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Impact of Use Sewage Sludge in Agriculture on Physical Properties of Soil

Abubaker Mohamed Outhman[1]
[1.]*ph.D student on Department of Environmental Science, School of Forestry & Environment, SHIATS, Deemed University, Allahabad*

Abstract: Two cereal crops Barley (Hordeum *vulgare L.*,),Wheat (*Triticum astivum*)were grown to study the impact of sewage sludge on physical properties of soil. These plants were grown in twelve plots for each plant. And added different levels of sewage sludge (0Kg, 4 Kg, 8 Kg, 12 Kg) as manure to the plots with tree replicate for each level of sewage sludge the experiment was repeat twice in two seasons. The results shown that significant impact because of added the sewage sludge to soil in both years on bulk density, particle density, percentage pore space (% sand %silt & clay **,** soil texture) at depth 0-15cm and 15-30 cm depth.
Keywords: sewage sludge, soil, physical properties , wheat , barley .

I. Introduction

The ripped increase in population in among the world, make the human need more resource to produce more things to supply enough requirement, because of that it has been well recognized that environmental issues like global warming and ozone depletion. Soil is one of the most important and fundamental resources for human survival and development, land application of sewage sludge is both environmentally , economy is useful. (LI Wei-Xin et al., 2008). The large volume of solid and liquid waste as sewage sludge which contain different quantity and quality of organic matter, plant nutrients, The sewage sludge one of major source of nutrients (Yongjie Wei,et al 2005). Use of sewage sludge in agriculture is the most convenient practice of sludge disposal, It provides organic matter (O.M) to soil and this addition may represent a good alternative to prevent degradation of soils (Roldan et al., 1996) And use of sewage sludge in agriculture as a partial substitute of mineral fertilizers (Mona et, al,2013**)** and to improve many physical properties of agricultural soils such as water holding capacity, aeration, porosity and cation exchange capacity bulk density, particle density, percentage pore space (% sand %silt & clay) (Engelhart et al., 2000). the application of this residue offers the possibility of recycling plant nutrients with the beneficial effects on soil fertility and plant nutrition (Gascó and Lobo, 2007). wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally**.** Wheat is an edible grain, one of the oldest and most important of the cereal crops the aim of this study to investigate the impact of apply of sewage sludge on some of physical properties of soil grown by wheat and barley.

II. Material And Method:

The experiments were carried out during the growing seasons of 2012, 2014 at fields of school of forestry and Environment, Sam Higginbottom Institute of Agriculture & Technology Sciences –Deemed to be-University –Allahabad from October 2013 to April 2014.

Selected Experimental Site:

The field experiments plans to lay out on the Research farm of Department of Environmental Science, School of Forestry and Environment, SHIATS, Allahabad. The area is situated on the right bank adjacent to Yamuna River in south of Allahabad city, which is located at $25^0.80^{'}$ N Latitude and $81^0.50^{'}$ E Longitude and 98 meter above the sea level.

Climate And Weather Condition:

The area of Allahabad District comes under subtropical and semi arid climate. Due to subtropical climate prevailing in the south east part of U.P with the extremes in temperature dropping to 4 – 6^oC in December to January and very hot in summer with temperature ranging between 46-48 ^oC in the month of May to June.

Land Preparation:

The experimental field will be plan to prepared by ploughing twice with a tractor drawn disc plough followed by cross harrowing after one irrigation to give the soil sufficient moisture required for the germination

of the crop. The field was thoroughly leveled by a leveler. The ploughed field will be leveled and weeds, grasses are then removes with the help of rake, and then demarcation are complete according to the layout.

Treatment Combination:
Barley crop
T_1 = 00.00 Tonnes Sewage sludge, T_2 = 04.00 Tonnes Sewage sludge
T_3 = 08.00 Tonnes Sewage sludge, T_4 = 12.00 Tonnes Sewage sludge
Wheat crop
T_5 = 00.00 Tonnes Sewage sludge, T_6 = 04.00 Tonnes Sewage sludge
T_7 = 08.00 Tonnes Sewage sludge, T_8 = 12.00 Tonnes Sewage sludge

Statistical Analysis:
Randomized Block Design was used for statistical analysis. The experiment will be conducted in Randomized block design having eight treatments and three replications. For the two different crops (Wheat and Barley). .

Soil sampling:
All the soil samples were collected randomly from 0-15 soil depth and 15-30 soil depth The samples were mixed and its weight is reduced by air drying, quartering and passing it through 2mm sieve.

Collection and preparation of soil sample:
Soil sample were taken randomly from different place of the experimental field at 0-15 and 15-30 cm depth. The samples collected from field were mixed depth wise, weight was reduced by air drying and passing it through 2mm sieve. The samples were sieved to obtain the composite soil sample in respective depths thereafter samples were stored for mechanical analysis. The soil samples were analyzed for mechanical separates (% sand, %silt & clay), the bulk density and particle density were determined depth wise by core method (Black, 1965).

III. Result And Discussion:

1: Effect of different levels of sewage sludge on bulk density (g/cc) of soil at 0-15 and 15-30 cm after crop harvest:

The table and figure (1) shows that the effect of sewage sludge on bulk density (g/cc) of post harvest soil at 0-15 and 15-30 cm depth in 2012 and 2013 found significant. The table and figure 4.7 shows that the effect of sewage sludge on bulk density (g/cc) of post harvest soil at 0-15 and 15-30 cm depth in 2012 and 2013 found significant. The effect of sewage sludge on bulk density at 15-30 cm depth was also found significant as found on 0-15.The maximum bulk density of soil 1.36 & 1.38 g/cc at 15-30 cm in 2012 & 13 was recorded in T_0 (04.00 Tones Sewage sludge + wheat) followed by 1.35 and 1.37 g/cc in T_1 (00.00 Tones Sewage sludge+ wheat) and minimum bulk density of soil 1.30 and 1.31g/cc was found in T_7 (12.00 Tones Sewage sludge+ barley). Increasing the dose of sewage sludge application significantly decreased the bulk density due to saturation percentage, porosity and organic matter content in alluvial soil. This may be due to high organic matter content in sewage sludge. The reduction of bulk density as a result of sewage sludge application may be due to homogenous distribution of manure constituents between soil particles and also the decomposition by microorganism, produce many essential cementing materials that can link the soil particles and forming soil aggregates. On other hand due to sufficient soil nutrients availability is also enhancing the root spread and organic matter into the soil. Similar results were obtained by **Mendoza *et al.* (2006) and Prakash *et al.* (2009)**.Organic matter added to the soil as Sewage sludge composts improve the soil properties, such as bulk density, porosity and water holding capacity **Parkpain*et al.*1998**) **Yanchan*et al.*(2013)**,**Surajit*et al.* (2015).**

Table 1: Effect of different levels of sewage sludge on bulk density (g/cc) of soil at 0-15 and 15-30 cm depth after crop harvest.

Treatments	0-15 cm soil depth			15-30 cm soil depth		
	2012-13	2013-2014	Pooled	2012-13	2013-2014	Pooled
T_0	1.34	1.35	1.35	1.36	1.38	1.37
T_1	1.33	1.34	1.34	1.35	1.37	1.36
T_2	1.32	1.33	1.33	1.34	1.35	1.35
T_3	1.31	1.32	1.32	1.33	1.34	1.34
T_4	1.34	1.35	1.35	1.34	1.36	1.35
T_5	1.32	1.33	1.33	1.33	1.35	1.34
T_6	1.31	1.32	1.32	1.32	1.34	1.33
T_7	1.29	1.30	1.30	1.30	1.31	1.31

F-test	S	S	S	S	S	S
S.Ed (±)	0.013	0.013	0.012	0.012	0.018	0.011
C.D at (P=0.05)	0.027	0.028	0.024	0.025	0.038	0.023

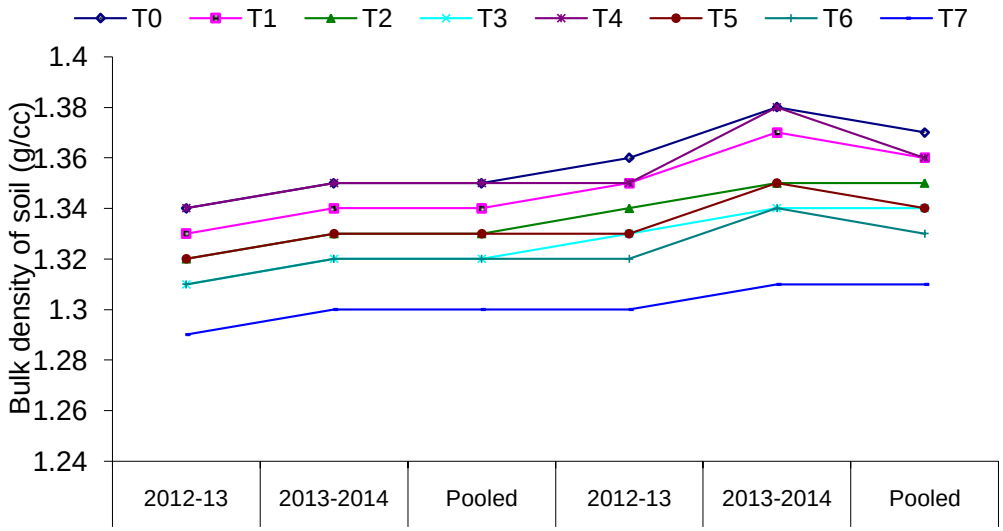

Fig 1 :Effect of different levels of sewage sludge on bulk density (g/cc) of soil at 0-15 and 15-30 cm depth after crop harvest.

2: Effect of different levels of sewage sludge on particle density (g/cc) of soil at 0-15 and 15-30 (cm) after crop harvest:

The table (2) and figure (2) depicted that the effect of sewage sludge on particle density (g/cc) of past harvest soil at 0-15 and 15-30 cm depth in 2012 & 2013 was found non-significant in 2012 at 0-15 cm depth, the pooled values of particle density at 0-15 cm depth in 2013 was also found non-significant. The table (4.8) and figure (4.8) depicted that the effect of sewage sludge on particle density (g/cc) of past harvest soil at 0-15 and 15-30 cm depth in 2012 & 2013 was found non-significant in 2012 at 0-15 cm depth

As theses indicates an enrichment of fine fraction i.e. silt and clay apart from the retention of dissolve organic matter leading to change in porosity, it brings significant increases in percentage pore space of post harvest soil of wheat and Barley grown plot. Similar findings had also been reported by **Malla and Totawat (2006); Tarchizky*et al.* (1999) and Shende (1984).**

Table 2: Effect of different levels of sewage sludge on particle density (g/cc) of soil at 0-15 and 15-30 cm depth after crop harves

Treatments	0-15 cm soil depth			15-30 cm soil depth		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
T_0	2.31	2.30	2.31	2.56	2.55	2.56
T_1	2.36	2.34	2.35	2.57	2.59	2.58
T_2	2.41	2.40	2.41	2.60	2.60	2.60
T_3	2.43	2.42	2.43	2.65	2.65	2.65
T_4	2.31	2.30	2.31	2.56	2.55	2.56
T_5	2.36	2.34	2.35	2.57	2.59	2.58
T_6	2.41	2.40	2.41	2.61	2.60	2.61
T_7	2.43	2.42	2.43	2.65	2.65	2.65
F-test	S	S	S	NS	S	NS
S. Ed. (±)	0.009	0.012	0.009	-	0.016	-
C. D. at (P=0.05)	0.019	0.026	0.018	-	0.032	-

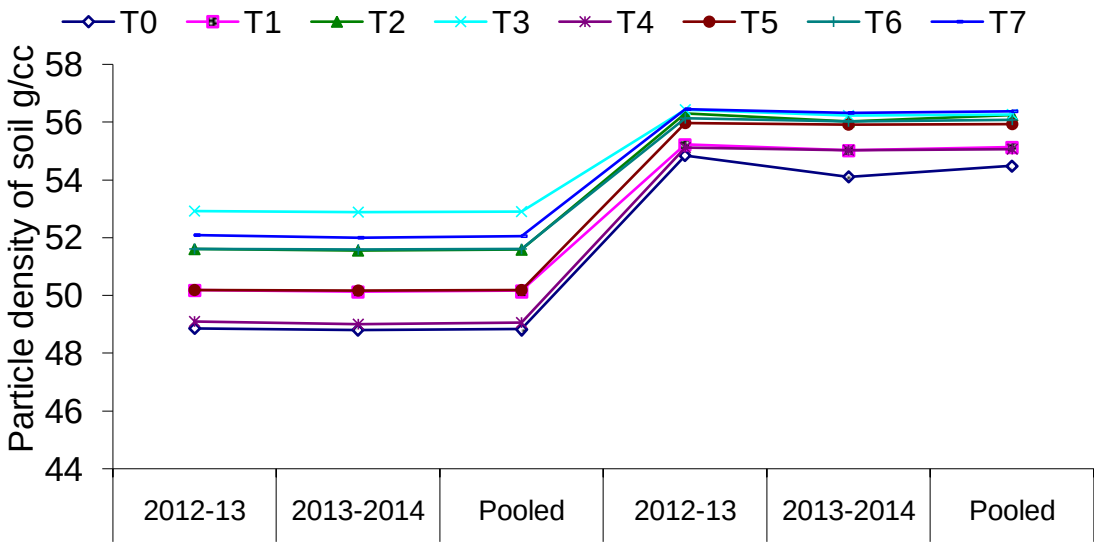

Fig 2.Effect of different levels of sewage sludge on particle density (g/cc) of soil at 0-15 and 15-30 cm depth after crop harvest.

3:-Effect of different levels of sewage sludge on percentage pore space of post- harvest soil at 0-15 and 15-30 cm depth after crop harvest .

The table and figure (3) shows the effect of sewage sludge on percentage pore space of post harvest soil at 0-15 and 15-30 cm depth in 2012 & 2013 was found significant. The maximum percentage pore space 56.44 and 56.31% at 0-15 cm depth in 2012 and 2013 was recorded in T_7 (12.00 Tones Sewage sludge+ barley) followed by 55.11 and 55.01% in T_4 (00.00 Tones Sewage sludge+ barley) and minimum soil percentage pore space of soil 54.84 & 54.11 % were found in T_o (00.00 Tones Sewage sludge+ wheat). The effect of sewage sludge on percentage pore space at 15-30 cm depth was also found significant as found on 0-15cm depth. The maximum percentage pore space of soil 52.91 and 52.88% at 15-30 cm in 2012 and 13 was recorded in T_7 (12.00 Tones Sewage sludge+ barley) followed by 52.10 and 52.00% in T_3 (12.00 Tones Sewage sludge+ wheat) and minimum percentage pore space of soil 48.86 and 48.80% was found in T_0 (00.00 Tones Sewage sludge +wheat. As theses indicates an enrichment of fine fraction i.e. silt and clay apart from the retention of dissolve organic matter leading to change in porosity, it brings significant increases in percentage pore space of post harvest soil of wheat and Barley grown plot. Similar findings had also been reported by **Malla and Totawat (2006); Tarchizky*et al.*, (1999); Shende (1984)**

Table 3: Effect of different levels of sewage sludge on percentage pore space of soil at 0-15 and 15-30 (cm)

Treatments	0-15 cm soil depth			15-30 cm soil depth		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
T_0	54.84	54.11	54.48	48.86	48.80	48.83
T_1	55.22	55.01	55.12	50.18	50.12	50.15
T_2	56.29	56.01	56.23	51.59	51.54	51.57
T_3	56.43	56.23	56.26	52.10	52.00	52.05
T_4	55.11	55.01	55.06	49.11	49.01	49.06
T_5	55.96	55.90	55.93	50.17	50.16	50.17
T_6	56.12	56.01	56.07	51.61	51.59	51.60
T_7	56.44	56.31	56.37	52.91	52.88	52.90
F-test	S	S	S	S	S	S
S. Ed. (±)	0.063	0.039	0.042	0.011	0.030	0.015
C. D. at (P=0.05)	0.129	0.080	0.087	0.023	0.061	0.032

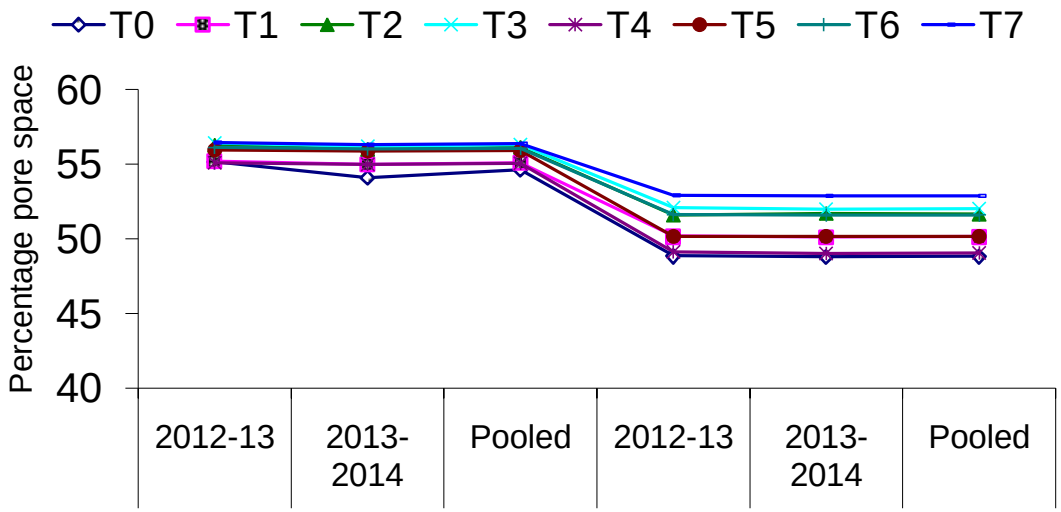

Fig.3. Effect of different levels of sewage sludge on percentage pore space of soil at 0-15 and 15-30 cm soil depth.

4.10 Effect of different levels of sewage sludge on percent sand of post-harvest soil at 0-15 and 15-30 cm soil depth

The table (4.10) and figure 4.10 depicted the effect of sewage sludge on percent sand of post harvest soil at 0-15 and 15-30 cm depth in 2012 and 2013 was found significant. The maximum percent sand 64.40 and 64.30% at 0-15 cm depth in 2012 and 2013 was recorded in T_0 (00.00 Tones Sewage sludge+ wheat) which was at par with 64.30 and 64.20% in T_4 (00.00 Tones Sewage sludge+ barley) and minimum percent sand 64.00 and 63.70% was found in T_7 (12.00 Tones Sewage sludge + barley). Similarly the maximum percent sand 64.35% in pooled values was recorded in T_0 and minimum 63.85% in T_7 (12.00 Tones Sewage sludge + barley).

The effect of sewage sludge on percent sand of post harvest soil at 15-30 cm depth was also found significant as found on 0-15cm.The maximum soil percent sand 64.30 and 64.20% at 15-30 cm depth in 2012 and 2013 was recorded in T_0 (00.00 Tones Sewage sludge+ wheat) which was at par with 64.20 and 64.10% in T_4 (00.00 Tones Sewage sludge+ wheat) and minimum percent sand of soil 63.70 and 63.80% found in T_7 (12.00 Tones Sewage sludge+12.00 Tones Sewage sludge + barley). The pooled values also indicating the maximum percent sand 64.25% in T_0 and minimum 63.76% in T_7.

The percent sand of post harvest soil in the plots grown with Wheat and Barley it also decreases with increases soil depths, because sewage sludge contain higher amount of silt and clay particle, it brings significant increases in percent of silt and clay particles of post harvest soil of Wheat and Barley grown plot. Similar findings had also been reported by **Malla and Totawat (2006); Tarchitzy*et al.* (1999); Shende (1984).**

Table 4.10: Effect of different levels of sewage sludge on % sand of post-harvest soil at 0-15 and 15-30 cm soil depth.

Treatments	0-15 cm soil depth			15-30 cm soil depth		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
T_0	64.40	64.30	64.35	64.30	64.20	64.25
T_1	64.20	64.20	64.20	64.10	64.00	64.05
T_2	64.10	64.00	64.05	64.00	63.80	63.90
T_3	64.00	63.90	63.95	63.90	63.80	63.85
T_4	64.30	64.20	64.25	64.20	64.10	64.15
T_5	64.20	64.00	64.10	64.10	64.00	64.05
T_6	64.10	63.90	64.00	64.00	63.90	63.95
T_7	64.00	63.70	63.85	63.83	63.70	63.76
F-test	S	S	S	S	S	S
S. Ed. (±)	0.166	0.146	0.136	0.126	0.123	0.090
C. D. at (P=0.05)	0.342	0.302	0.280	0.261	0.254	0.186

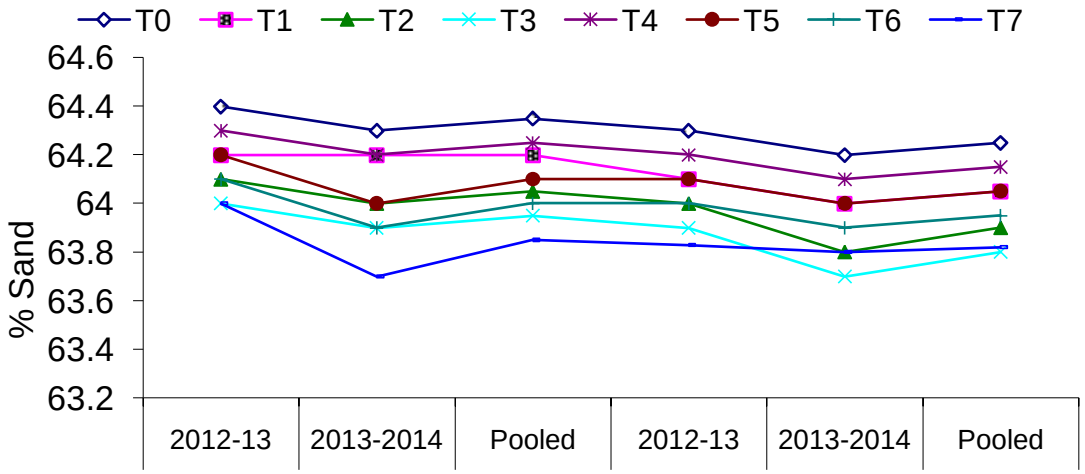

Fig 4.10.Effect of different levels of sewage sludge on % sand of post-harvest soil at 0-15 and 15-30 cm depth.

4.11:- Effect of different levels of sewage sludge on percent silt of post-harvest soil at 0-15 and 15-30 (cm) .

The table (4.11) and figure 4.11 depicted the effect of sewage sludge on percent silt of past harvest soil at 0-15 and 15-30 cm depth in 2012 and 2013 was found significant. The maximum percent silt 23.70 and 24.70% at 0-15 cm depth in 2012 and 2013 was recorded in T_1 (04.00 Tones Sewage sludge+ wheat) which was at par with 23.40 and 23.40% in T_3 (12.00 Tones Sewage sludge+ wheat) and minimum soil percent silt 23.20 and 23.10% in T_7 (12 .00 Tones Sewage sludge+ barley). Similarly the pooled values were also indicated the maximum percent silt 24.60% was recorded in T_4 and T_0 and minimum percent silt 23.25 % was found in T_7.

The effect of sewage sludge on percent silt of post harvest soil at 15-30 cm depth was also found significant. The maximum percent silt of soil 24.50 and 24.70% at 15-30 cm in 2012 and 2013 was recorded in T_0 (00.00 Tones Sewage sludge+ wheat) which was at par with 24.50 and 24.70% in T_4 (00.00 Tones Sewage sludge+ barley) and minimum percent silt of soil 23.70 and 24.10% was found in T_7 (12.00 Tones Sewage sludge+ barley). The pooled values were also indicating the maximum percent silt 24.60% in T_4 and minimum 23.85% in T_3.

Percent silt of post harvest soil of the plots grown with Wheat and Barley it also decreases with increases soil depths. It may due to sewage sludge contain higher amount of silt particles, it brings significant decreases in percent of sand particles of post harvest soil of Wheat and Barley grown plot. Similar findings were also reported by **Malla and Totawat (2006); Tarchitzy*et al.* (1999); Shende (1984).**

Table 4.11:- Effect of different levels of sewage sludge on % silt of post-harvest soil at 0-15 & 15-30 depth cm:

Treatments	0-15 cm			15-30 cm		
	2012-13	2013-2014	Pooled	2012-13	2013-2014	Pooled
T_0	23.70	23.70	23.70	24.50	24.70	24.60
T_1	23.80	23.60	23.70	24.00	24.20	24.10
T_2	23.50	23.30	23.40	23.80	24.10	23.95
T_3	23.40	23.40	23.40	23.70	24.00	23.85
T_4	23.70	23.70	23.70	24.50	24.70	24.60
T_5	23.80	23.90	23.85	24.20	24.50	24.35
T_6	23.30	213.40	23.35	24.00	24.20	24.10
T_7	23.20	23.10	23.25	23.70	24.10	243.00
F-test	S	S	S	S	S	S
S. Ed. (±)	0.146	0.202	0.103	0.115	0.058	0.064
C. D. at (P=0.05)	0.302	0.417	0.213	0.237	0.119	0.132

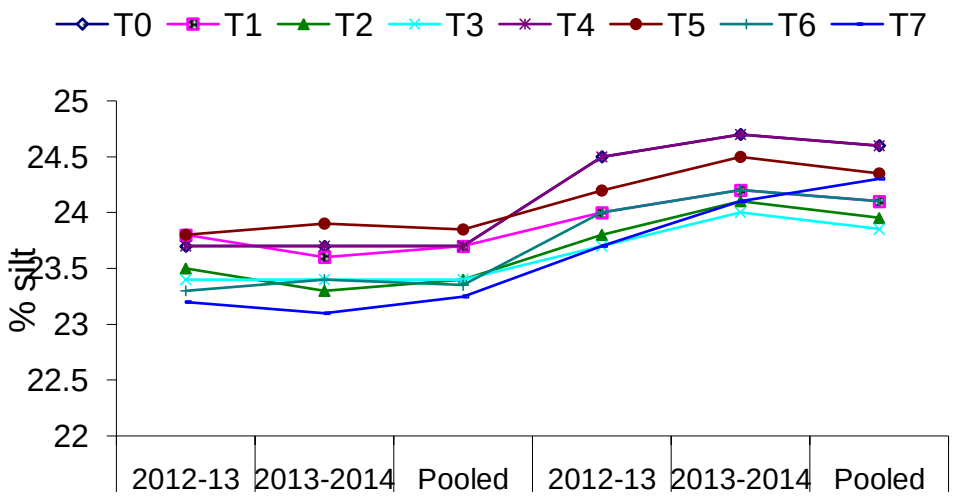

Fig 4.11. Effect of different levels of sewage sludge on % silt of post-harvest soil at 0-15 and 15-30 cm depth

4.12 Effect of different levels of sewage sludge on percent clay of post-harvest soil at 0-15 and 15-30 cm soil depth.

The table (4.23) and figure (4.23) depicted that the effect of sewage sludge on percent clay of post harvest soil at 0-15 and 15-30 cm depth in 2012 and 2013 was found significant. The maximum percent clay 12.80 and 13.00 % at 0-15 cm depth in 2012 & 2013 was recorded in T_7 (12.00 Tones Sewage sludge+ barley) which was at par with 12.60 and 12.70% in T_4 (00.00 Tones Sewage sludge+ barley) and minimum percent clay of soil 11.50 and 11.70% was recorded in T_0 (00.00 Tones Sewage sludge+ wheat). Similarly the maximum percent clay 12.90 % in pooled values was recorded in T_7 and minimum 11.60 % in T_4.

The effect of sewage sludge on percent clay of soil after crop harvest at 15-30 cm depth was also found significant as found on 0-15.The maximum percent clay 12.40 and 12.30% at 15-30 cm depth in 2012 and 2013 was recorded in T_4(00.00 Tones Sewage sludge+ wheat) which was at par with 12.30 and 12.10 % in T_7 (12.00 Tones Sewage sludge+ barley) and minimum percent clay of soil 11.30 and 11.20 % was found in T_0 (00.00 Tones Sewage sludge+ wheat). The pooled values were also indicating the maximum percent clay 12.35 % in T_3 and minimum 11.25% in T_4.

The percent clay of post harvest soil of the plots grown with Wheat and Barley also increases with increases soil depths. It is due to sewage sludge contain higher amount of clay particles, it brings significant increases in percent of sand particles of post harvest soil of Wheat and Barley grown plot. Similar findings had also been reported by **Malla and Totawat (2006); Tarchitzy*et al.* (1999); Shende (1984).**

Table 4.12: Effect of different levels of sewage sludge on % clay of post-harvest soil at 0-15 and 15-30 cm soil depth.

Treatments	0-15 cm soil depth			15-30 cm soil depth		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
T_0	11.50	11.70	11.95	11.30	11.20	11.75
T_1	12.00	12.20	12.10	11.90	11.80	11.85
T_2	12.40	12.60	12.50	12.20	12.10	12.15
T_3	12.60	12.70	12.65	12.40	12.30	12.35
T_4	11.90	12.00	11.60	11.80	11.70	11.25
T_5	12.00	12.10	12.05	11.70	11.50	11.60
T_6	12.60	12.70	12.65	12.00	11.90	11.95
T_7	12.80	13.00	12.90	12.30	12.10	12.20
F-test	S	S	S	S	S	S
S. Ed. (±)	0.328	0.201	0.189	0.153	0.121	0.105
C. D. at (P=0.05)	0.676	0.416	0.390	0.316	0.250	0.216

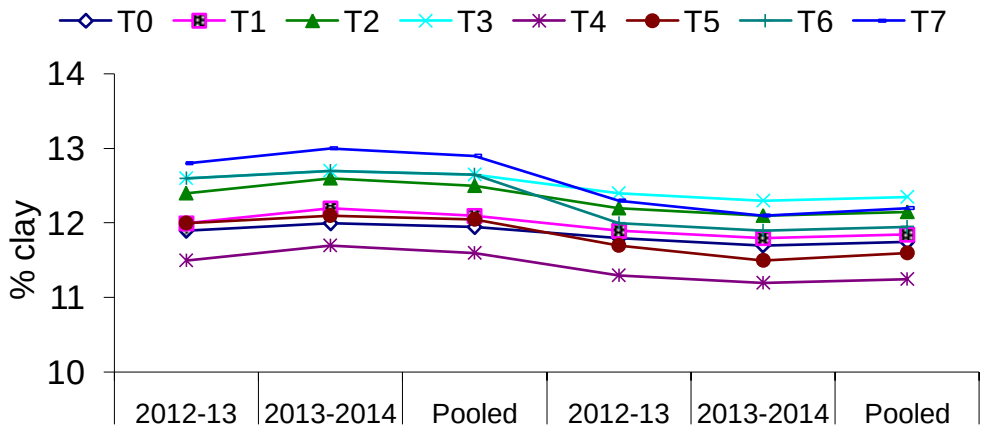

Fig 4.12 Effect of different levels of sewage sludge on % clay of post harvest soil at 0-15 and 15-30 cm dept

Effect of different levels of Sewage sludge on soil texture of past harvesting at 0-15 and 15-30 cm soil depth.

The results depicted in table 4.13 shows that the effect of different levels of sewage sludge on texture of post harvest soil at depth 0-15 and 15-30 cm depth in 2012 and 2013, was found from the data analyzed, on the basis of percent sand, silt and clay particles and these percentage were plotted on texture triangle. The results found the texture of post harvest soil was sandy loam and the trend of increase the silt and clay particle with every higher levels of sewage sludge improve the texture of soil and the texture is also improved with increase in soil depth.

Table 4.13 Effect of different levels of sewage sludge on soil texture of post harvesting at 0-15 and 15-30 cm soil depth .

Treatments	0-15 cm soil depth				15-30 cm soil depth			
	2012-2013				2013-2014			
	% sand	% silt	% clay	Soil texture	% sand	% silt	% clay	Soil texture
T_0	64.35	24.20	11.95	S.L.	64.25	24.60	11.75	S.L.
T_1	64.20	23.70	12.10	S.L.	64.05	24.10	11.85	S.L.
T_2	64.05	23.40	12.50	S.L.	63.90	23.95	12.15	S.L.
T_3	63.95	23.40	12.65	S.L.	63.80	23.85	12.35	S.L.
T_4	64.25	24.20	11.60	S.L.	64.15	24.60	11.25	S.L.
T_5	64.10	23.85	12.05	S.L.	64.05	24.35	11.60	S.L.
T_6	64.00	23.35	12.65	S.L.	63.95	24.10	11.95	S.L.
T_7	63.85	23.25	12.90	S.L.	63.82	24.00	12.20	S.L.

IV. Summary & Conclusion:

The currently investigate shown that the physical properties of post harvest soil such as bulk density, particle density, percentage pore space and soil texture were very slight change by using of sewage sludge where as the effect is increase by increase dose of sewage sludge whit both crops Barley and wheat within two seasons. The high effect was in the treatment 7 and the less effect in the treatment 0.

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