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Impact of organic inputs on physico-chemical properties of soil under certified organic farms in Nagpur district

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Abstract
The field investigation in relation to "Impact of organic inputs on physic-chemical properties of soil 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. 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 bulk density of soil decreased and hydraulic conductivity and water holding capacity increased by 1.34 to 20.46 per cent due to long term effect of various organic sources.

Keywords: organic, physic-chemical, 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) [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).

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.
Bulk density was determined by core method technique (Blake and Hartz, 1963). The saturated hydraulic conductivity was measured using constant head method of Richards (1954). Maximum water holding capacity of soil was determined by Keen Raczkowski box method (Piper, 1966) [5]. 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) [3], organic carbon (wet oxidation method given by Walkley and Black 1934 [12].

Results and Discussion

Bulk density of soil (Mg m^{-3})

The data in respect to bulk density of soil is presented in table-1. Bulk density of soil is an index of soil compactness. The application of organic and inorganic nutrient sources for 9-19 years under the different crops resulted not much variation in bulk density of soil after the harvest of the crops at different locations. The bulk density of surface soil estimated after the harvest of crop resulted the lowest bulk density of soil (1.23 Mg m^{-3}) with the application of ghanjivamrut @ 500 kg^{-1} from 10 years to mandarin at Gangner location. Bulk density is of greater importance in understanding the physical behavior of soils. It decreases as mineral soils become finer in texture and use of organic sources, which give good estimate of the porosity of soil. In the present study, the value of bulk density varied from 1.23 to 1.60 Mg m^{-3}. The soils of all locations comes under the texture clay in nature. The numerical variation in the type of fertilizer application (organic / inorganic sources) did not drastically change the soil bulk density. However, the soil bulk density differed among the addition of ghanjivamrut @ 500 kg ha^{-1} to tomato which is reported 1.38 Mg m^{-3} as compared to cotton 1.44 Mg m^{-3} at Selu location. Surekha and Rao. (2009) [10] reported that, the organic sources applied for long period enhanced the soil physical parameters i.e, bulk density and penetration resistance, soil fertility parameters over inorganic alone.

Hydraulic conductivity of soil (cm hr^{-1})

The data pertaining to hydraulic conductivity of soil is reflected in table- 1. The HC of soils is one of the important physical property which is associated to flux/movement of water in soil and tendency to measure the permeability of soil. In the present study, the result of hydraulic conductivity of soil exhibited difference between the continuous application of organic sources and chemical fertilizer alone. Increase in hydraulic conductivity of soil is associated with decrease in bulk density and organic sources which influence on the amount of water and also air present in soil.

Among the use of different organic sources to different crops since 9-19 years, the value of hydraulic conductivity of soil ranged between 0.78 to 1.16, 0.70 to 1.19, 0.87 to 1.16, 0.76 to 1.18, 0.81 to 1.19 and 0.78 to 1.22 cm hr^{-1} whereas the value of hydraulic conductivity of soil recorded 0.78, 0.70, 0.87, 0.76, 0.81 and 0.78under inorganic fertilizer applied at Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan, respectively.

Hydraulic conductivity of soil increased numerically due to the application of FYM (2.5 t to 10 t ha^{-1}), ghanjivamrut @ 500 kg ha^{-1}andjivamrut @ 500 lit ha^{-1}. Increased in HC of soil is associated with decrease trend in bulk density and increased in pore space reported by Singh (2010) [24]. Thakur *et al.* (2011) [11] also reported that, saturated HC value was maximum under 100% NPK + FYM @ 15 t ha^{-1} (1.11 cm hr^{1}) as compared to 100% NPK (0.69 cm hr^{-1}) indicates the favorable effect of FYM on HC of soil.

Maximum water holding capacity (%)

Maximum water holding capacity is an important physical property of soils, which gives information on how long a crop can sustain well on a soil. Organic matter does tend to increase the total water holding capacity of soil, its also increases their wilting point.

The data in respect to maximum water holding capacity of soil as influenced by various organic source is presented in table-1. The value of water holding capacity varied from 53.60 to 68.70 per cent under the application of organic and inorganic inputs. The application of organic inputs from 9 to 19 years resulted increase the water holding capacity of soil by 1.34 to 20.46 per cent over the application of fertilizer alone. The maximum increase of WHC (20.46%) is recorded in mandarin crop where Ghanjivamrut @ 500 kg ha^{-1} was applied. Rawls *et al.* (2003) [7] reported that, at high organic carbon values, all soils showed an increase in water retention.

Table 1: Effect of various organic sources on physical properties of soil after harvest of different crops

Location	Crops		Source	Bulk density (Mg m^{-3})	Hydraulic conductivity (cm hr^{-1})	MWHC (%)
Selu	1)	Mandarin[e]	Organic	1.32	1.13	62.34
	2)	Mandarin	Fertilizer	1.47	0.78	53.60
	3)	Tomato[e]	Organic	1.38	1.16	62.40
	4)	Tomato	Fertilizer	1.52	0.81	53.85
	5)	Cotton [a]	Organic	1.44	1.13	61.95
	6)	Inorganic	Fertilizer	1.50	0.83	58.15
Kalmeshwar	1)	Fenugreek+ Spinach[d]	Organic	1.35	1.19	65.85
	2)	Inorganic	Fertilizer	1.49	0.86	58.35
	3)	Mandarin [b]	Organic	1.30	1.08	56.40
	4)	Mandarin	Fertilizer	1.60	0.70	55.65
Gangner	1)	Mandarin [e]	Organic	1.23	1.15	58.45
	2)	Mandarin	Fertilizer	1.48	0.98	54.80
	3)	Rice [b]	Organic	1.38	1.02	58.65
	4)	Rice	Fertilizer	1.60	0.97	53.86
	5)	Soybean[d]	Organic	1.30	1.16	63.20
	6)	Soybean	Fertilizer	1.51	0.87	59.45
Saoner	1)	Pigeonpea[c]	Organic	1.38	1.18	63.00
	2)	Pigeonpea	Fertilizer	1.58	0.98	57.90
	3)	Wheat [a]	Organic	1.29	1.15	61.45
	4)	Wheat	Fertilizer	1.58	0.76	53.87
	5)	Sweet orange [e]	Organic	1.33	1.05	64.10
	6)	Inorganic	Fertilizer	1.52	0.78	61.30
Chacher	1)	Rice [b]	Organic	1.46	1.10	63.00
	2)	Rice	Fertilizer	1.55	0.81	57.60
	3)	Mandarin[e]	Organic	1.32	1.19	63.65
	4)	Inorganic	Fertilizer	1.48	0.99	59.60

Chinchbhavan	1)	Mandarin [e]	Organic	1.41	1.17	68.70
	2)	Mandarin	Fertilizer	1.48	0.78	57.03
	3)	Tomato[a]	Organic	1.39	1.22	66.09
	4)	Inorganic	Fertilizer	1.46	0.86	58.10

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}

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-2). 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) [8] 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 data of electrical conductivity of soil is presented in table-2. The values of electrical conductivity of soil ranged between 0.289 to 0.479dS 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 0.479dS 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) [6] 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-2. 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) [2] 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-2. 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) [9] 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) [4] 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.

Table 2: 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}

Conclusion

From the study it can be concluded that, the application of organic inputs improve the physico-chemical properties of soil.

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