International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 2097-2099

Received: 20-05-2018
Accepted: 23-06-2018

Deepa Kalappanavar
Department of Soil Science and Agricultural Chemistry University of Agricultural Sciences, Dharwad, Karnataka, India

SK Gali
Department of Soil Science and Agricultural Chemistry University of Agricultural Sciences, Dharwad, Karnataka, India

Correspondence
Deepa Kalappanavar
Department of Soil Science and Agricultural Chemistry University of Agricultural Sciences, Dharwad, Karnataka, India

Effect of organics and inorganics on physico-chemical properties of soil in a vertisol

Deepa Kalappanavar and SK Gali

Abstract
A field experiment was undertaken during *kharif* 2016 in order to study the "Effect of different organics and inorganics on physico- chemical properties of soil in a Vertisol". Application of poultry manure accounted for lowest BD (1.03 Mg m^{-3}) highest MWHC (65.81 %), aggregate stability (85.38 %), porosity (50.40 %) and soil organic carbon (9.7 g kg^{-1}) followed by other organic manures in both surface and subsurface soil. Application of organic manures either alone or in combination with RDF alone did not influence soil porosity, soil pH and EC.

Keywords: organics, BD, aggregate stability, maximum water holding capacity, and soil organic carbon (SOC)

Introduction
Organic agriculture is gaining much importance and popularity in recent days with increasing health concern among the farmers and consumers. Effective and prudent use of organic manures along with inorganic fertilizers can sustain soil health and also substantially improve crop productivity. Among the various organic manures, the by-products obtained from animal husbandry *viz.*, farmyard manure, sheep manure, poultry manure and vermicompost are used as source of organic matter as they are cheap, locally available, eco-friendly and nutrient rich. Addition of well decomposed organic manure not only supplies plant nutrients to the plants but also acts as binding material and improves the soil physical properties. Poultry manure has been adjudged to be the most valuable of all organic manures produced and is relatively a cheap source of both macro and micronutrients and can increase soil carbon, soil porosity and aggregate stability. (Usha rani *et al.*, 2014) [8].

Materials and Methods
The study was conducted in the long term maize experiment field at main agricultural research station (MARS), Dharwad, Karnataka during *kharif*, 2016. The experiment was laid out in randomized complete block design with 13 treatments, replicated thrice. The treatments included, 100 per cent RDF+ FYM (T_1), 100 per cent RDF + Vermicompost (T_2), 100 per cent RDF + Poultry manure (T_3), 100 per cent RDF + Sheep manure (T_4), FYM alone (T_5), Vermicompost alone (T_6), Poultry manure alone (T_7), Sheep manure alone (T_8), 50 per cent RDF +FYM (T_9), 50 per cent RDF + Vermicompost (T_{10}), 50 per cent RDF + Poultry manure (T_{11}), 50 per cent RDF + Sheep manure (T_{12}) and RDF alone (T_{13}). The quantity of Farm yard manure (FYM), Vermicompost (VC), Poultry manure (PM) and Sheep manure (SM) applied was based on their N content to meet RDN in organic alone treatment and equivalent basis of N in FYM in all other INM treatments required for each plot was calculated as per the treatment details and applied a fortnight before sowing. Recommended dose of nitrogen, phosphorous and potassium were applied in the form of urea, diammonium phosphate (DAP) and muriate of potash (MOP), respectively at the time of sowing of maize.
After the harvest of crop, the soil samples were collected from a depth of 0-22.5 and 22.5- 45.0 cm from each treatment and the soil samples were analyzed for bulk density by soil core method (Dastane, 1967) [3], aggregate stability by wet sieving method (Yoder, 1936) [11], maximum water holding capacity by keen's cup method (Piper, 2002), pH and EC were determined in 1:2.5 soil: water suspention using pH meter and conductivity meter respectively (Sparks, 1966) [6]. Soil organic carbon was estimated by walkley and black's wet oxidation method (Walkely and Black's, 1934).

Results and Discussion
Physical Properties
Bulk density and porosity (Table 1)
Bulk density of surface soil varied from 1.03 to 1.42 Mg m^{-3}. Significantly lowest (1.03 Mg m^{-3}) bulk density was recorded in treatment receiving poultry manure alone (T_7) and it was on par with other organics and INM treatments except 100 per cent RDF + FYM. Significantly highest bulk density of 1.42 Mg m^{-3} was recorded in RDF alone treatment (T_{13}) and it was on par with 100 per cent RDF + FYM (T_1,1.27 Mg m^{-3}). The bulk density of subsurface soil was higher than surface soil in all the treatment and it ranged from 1.20 (T_7) to 1.74 (T_{13}) Mg m^{-3} and followed the same trend as that of surface soil. The porosity of surface soil and subsurface soil ranged from 47.50 to 50.40 per cent and 46.62 to 48.70 per cent respectively. But, however, the variation in the porosity of soil due to different treatments was non significant.

Table 1: Effect of different organics and inorganics on bulk density and porosity of soil at harvest

Treatments	BD (Mgm^{-3})		Porosity (%)	
	Soil depth (cm)			
	0 - 22.5	22.5 - 45.0	0 - 22.5	22.5 - 45.0
T_1: 100 % RDF + FYM	1.27^{ab}	1.47^{b}	50.13^{a}	48.12^{a}
T_2: 100 % RDF + VC	1.20^{bc}	1.37^{bc}	50.29^{a}	48.41^{a}
T_3: 100 % RDF + PM	1.17^{bc}	1.30^{bc}	50.36^{a}	48.60^{a}
T_4: 100 % RDF + SM	1.20^{bc}	1.33^{bc}	50.23^{a}	48.20^{a}
T_5: FYM alone	1.07^{c}	1.33^{bc}	50.20^{a}	48.42^{a}
T_6: VC alone	1.09^{bc}	1.30^{bc}	50.27^{a}	48.43^{a}
T_7: PM alone	1.03^{c}	1.20^{c}	50.40^{a}	48.70^{a}
T_8: SM alone	1.05^{c}	1.27^{bc}	50.23^{a}	48.10^{a}
T_9: 50 % RDF + FYM	1.20^{bc}	1.40^{bc}	50.13^{a}	46.30^{a}
T_{10}: 50 % RDF + VC	1.19^{bc}	1.37^{bc}	50.29^{a}	46.51^{a}
T_{11}: 50 % RDF + PM	1.13^{bc}	1.20^{c}	50.36^{a}	47.91^{a}
T_{12}: 50 % RDF + SM	1.20^{bc}	1.23^{bc}	50.23^{a}	47.20^{a}
T_{13}: 100 % RDF	1.42^{a}	1.74^{a}	47.50^{a}	46.62^{a}
LSD	0.16	0.21	NS	NS

Note: Initial value of BD = 1.39 M g m^{-3} and porosity = 46.39 %
Means followed by same latter (s) within a column are not significantly different (DMRT P = 0.05)

Aggregate stabilizy and maximum water holding capacity (Table 2)
Aggregate stability and maximum water holding capacity (MWHC) of surface soil in different treatments ranged from 72.41 to 85.38 per cent and 55.41 to 65.81 per cent, respectively. Aggregate stability and MWHC of soil was significantly influenced by the application of either organics alone or combination with inorganics. In surface soil, poultry manure treated plot (T_7) showed significantly highest (85.38 % and 65.81%) aggregate stability and MWHC followed by sheep manure (T_8, 83.33 % and 65.42%) and vermicompost treatments (T_6, 81.71 %) which were on par with T_7. The lowest (72.41 %) aggregate stability and MWHC (55.41 %) was recorded in RDF treatment (T_{13}). Among INM practice, 50 per cent RDF + poultry manure showed significantly higher (82.52 %) aggregate stability and it was on par with 50 per cent RDF + sheep manure (80.99 %) and RDF + vermicompost (80.58 %). The values of MWHC in surface soil for all the INM treatments were on par. The aggregate stability of sub surface soil was lower than surface soil and the variation in different treatments was non significant.

Application of different organic manures and inorganic fertilizers significantly influenced the bulk density, maximum water holding capacity and aggregate stability of soil but, however, the porosity of soil was not influenced (Table 1 and 2). The significantly lowest bulk density (1.03 Mg m^{-3}) and highest water holding capacity (65.81 %) and aggregate stability (85.38 %) in surface soil were recorded in poultry manure treatment (T_7) followed by other organics. A significant increase in soil organic carbon in these treatments (Table 3) was probably responsible for such favourable effects and could be also attributed to release of organic acids during decomposition of organic matter that helps in formation of stable aggregates and favourable pore geometry in soil as stated by Kalhapure *et al*. (2013) [4]. The biomass added to the soil through different organic sources and decomposition products of the organic matter which are capable of imparting binding effect on soil particles have been responsible to improve aggregation, porosity and humus which, in turn, have induced favourable effect on physical properties of soil (Pathak *et al*., 2005) [5]. The highest bulk density (1.42 Mgm^{-3}) and lowest porosity (47.50 %), water holding capacity (55.41 %) and aggregate stability (72.41 %) were recorded in RDF alone treatment (T_{13}). This might be due to deteriorating effect of long term use of inorganic fertilizers on soil structure (Channal, 2012). These findings are also in conformity with those of Lalith *et al*. (2013). The subsoil recorded higher bulk density and lower water holding capacity and aggregate stability than surface soil which could be attributed to compaction effects and low soil organic carbon content.

Table 2: Effect of different organics and inorganics on aggregate stability and maximum water holding capacity of soil at harvest

Treatments	Aggregate stability (%)		MWHC (%)	
	Soil depth (cm)			
	0-22.5	22.5-45.0	0 - 22.5	22.5 - 45.0
T_1: 100 % RDF + FYM	76.66^{d}	72.73^{a}	57.40^{cd}	51.40^{a}
T_2: 100 % RDF + VC	77.35^{d}	73.84^{a}	59.01^{b-d}	52.41^{a}
T_3: 100 % RDF + PM	80.55^{b-d}	75.79^{a}	60.33^{a-d}	53.32^{a}
T_4: 100 % RDF + SM	78.61^{cd}	74.50^{a}	59.01^{b-d}	53.12^{a}
T_5: FYM alone	80.77^{b-d}	76.77^{a}	63.22^{a-c}	53.42^{a}
T_6: VC alone	81.71^{a-c}	77.71^{a}	64.32^{ab}	53.74^{a}
T_7: PM alone	85.38^{a}	78.11^{a}	65.81^{a}	55.21^{a}
T_8: SM alone	83.33^{ab}	78.04^{a}	65.42^{a}	53.70^{a}
T_9: 50 % RDF + FYM	77.37^{d}	75.08^{a}	59.01^{b-d}	50.51^{a}
T_{10}: 50 % RDF + VC	80.58^{b-d}	75.45^{a}	57.71^{cd}	51.52^{a}
T_{11}: 50 % RDF + PM	82.52^{a-c}	77.12^{a}	59.10^{b-d}	54.22^{a}
T_{12}: 50 % RDF + SM	80.99^{b-d}	75.84^{a}	58.01^{b-d}	53.80^{a}
T_{13}: 100 % RDF	72.41^{e}	67.67^{a}	55.41^{d}	50.71^{a}
LSD	6.04	NS	5.56	NS

Note: Initial value of MWHC = 52.30 % and porosity = 72.12 %
Means followed by same latter (s) within a column are not significantly different (DMRT P = 0.05)

Chemical Properties
Soil pH and EC (Table 3)
The pH of surface and sub surface soil ranged from 7.01 to 7.45 and 7.17 to 7.60, respectively. The soil pH was highest in treatment which received 100 per cent RDF alone (T_{13}). But, however, the pH values did not differ significantly due to different treatments. pH values were comparatively lower in organic manures applied soil (T_1 to T_{12}) than soil which received RDF alone (T_{13}). Similar reduction in soil pH due to application of FYM @ 5 and 10 t per ha and poultry manure @ 3 t per ha was observed by Babu and Reddy (2000) and Vaisaki (2012).

The total soluble salt content of surface soil was not affected by the application of organics and INM practice. The treatment with only chemical fertilizer (T_{13}) recorded the significantly highest soluble salt content (EC, 0.67 dS m^{-1}) over rest of the treatments. This could be due to continuous use of inorganic fertilizers which is likely to cause accumulation of inorganic salts in soil. The lowest (0.15 dS m^{-1}) soluble salt content was recorded in poultry manure (T_7) treated soil and was on par with rest of the organic and INM treatments. The sub surface soil recorded higher salt content (0.59 to 0.88 dS m^{-1}) than surface soil. The EC values for sub surface soil in different treatments were on par with each other. The EC values in all the INM and organics treatments were on par with each other but, however, significantly lower than RDF treatment. A significantly lower soluble salt content in all the organic manure applied soils (T_1 to T_{12}) is ascribed to decrease in salt content due to production of acids during decomposition of manures similar findings was also observed by Usha rani *et al*. (2014) [8].

Table 3: Effect of different organics and inorganics on pH, electrical conductivity and organic carbon of soil at harvest

Treatments	pH		EC (dS m^{-1}) Soil depth (cm)		OC (g kg^{-1})	
	0 - 22.5	22.5-45.0	0- 22.5	22.5 - 45.0	0 – 22.5	22.5 - 45.0
T_1: 100 % RDF + FYM	7.17^{a}	7.27^{a}	0.25^{b}	0.66^{a}	8.4^{c-e}	5.1^{a}
T_2: 100 % RDF + VC	7.19^{a}	7.25^{a}	0.23^{b}	0.74^{a}	8.5 $^{c-e}$	5.1^{a}
T_3: 100 % RDF + PM	7.01^{a}	7.17^{a}	0.22^{b}	0.70^{a}	8.8^{a-d}	5.3^{a}
T_4: 100 % RDF + SM	7.03^{a}	7.20^{a}	0.22^{b}	0.62^{a}	8.6^{b-e}	5.2^{a}
T_5: FYM alone	7.23^{a}	7.43^{a}	0.18^{b}	0.64^{a}	9.2^{a-d}	5.2^{a}
T_6: VC alone	7.25^{a}	7.40^{a}	0.17^{b}	0.62^{a}	9.4^{a-c}	5.1^{a}
T_7: PM alone	7.22^{a}	7.35^{a}	0.15^{b}	0.59^{a}	9.7^{a}	5.2^{a}
T_8: SM alone	7.24^{a}	7.40^{a}	0.17^{b}	0.61^{a}	9.6^{ab}	5.2^{a}
T_9: 50 % RDF + FYM	7.21^{a}	7.29^{a}	0.21^{b}	0.67^{a}	8.3^{de}	5.1^{a}
T_{10}: 50 % RDF + VC	7.20^{a}	7.29^{a}	0.19^{b}	0.67^{a}	8.6^{b-e}	5.1^{a}
T_{11}: 50 % RDF + PM	7.18^{a}	7.27^{a}	0.16^{b}	0.79^{a}	8.7^{a-d}	5.2^{a}
T_{12}: 50 % RDF + SM	7.19^{a}	7.23^{a}	0.17^{b}	0.78^{a}	9.0^{a-d}	5.1^{a}
T_{13}: 100 % RDF	7.45^{a}	7.60^{a}	0.67^{a}	0.88^{a}	7.6^{e}	4.7^{a}
LSD	NS	NS	0.16	NS	0.93	NS

Note: Initial value of pH = 7.41 and EC = 0.21 dS m-1
Means followed by same latter (s) within a column are not significantly different (DMRT P = 0.0

Soil organic carbon (Table 3)
The highest soil organic carbon (SOC) content in surface soil was recorded in treatment receiving poultry manure alone (T_7, 9.7 g kg^{-1}). The other organic treatments (T_5, T_6 and T_8) also accounted for on par values of SOC with it. All the INM treatments *i.e*., the treatments with 100 per cent RDF + organics (T_1 to T_4) as well as 50 per cent RDF + organics (T_9 to T_{12}) accounted for on par SOC values. The lowest SOC in surface soil (7.6 g kg^{-1}) was recorded in treatment receiving only RDF alone (T_{13}). Organic carbon content of sub surface soil was much lower (4.7 to 5.3 g kg^{-1}) than the surface soil in all the treatments and the effect of treatments was non-significant.
A significant improvement in soil organic carbon (SOC) of surface soil with application of organic manures alone (T_5 to T_8) over all other treatments was observed (Table 3). As the organic manures contained high amount of total organic carbon, their continuous use has resulted in significant increase in SOC. Among the organics, poultry manure which had highest total organic carbon (22.00 %) accounted for significantly highest SOC of 9.70 g kg^{-1} but, however other organics also recorded on par SOC values. Increase in soil organic carbon due to application of organics was also reported by Tetarwal *et al*. (2011) [7] and Channal (2012) [2]. The SOC in all other treatments (T_1 to T_4 and T9 to T_{12}) was on par, but, significantly higher than the treatment with RDF alone (T_{13}, 7.6 g kg^{-1}) which accounted for lowest SOC. Use of chemical fertilizer alone and loss of soil organic matter by oxidation was probably responsible for the lowest SOC in RDF alone treatment. The SOC in subsoil was much lower than in surface soil and treatments had no influence on it.

Conclusions
Physico-chemical properties of soil such as porosity, maximum water holding capacity, aggregate stability and organic carbon improved significantly due to the application of organic manures alone as well as in INM treatments. Application of poultry manure accounted for lowest BD (1.03 Mg m^{-3}), highest MWHC (65.81 %) and aggregate stability (85.38 %) followed by other organic manures.

References

1. Babu R, Reddy VC. Effect of nutrient sources on growth and yield of direct seeded rice (*Oryza sativa* L.). Crop Res. 2000; 19(2):189-193.
2. Channal BK. Effect of organic and inorganic sources of nutrients on soil fertility and productivity of maize (*Zea mays* L). M.Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad, Karnataka (India), 2012.
3. Dastane NG. A Practical Manual for Water Use, Res. Agric. Navabharat Prakashan, Pune, 1967, 120.
4. Kalhapure AH, Shete BT, Dhonde MB. Integrated nutrient management in maize (*Zea mays* L.) for increasing production with sustainability. Int. J Agri. Food Sci. Technol. 2013; 4(3):195-206.
5. Pathak SK, Singh SB, Jha RN, Sharma RP. Effect of nutrient management on nutrient uptake and changes in soil fertility in maize (*Zea mays*)-wheat (*Triticum aestivum*) cropping system. Indian J Agron. 2005; 50(4):269-273.
6. Sparks. Methods of Soil Analysis Part 2: Chemical Methods, Soil Sci. Soc. America, Inc Publishers, Madison, Wisconsin, USA, 1996, 618.
7. Tetarwal JP, Baldevram, Meena DS. Effect of integrated nutrient management on productivity, profitability, nutrient uptake and soil fertility in rainfed maize (*Zea mays).* Indian J Agron. 2011; 56**(**4):373-376.
8. Usha rani I, Padmaja G, Chandrasekhar Rao P. integrated effect of organic manures and inorganic fertilizers on soil dehydrogenase enzyme activity and yield of maize-spinach cropping system, Crop Res. 2014; 46(1/2/3):39-43.
9. Vaisaki KC. Effect of integrated nutrient management on soil properties and performance of maize (*Zea mays* L.). M. Sc. (Agri.) Thesis, Agric. College, Bapatla, Hyderabad (India), 2012.
10. Walkley A, Black JA. An estimation of digestion method for determining soil organic matter and a proposed modification of chromic acid titration method. Soil Sci. 1934; 37:29-38.
11. Yoder RE. A direct method of aggregate analysis and a study of the physical nature of erosion losses. J American Soc. Agron. 1936; 28:337-351.