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Impact of long term organic sources on physical properties and yield of vegetable crops in Nagpur district

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Abstract
The field investigation in relation to "Impact of long term organic sources on physical properties and yield of vegetable crops in Nagpur district" was carried out during kharif - rabi season of 2018 - 19 at the certified organic farmer's fields of Nagpur district. Total 32 soil samples from surface (0-15cm) and sub-surface (15-30cm) layer were collected from S different fields to assess the physical properties of soil and yield of different crops as influenced by various organic resources. The results indicated that, the use of organic sources has decreased the bulk density over inorganic fertilizer alone and also has increased the hydraulic conductivity of soil. The mean weight diameter ranged from 0.97 mm to 1.25 mm in overall locations. Highest value of MWD (1.25 mm) was recorded in surface soil of brinjal crop where treatment consisting FYM @ 10 t ha^{-1}. The application of FYM @ 10 t ha^{-1}has increased the water holding capacity to the tune of 6.97 percent at subsurface level over the application of inorganic fertilizer alone. The highest (1.15 cm hr^{-1}) value of the infiltration rate was recorded with plot treated with FYM @ 10 t ha^{-1}. Maximum yield of brinjal (310.6 q ha^{-1}) and okra (93.5 q ha^{-1}) was obtained with FYM 10 t ha^{-1}as compared to application of other nutrient sources whereas fenugreek (64.9 q ha^{-1}) and spinach (72.0 q ha^{-1}) resulted maximum in inorganic fertilizer.

Keywords: Water holding capacity, hydraulic conductivity, infiltration rate, organic carbon

Introduction
Organic agriculture has its roots in traditional agricultural practices that evolved in countless villages and farming communities over the million years. India has traditionally practiced organic agriculture, and farmers were following organic cultivation till the invent of chemical fertilizer and pesticides in the middle of the last century (1950) that dramatically changed the face and fate of agriculture. The process of modernization, particularly the green revolution technologies, has led to the increased use of chemicals. However, continuous use of these high energy inputs indiscriminately, now leads to decline in production and productivity of various crops as well as deterioration of soil health and environments. Soil organic matter is responsible for maintenance of not only the soil's physical conditions but also supplies essential plant nutrients for successful crop production. Humus, the most important and largest constituent of soil organic matter is formed by the decomposition of plant and animal residues by micro-organism. It is a store house of various nutrients essential for plant growth. Besides, humus also exerts a pronounced influence of physical, chemical and biological properties of soil. (Gathala *et al*., 2007) [4].

Material and Methods
The field investigation in relation to "Impact of long term organic sources on physical properties and yield of vegetable crops in Nagpur district" was conducted during kharif- rabi season of 2018 – 2019 at the farmer's fields (organic field) of Nagpur district. In order to study the properties of soil, soil samples were taken from 0–15 and 15-30 cm depth, from randomly selected spots over the field after harvest. Soil samples were analysed for bulk density, hydraulic conductivity, maximum water holding capacity and infiltration rate by core method (Blake and Hartz, 1963), constant head method (Richards, 1954) [15], K R box method (Piper, 1966) [14] and double ring infiltrometer (Parr and Bertrand, 1960) [12].

Simple correlations were worked out between soil properties and vegetables crop yield by standard statistical method by (Gomez and Gomez, 1983) [11]. Treatment details are given in table no 1.

Table 1: Treatment details of different vegetables crop

Treatments	Crop
Jivamrit @ 500 lit. ha^{-1}	Fenugreek
	Spinach
	Okra
	Brinjal
Ghanajivamrit @ 500 kg ha^{-1}	Fenugreek
	Spinach
	Okra
	Brinjal
FYM @ 10 t ha^{-1}	Fenugreek
	Spinach
	Okra
	Brinjal
Control (46:0:0 NPK kg ha^{-1})	Fenugreek
Control (46:0:0 NPK kg ha^{-1})	Spinach
Control (64:46:0 NPK kg ha^{-1})	Okra
Control (64:54:0 NPK kg ha^{-1})	Brinjal

Results and Discussion

Physico-chemical properties of the soil

The soil of area is deep black (vertisol) and clay to clay loam in texture. The results of the soil analysis indicate that the soil was neutral total alkaline in reaction with moderate to high in organic carbon. The value of soil pH was in the range of 6.97 to 8.21 and electrical conductivity recorded in between (0.204 to 0.408 dSm^{-1}).

Mean weight diameter (mm)

The MWD is a sensitive index of the aggregation status of soil, it has physical significance as it gives an estimate of the average size of the soil aggregation. The mean weight diameter ranged from 0.97 mm to 1.25 mm in overall locations. Highest value of MWD (1.25 mm) was recorded in surface soil of brinjal crop where treatment consisting FYM @ 10 t ha^{-1} whereas, lowest MWD (0.97) was recorded in fenugreek field treated with Jivamrit @ 500 lit. ha^{-1}.

The MWD is improved by increasing the organic treatment or organically treated soil. Similar result were found by Mitran *et al*., (2017). Gundlur *et al*., (2015) reported that, the mean weight diameter were improved in the treatments receiving organics in conjugation with inorganic fertilizers as compared to only inorganic fertilizer.

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

The data in respect to bulk density of soil is presented in table 2. Bulk density of soil is an index of soil compactness. The application of organic and inorganic nutrient sources for 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 value (1.16 Mg m^{-3}) in spinach crop with the application of Ghanjivamrit @ 500 kg^{-1} from years whereas, highest bulk density of soil (1.43 Mg m^{-3}) was recorded at subsurface level under inorganic fertilizer treatment where no organic matter added.

In the present study, the value of bulk density varied from 1.16 to 1.40 Mg m^{-3} and 1.28 to 1.43 Mg m^{-3} in surface and subsurface soil, respectively. Surekha and Rao.(2009) 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. Selvi *et al*., (2005) [16] also reported that, there is decrease in the bulk density in NPK-applied treatments along with FYM (1.30 Mg m^{-3}) than control (1.44 Mg m^{-3}). Due to long term effect of organic sources applied Ghanajivamrit @ 500 kgha^{-1}resulted a decreased soil bulk density of 1.16 to 1.29 Mg m^{-3} and1.28 to1.38Mg m^{-3} in surface and subsurface soil, respectively.

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

The data pertaining to hydraulic conductivity of soil is reflected in table 2. 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 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 vegetables crops for long term period, the value of hydraulic conductivity of soil ranged between 0.77 to 1.32cm hr^{-1}and 0.70 to 1.13 cm hr^{-1} in surface and subsurface soil respectively. The value of HC of soil decreases with the depth. The highest value of hydraulic conductivity of soil was recorded 1.32 cm hr^{-1}under okra crop treated with FYM @ 10 tonne ha^{-1}and fenugreek crop treated with Ghanajivamrit @ 500 kg ha^{-1}whereas, the lowest value of hydraulic conductivity of soil were recorded for 0.61cm hr^{-1}at subsurface level under crop okra treated with inorganic fertilizer. The value of HC increases ascribed to better aggregation and increased infiltration rate by addition of FYM which directly influenced hydraulic conductivity of soil. Application of FYM @ 10 t ha^{-1}for long period recorded maximum hydraulic conductivity. Similar result were also found by gunjal and Chitodkar. (2017) [6] where he found that, FYM treatments had a significant effect on hydraulic conductivity of soil. Application of FYM with chemical fertilizers recorded maximum hydraulic conductivity.

Water holding capacity (%)

The data pertaining water holding capacity of soil is reflected in table 2.The water holding capacity of soil is very important property which influence nutrient and moisture availability to plant. The application of FYM 10 t ha^{-1} increased the WHC to the tune of 6.97 percent at subsurface level over the application of inorganic fertilizer alone. The highest value of WHC (65.9%) was recorded under okra crop treated with Ghanajivamrit @ 500 kg ha^{-1} and FYM @ 10 t ha^{-1} whereas, lowest value (56.1%) was recorded for spinach crop treated with inorganic fertilizers. Tadesse *et al*., (2013) [18] reported that, application of 15 t ha^{-1} FYM increased the soil organic matter and WHC by about 2.16 per cent and 17.6 per cent respectively. Similar result were also shown by Patel *et al*. (2014) [13] where WHC of organic amendments treated soil are more (FYM = 58.74 %, VC = 54.57%, FYM+ VC = 61.48%) as compared to control that is (43.13%).

Infiltration rate

The infiltration rate values varied from 0.65 to 1.15 cm hr^{-1} after harvest of the crop. The highest value (1.15 cm hr^{-1}) of infiltration rate was recorded with plot treated with FYM 10 t ha^{-1} whereas, lower value (0.65 cm hr^{-1}) was obtained in surface soil with the application inorganic fertilizers treated plot adjacent to FYM plot. The trend of variation of infiltration rate among the treatments might be attributed to the variation in the improvement of soils structure with

application of manure and fertilizers. The lowest value of infiltration rate obtained with the inorganic fertilizer (0.65 cm hr^{-1}) was clearly indicated the deterioration of soil structure over a long term cultivation of crop and highest value of infiltration rate (1.15 cm hr^{-1}) obtained with treatment applied higher doses of FYM might be due to improvement of soil structure and soil aggregates thereby, increased macroporosity which resulted in reducing the bulk density of the soil. Similar result was found by Gunjal and Chitodkar (2017) [6] observed that, cumulative infiltration varied from 0.90 to 1.03 cm hr^{-1}in experiment area where the highest cumulative infiltration (1.03 cm hr^{-1}) was observed by application treatment 100 per cent GRDF(120:60:40 N, P_2O_5, K_2O kg ha^{-1} + 10 t FYM ha^{-1}), which was significantly higher over other treatments except treatment 125 per cent RDN + 25 per cent N through FYM (1.02 cm hr^{-1}). Abbas and Fadul. (2013) [1] also resulted that the highest infiltration rate was found in the manure application of 20 t ha^{-1} as compared to the control. This might be due to the improved physical properties of heavy clay soil as a result from the application of FYM.

Table 2: Effect of various organic sources on mean weight diameter, bulk density , hydraulic conductivity, water holding capacity and infiltration rate of soil at harvest of different crop.

Crops	Treatments	Depth (cm)	MWD (mm)	Bulk density (Mg m^{-3})	Hydraulic conductivity (cm hr^{-1})	WHC (%)	Infiltration rate
Fenugreek	Jivamrit (500 litre ha^{-1})	0-15cm	0.97	1.31	1.03	56.2	0.66
		15-30cm		1.38	0.82	59.9	
Spinach		0-15cm	1.05	1.25	1.10	58.1	0.75
		15-30cm		1.32	0.88	62.3	
Okra		0-15cm	0.98	1.26	1.12	57.3	0.85
		15-30cm		1.36	0.86	61.7	
Brinjal		0-15cm	1.02	1.22	1.08	60.0	1.00
		15-30cm		1.32	0.93	64.5	
		S mean	1.00	1.26	1.0	57.9	0.81
		SS mean		1.34	0.87	62.1	
Fenugreek	Ghanajivamrit (500 kg ha^{-1})	0-15cm	1.09	1.20	1.32	57.1	0.98
		15-30cm		1.38	1.09	60.7	
Spinach		0-15cm	1.18	1.16	1.23	58.6	0.95
		15-30cm		1.28	1.13	63.2	
Okra		0-15cm	1.14	1.20	1.27	62.4	1.00
		15-30cm		1.32	1.10	65.4	
Brinjal		0-15cm	1.08	1.29	1.22	59.8	1.12
		15-30cm		1.35	1.08	65.9	
		S mean	1.12	1.21	1.26	59.47	1.01
		SS mean		1.33	1.1	63.8	
Fenugreek	FYM (10 t ha^{-1})	0-15cm	1.04	1.27	1.27	57.3	0.89
		15-30cm		1.34	1.08	63.5	
Spinach		0-15cm	1.15	1.21	1.25	59.3	0.85
		15-30cm		1.33	1.11	64.4	
Okra		0-15cm	1.10	1.22	1.32	58.9	1.15
		15-30cm		1.30	1.07	65.7	
Brinjal		0-15cm	1.25	1.27	1.32	60.6	1.12
		15-30cm		1.32	0.94	64.6	
		S mean	1.13	1.24	1.29	59.0	1.00
		SS mean		1.32	1.05	64.5	
Fenugreek	Control (46:0:0 N:P:K kg ha^{-1})	0-15cm	1.10	1.35	0.82	56.7	0.67
		15-30cm		1.42	0.70	60.3	
Spinach	Control (46:0:0 N:P:K kg ha^{-1})	0-15cm	1.02	1.31	0.85	56.1	0.65
		15-30cm		1.40	0.73	59.2	
Okra	Control (64:46:0N:P:K kg ha^{-1})	0-15cm	1.17	1.40	0.77	56.3	0.67
		15-30cm		1.42	0.61	60.2	
Brinjal	Control (64:54:0N:P:K kg ha^{-1})	0-15 cm	1.14	1.39	1.02	57.1	0.7
		15-30 cm		1.43	0.74	60.5	
		S mean	1.10	1.36	0.86	56.55	0.67
		SS mean		1.41	0.69	60.05	
		O.S range	0.97-1.25	1.16 – 1.40	0.77 – 1.32	56.1-62.4	0.65-1.15
		O.SS range		1.28 – 1.43	0.61 – 1.13	59.2-65.9	

Yield of vegetables (q ha^{-1})

Yield of Fenugreek (q ha^{-1})

The yield of fenugreek was obtained between 28.7 to 64.9 q ha^{-1} with the use of different nutrient sources with mean of 43.65 q ha^{-1}. The maximum yield (64.9 q ha^{-1}) was obtained in inorganic treated plot. Khiriya and Singh (2003) [9] reported that the application of FYM 15 t ha^{-1} to fenugreek significantly increased the number branches per plant, pods per plant, seeds per pod, test weight, seed weight and seed and straw yields over control,

Yield of spinach

The yield of different vegetable crops is represented in table 10.The yield of spinach was obtained 43.4 q ha^{-1}, 55.4 qha^{-1}, 67.1 q ha^{-1}, 72.0 q $ha^{-1}$with the application of JIvamrit @ 500 lit. ha^{-1}, Ghanajivamrit @ 500 kg ha^{-1}, FYM @ 10 t ha^{-1} and inorganic fertilizer, respectively. Which is as per the result of

Vethamoni *et al*., (2018) [19] found that among the various organic treatments the yield of Palak comes under the range of 48.95 q ha^{-1} to 68.02 q ha^{-1}

Yield of Okra

The highest yield of okra (93.5 q ha^{-1}) was obtained with the application of FYM @ 10 t ha^{-1}. Yield of Okra was obtained under treatments treated with Jivamrit, Ghanajivamrit, FYM and control were 54.7 q ha^{-1}, 75.8 q ha^{-1}, 93.5 q ha^{-1}, 75.9 q ha^{-1} repectively. Muthuvel (2002) [10] observed that four sprays of Panchagavya @ 3 per cent and Moringa leaf extract spray @ 25 ml plant 1 resulted in higher plant height, number of branches par plant, number of fruits per plant and fruit yield of okra than control (water spray)

Yield of Brinjal

In the present study the yield of brinjal was observed for different treatments comprising Jivaamrit @ 500 lit. ha^{-1}, Ghanajivamrit @ 500 kg ha^{-1}, FYM @ 10 t ha^{-1} and control as 185.3 q ha^{-1}, 210.2 q ha^{-1}, 310.6 q ha^{-1}, 255.4 q ha^{-1}.Kumar.(2016) found that among various organic treatments highest yield was recorded with FYM @ 12 t ha^{-1} and vermicompost @ 5 t ha^{-1} as compared to control (without nutrient) and RDF.

Table 3: Yield of vegetables under different treatments.

Crop	Treatment				
	Jivamrit (500 litre ha^{-1})	Ghanajivamrit (500 kg ha^{-1})	FYM (10 t ha^{-1})	Control (N:P:K kg ha^{-1})	Inorganic fertilizer applied under control
	Yield (q ha^{-1})				
Spinach	43.4	55.4	67.1	72.0	46:0:0 NPK kg ha^{-1}
Fenugreek	28.7	35.6	45.4	64.9	46:0:0 NPK kg ha^{-1}
Brinjal	185.3	210.2	310.6	255.4	64:54:0 NPK, kg ha^{-1}
Okra	54.7	75.8	93.5	75.9	64:46:0 NPK, kg ha^{-1}

Conclusion

The use of organic sources has decreased the bulk density over inorganic fertilizer alone and also has increased the hydraulic conductivity of soil. The value of HC increases ascribed to better aggregation and increased infiltration rate by addition of FYM which directly influenced hydraulic conductivity of soil. The application of FYM @ 10 t ha^{-1} has increased the water holding capacity to the tune of 6.97 percent at subsurface level over the application of inorganic fertilizer alone. The highest (1.15 cm hr^{-1}) value of the infiltration rate was recorded with plot treated with FYM @ 10 t ha^{-1} this was due to treatment applied higher doses of FYM might be due to improvement of soil structure and soil aggregates thereby increased macroporosity which resulted in reducing the bulk density of the soil. Higher macroporosity resulted in higher infiltration as the water moves through macropores during infiltration. Maximum yield of brinjal (310.6 q ha^{-1}) and okra (93.5 q ha^{-1}) was obtained with FYM 10 t ha^{-1}as compared to application of other nutrient sources whereas fenugreek (64.9 q ha^{-1}) and spinach (72.0 q ha^{-1}) resulted maximum in inorganic fertilizer.

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

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