973) [6], S by turbidimetric method given by Chesnin and Yien (1951) [1] 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) [8] using Atomic Absorption Spectrophotometer.

Results and Discussion

Soil pH (Soil reaction)

The pH (soil reaction) is considered one of the most important characteristics of soils because of its intrinsic function in various phases of soil development, its direct effect on micro-biological activities, its role in deciding availability and uptake of various plant nutrients and its intrinsic relationship with other soil constituent determine by chemical analysis. 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 9 to 19 years. The value of soil pH varied from 7.25 to 8.39 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 for 9 to 19 years, 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) [15] 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.

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

Location		Crops	Source	OC (g kg^{-1})	EC dS m^{-1}	Soil pH Soil :water ratio (1:2.5)	$CaCO_3$ (%)
Selu	1)	Mandarin ^{e}	Organic	7.45	0.415	8.38	4.10
	2)	Mandarin	Fertilizer	8.35	0.456	5.56	4.40
	3)	Tomato ^{e}	Organic	7.38	0.335	8.85	4.45
	4)	Tomato	Fertilizer	7.82	0.356	7.48	4.50
	5)	Cotton ^{a}	Organic	7.32	0.289	7.89	3.45
	6)	Inorganic	Fertilizer	7.55	0.372	5.68	3.85
Kalmeshwar	1)	Fenugreek+ Spinach ^{d}	Organic	7.46	0.468	8.67	3.90
	2)	Inorganic	Fertilizer	7.58	0.479	7.29	4.45
	3)	Mandarin ^{b}	Organic	7.69	0.478	8.09	3.35
	4)	Mandarin	Fertilizer	7.85	0.435	7.21	3.70
Gangner	1)	Mandarin ^{e}	Organic	8.01	0.456	5.98	3.70
	2)	Mandarin	Fertilizer	8.26	0.467	3.85	3.90
	3)	Rice ^{b}	Organic	6.96	0.428	6.38	3.05
	4)	Rice	Fertilizer	7.75	0.478	4.98	3.35
	5)	Soybean ^{d}	Organic	7.06	0.449	8.55	3.65
	6)	Soybean	Fertilizer	7.79	0.466	5.67	4.30
Saoner	1)	Pigeonpea^{c}	Organic	7.89	0.452	9.01	3.50
	2)	Pigeonpea	Fertilizer	8.35	0.445	7.58	3.55
	3)	Wheat ^{a}	Organic	8.12	0.457	8.36	3.25
	4)	Wheat	Fertilizer	8.39	0.355	7.89	3.85
	5)	Sweet orange ^{e}	Organic	7.87	0.368	8.45	3.90
	6)	Inorganic	Fertilizer	7.56	0.336	6.51	4.50
Chacher	1)	Rice ^{b}	Organic	7.25	0.387	6.38	4.15
	2)	Rice	Fertilizer	7.86	0.382	5.35	4.40
	3)	Mandarin ^{e}	Organic	7.67	0.470	7.63	3.70
	4)	Inorganic	Fertilizer	7.58	0.373	6.38	4.65
Chinchbhavan	1)	Mandarin ^{e}	Organic	7.25	0.347	8.55	4.15
	2)	Mandarin	Fertilizer	7.67	0.379	6.11	4.60
	3)	Tomato ^{a}	Organic	7.35	0.376	9.22	3.25
	4)	Inorganic	Fertilizer	8.28	0.356	5.78	3.65

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}

Electrical Conductivity (dS m^{-1})

The data of electrical conductivity of soil is presented in table-1. The values of electrical conductivity of soil ranged between 0.289 to 0.479 dS m^{-1} with the use of organic and inorganic fertilizers among the locations. The lowest EC of soil was recorded 0.289dS m^{-1} with the use of FYM 10 t ha^{-1} at Selu location where as maximum EC of soil was recorded 0.479 dS m^{-1} with the application of inorganic fertilizer at the Kalmeshwar location. The EC of soil remained almost unchanged by the action of organic sources which is under permissible limit (< 1 dS m^{-1}). Similar observations were reported by Rathod *et at.* (2003) [12] 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 carbon varied from 3.85 to 9.22 g kg^{-1} in the field treated with various organic sources and chemical fertilizers alone. When the continuous use of 10t FYM ha^{-1} to tomato crop from 19 years at Chinchbhavan locations recorded the highest organic carbon content in soil (9.89 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) [3] reported that, the incorporation of crop residues and FYM alone or in combination with green manuring significantly increases the organic carbon content

Calcium Carbonate (%)

The results of $CaCO_3$ content in soil is presented in table-1. The calcium carbonate is one of the important property of soil which is associated with the nutrient availability, effect of organic carbon, soil reaction and availability of micronutrients of soil and exchangeable cations. The value of calcium carbonate content in soil varied from 3.05 to 4.65 per cent under the application of organic and inorganic inputs. The value of calcium carbonate did not have much more difference in all the locations. The different locations viz. Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan recorded the values of calcium carbonate in soil between 3.45 to 4.50, 3.35 to 4.45, 3.05 to 4.30, 3.25 to 4.50, 3.70 to 4.65 and 3.25 to 4.60 per cent, respectively, when the field applied organic or inorganic fertilizer alone. These values of calcium carbonate ranges under the moderately calcareous in nature.

Similar findings were reported by Sleutel *et al.* (2006) [16] that, long-term applications of animal manure increase SOM and decreases calcium carbonate content in two ways by adding OM contained in the manure and by increased OM in crop residues due to higher crop yields. Also Kharche (2013) [7] reported that, the significant reduction in free $CaCO_3$ could be attributed to considerable amount of biomass added to the soil due to long-term cultivation and organic matter applied through conjunctive use treatments. The reduction in $CaCO_3$ might be due to organic acids released during the decomposition of organic materials which react with $CaCO_3$ to release CO_2 thereby reducing $CaCO_3$ content of the soil.

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 198.50 to 437.77 kg $ha^{-1.}$ The application of organic inputs from 9 to 19 years resulted in maximum available N content of soil by 13.50 to 63.35 per cent over the application of inorganic fertilizer alone. The maximum increase of available N (63.35 %) is recorded in tomato crop where 10 t FYM 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) [13] 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 12.55 to 25.25 kg ha^{-1} under the application of organic and inorganic fertilizers. The value of available P content of soil comes under the categories of medium to high range. All the locations found decreased the availability of P when the use organic sources over the inorganic sources. Available P also noted higher value 25.25 kg ha^{-1} at Gangner location under the application of inorganic fertilizers.

In the present study, there was decreased in available phosphorous content in soil with the use of organic inputs upto 30.35 per cent over the application of chemical fertilizers alone. Balanced inorganic fertilizer and crop residues helps in increasing the phosphorous content in solution and solubilization of native soil phosphorous. Chesti and Ali (2012) [2] 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 solubilizing 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) [14].

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 319.45 to 474.34 kg ha^{-1}. The data further revealed that, the application of organic fertilizers alone recorded an increased in available K content in soil by 2.12 to 13.58 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) [18].

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 (kg ha^{-1})
Selu	1)	Mandarin^{e}	Organic	382.81	14.78	432.58	13.98
	2)	Mandarin	Fertilizer	251.44	16.67	385.40	12.02
	3)	Tomato^{e}	Organic	245.45	20.75	474.34	14.98
	4)	Tomato	Fertilizer	198.50	24.87	426.76	12.23
	5)	Cotton ^{a}	Organic	334.56	12.55	360.56	14.32
	6)	Inorganic	Fertilizer	255.87	18.02	340.67	12.97
Kalmeshwar	1)	Fenugreek+ Spinach^{d}	Organic	376.33	15.25	425.17	15.44
	2)	Inorganic	Fertilizer	272.55	19.75	380.56	12.67
	3)	Mandarin ^{b}	Organic	359.67	18.78	388.65	14.67
	4)	Mandarin	Fertilizer	287.24	24.06	367.56	12.96
Gangner	1)	Mandarin ^{e}	Organic	343.78	17.09	331.87	13.65
	2)	Mandarin	Fertilizer	272.56	23.21	319.45	11.04

	3)	Rice [b]	Organic	291.47	21.09	389.89	12.66
	4)	Rice	Fertilizer	237.80	25.25	369.58	11.76
	5)	Soybean[d]	Organic	357.66	18.02	430.67	14.09
	6)	Soybean	Fertilizer	301.87	21.65	395.67	12.71
Saoner	1)	Pigeonpea[c]	Organic	415.64	23.03	417.67	12.32
	2)	Pigeonpea	Fertilizer	301.79	24.67	406.78	10.67
	3)	Wheat [a]	Organic	372.22	21.70	429.56	13.98
	4)	Wheat	Fertilizer	299.35	23.56	413.78	12.54
	5)	Sweet orange [e]	Organic	366.79	12.65	394.89	14.65
	6)	Inorganic	Fertilizer	312.26	17.87	349.98	13.04
Chacher	1)	Rice [b]	Organic	371.38	19.87	400.78	12.09
	2)	Rice	Fertilizer	327.18	24.99	392.45	11.24
	3)	Mandarin[e]	Organic	277.81	16.75	397.56	14.01
	4)	Inorganic	Fertilizer	207.78	19.56	357.90	12.15
Chinchbhavan	1)	Mandarin [e]	Organic	373.53	15.87	419.45	15.67
	2)	Mandarin	Fertilizer	298.72	22.45	379.98	12.78
	3)	Tomato[a]	Organic	437.77	17.06	435.67	14.54
	4)	Inorganic	Fertilizer	267.98	23.65	383.56	12.34

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}

Available sulphur of soil (mg kg^{-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 available sulphur ranged from 10.67 to 15.67 mg kg^{-1} i.e. marginal to adequate (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) [11] 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 (mg kg-1) ranged from 0.52 to 0.70, 3.69 to 8.75, 4.08 to 7.87 and 2.55 to 4.89 respectively (table-3) 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 [10]. Kharche (2013) [7] reported that, the application of FYM significantly increased availability of micro-nutrient over rest of treatments probably due to decomposition of FYM.

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	0.69	4.55	5.98	4.15
	2)	Mandarin	Fertilizer	0.55	3.89	5.56	4.66
	3)	Tomato[e]	Organic	0.75	6.67	7.87	3.82
	4)	Tomato	Fertilizer	0.68	5.70	7.15	4.64
	5)	Cotton [a]	Organic	0.72	6.87	7.45	2.84
	6)	Inorganic	Fertilizer	0.58	5.35	7.21	3.15
Kalmeshwar	1)	Fenugreek+ Spinach[d]	Organic	0.62	4.45	6.51	2.62
	2)	Inorganic	Fertilizer	0.54	3.78	5.96	2.98
	3)	Mandarin [b]	Organic	0.64	8.75	6.91	4.34
	4)	Mandarin	Fertilizer	0.58	7.87	5.95	4.89
Gangner	1)	Mandarin [e]	Organic	0.64	4.55	6.08	2.86
	2)	Mandarin	Fertilizer	0.60	3.99	5.38	3.77
	3)	Rice [b]	Organic	0.67	5.66	6.61	4.18
	4)	Rice	Fertilizer	0.58	4.85	4.97	4.37
	5)	Soybean[d]	Organic	0.59	8.20	6.05	3.85
	6)	Soybean	Fertilizer	0.55	7.88	5.55	4.54
Saoner	1)	Pigeonpea[c]	Organic	0.57	6.45	7.55	3.12
	2)	Pigeonpea	Fertilizer	0.52	5.48	6.66	3.48
	3)	Wheat [a]	Organic	0.67	8.05	4.46	3.65
	4)	Wheat	Fertilizer	0.54	7.66	4.08	4.45
	5)	Sweet orange [e]	Organic	0.58	4.78	5.09	2.55
	6)	Inorganic	Fertilizer	0.53	4.56	4.28	3.23
Chacher	1)	Rice [b]	Organic	0.67	5.47	7.82	3.78
	2)	Rice	Fertilizer	0.59	4.55	6.78	4.34
	3)	Mandarin[e]	Organic	0.59	7.88	7.05	3.01
	4)	Inorganic	Fertilizer	0.53	6.67	6.45	3.56

Chinchbhavan	1)	Mandarin [e]	Organic	0.70	5.64	6.80	3.35
	2)	Mandarin	Fertilizer	0.66	5.26	5.68	3.93
	3)	Tomato[a]	Organic	0.65	3.88	7.35	3.76
	4)	Inorganic	Fertilizer	0.58	3.69	6.88	4.55

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}

Conclusion

From the study it can be concluded that, the application of organic inputs improve the physic-chemical properties and fertility status of soil.

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