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Effect of tillage practices on soil parameters

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Abstract
The experiment was carried out at agriculture farm of Sardar Vallabbhai Patel University of Agriculture and Technology, Meerut for comparative study of various tillage practices and its effect on the soil parameters. The three different tillage treatment T_0 [No tillage], T_1 [Disc Plough (1) + Disc Harrow (2)], T_2 [Cultivator (1) + Rotavator (1)] and T_3 [Rotavator (2)] were fixed and replicated three times. The various soil parameters like Moisture Content, Bulk Density, Soil Inversion, Soil Pulverisation and Cone Index were determined. It is clear from the obtained data that the effect of tillage on the soil parameters was positive. The treatment T_2 was found to be more effective than T_1 and T_3 In future, production of crops in various treatments should be carried out to check more accurate effect of tillage on it also.

Keywords: Treatments, future, carried

Introduction
Tillage is a crucial agriculture practice that involve preparing the soil for planting by breaking, loosening and aerating it. The importance of tillage lies in its ability to: improve soil structure and fertility, enhance seed germination and root growth, controls weeds and peasts, increase water infiltration and reduce erosion and promote healthy crop growth and yields. Effective tillage helps create a favorable soil environment, leading and improved crop productivity, reduce soil degradation and sustainable agriculture practices.
There are different types of tillage practices like conventional tillage, reduced tillage, No till, Conservation tillage...etc. Each tillage practice has its advantages and dis advantages. The choice depends on factors like soil type, climate crop selection and equipment availability. Presently, there many advanced tillage tool, implements and machineries are available for the tillage operation which has different types of effect over the soil.
The present study was conducted to examine the effect of various tillage practices over the soil parameters so that it may be easy for the farmers to select the best tillage practice according to the need.

Material and Methods
The experiment was carried out in research farm of Agriculture College, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. The farm was located at 29.0748° N latitude and 77.7082° E longitude. The soil type of the farm was observed as clay loam and the total area of field was selected as 3366 m^2 and divided into nine blocks of 300 m^2 each. The three treatments were selected and replicated three times to bring the more accuracy in to the results. It was confirmed that before start of experiment there was not a single tillage operation conducted on selected field area after the harvest of last crop i.e. wheat crop. The gap of 3m maintained was between each block and from the roadside also. The detail of the selected area is shown in Table 1 and layout is shown in Figure 1

Table1: The details of the experimental field

S. No	Particular	Data
1	Total Field Size	3366 m2
2	Soil Type	Clay-Loam
3	Size Of Each Block	15 m *20 m
4	Side Road Direction	North
5	Pre – Harvested Crop	Wheat
6	Location	29.0748° N and 77.7082° E

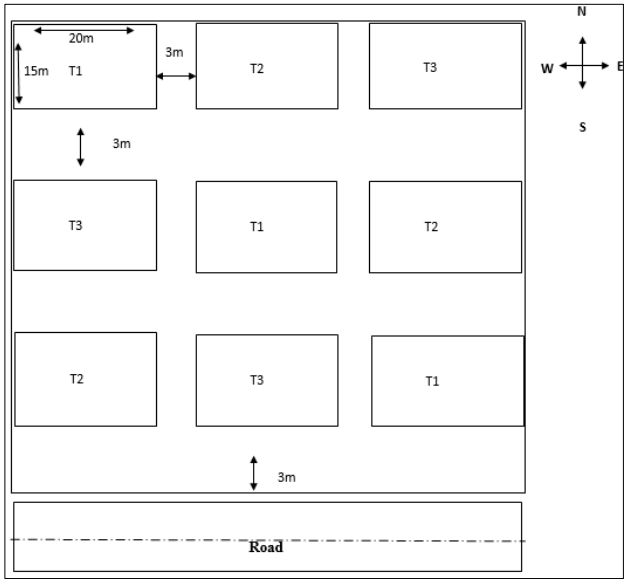

Fig 1: Layout of the field area

Field Size = 3366 m^2(65 m*51 m)

Block Size = 300 m^2(15 m*20 m)

Gap between the block = 3 m

Treatments Selected

The three treatments were selected to examine the effect of various tillage practices on the soil parameters.

Table 2: Details of the tillage treatments

S. No	Treatment	Details
1.	T_o	No Tillage
2.	T_1	Disc Plough (1) +Disc Harrow (2)
3.	T_2	Cultivator (1) + Rotavator (1)
4.	T_3	Rotavator (2)

Parameters Under Study

To evaluate the effect of various tillage practices on soil parameters were determined on the basis of data collected. The various parameters under study are show in Table 3.

Procedure Followed and Equipment/Implement Used

The various soil parameters were recorded before start of the tillage operation under the T_o then, tillage treatment were carried out in the sequence i.e. T_1, T_2 and T_3 in the selected ways and the speed of operation and gear set for various operation fixed is shown in Table 4 and the data was collected by standard procedure with the help of various equipment as described below.

Table 3: Details of various parameters under study

S. No.	Particular	Details
1.	Soil Parameter	1. Soil Moisture (%) 2. Bulk Density (g/cm^3) 3. Cone Index (%) 4. Soil Pulverization (%) 5. Soil Inversion (%)

Table 4: Details of the speed and gear setting during operation

Implement	Speed of Operation (km/hr)	Gear Selected
Disc plough	7	2(low)
Disc Harrow	10	2(low)
Cultivator	10	2(low)
Rotavator	15	2(low)

Moisture Content (%), (ASTM D-2216)

Apparatus

a) Crucibles - 200 ml
b) Electric drying oven - 2.8 Kw
c) Desiccator - Borosilicate glass
d) Weighing balance – 5 kg
e) Tongs – Steel

Procedure

The weight of sample before drying (M_1) and after drying (M_2) were measured by drying the sample for 24 hours at 110°C in oven.

Formula used

The following formula was used for calculating moisture content

$$W = \frac{M2-M3}{M3-M1} \times 100 \quad \ldots (3.1)$$

Where,
M_1 = Mass of empty moisture can with lid.
M_2 = Mass of the moisture can with wet soil and lid.
M_3 = Mass of the moisture can with dry soil and lid.

Bulk Density (g/cm^3), (ASTM D2937)

Apparatus Used

The detail of the apparatus used is as follows and shown in Plate 1
Cylindrical steel core cutter – 130 mm in height and 100mm diameter.
Steel dolly - 27 mm high and 100 mm in diameter.
Steel hammer - 5 kg in weight and 1700mm in high.
Weighing balance - 10 kg.
Knife - 120 mm in length
Steel ruler - 30 cm
Spade or pickaxe - T-shaped
Oven – 1100 °C temperature electrical oven

Plate 1: Core cutter apparatus

Procedure
Bulk density is determined by taking un-compacted soil sample of known volume by using the following procedure. Determine the internal diameter and height of core cutter place the dolly over the top of core cutter and press the core cutter into the soil using hammer remove the soil surrounding the core cutter and take out core cutter soil would project from the lower end of the core cutter remove the dolly and cut the tip and determining the density of the following soil sample.

Calculate the area (a) of cross-section of the core cylinder, cm^2;

$$A = \pi d^2 \div 4 \quad \ldots. (3.2)$$

The volume (V) was calculated of the core cylinder by following equation

$$V = A \times h \quad \ldots. (3.3)$$

Formula used
Dry Bulk Density (BD) of soil is the ratio of dry soil to the total volume of soil (including particles and pores). Which was calculated by using following equation 3.4

$$BD = \frac{Ws}{Vt} = \frac{Ws}{Va+Vs+Vw} \quad \ldots. (3.4)$$

Where,
B_D= Bulk density, gm/ cm^3
W_S=Dry weight of soil, gm
V_T=Total volume of soil, cm^3
V_S=Volume of soil solids, cm^3
V_A=Volume of air, cm^3
V_W=Volume of water, cm^3
Soil Inversion (%), Rao, A.N. (2016)

Procedure
The $1m^2$ iron bar was randomly placed in field before and after the tillage, operations and the number of weeds were counted in both conditions. The reading were replicated three times and the average value was calculated by putting in equation number 3.5.

Formula used
It is find out by subtracting the number of weed treated after tillage from number of weed before tillage and divided by number weed before tillage multiply by 100. It is expressed in percentage.

$$SI = \frac{(Nb - Ne)}{Nb} \quad \ldots. 3.5$$

Where,
SI = Soil inversion indicator
N_b = Number of weed or crop stubbles per unit area before tillage operation
N_e = Number of weed or crop stubbles exposed on the surface after operation

Soil Pulverization, Gee, G.W. (2002)
Apparatus
Sieves analyser of size (2,2.8,4,5.6,8,11.2)

Procedure
Used different sets of sieves for finding mass mean diameter (MMD) of the clods formed during the operation of implements by using relationship in equation 3.6

Formula used

$$MMD = \frac{W1+2.4W2+3.4W3+4.8W4+6.8W5+9.6W6+XW7}{W} \quad \ldots. (3.6)$$

Where
MMD = Mass mean diameter, mm
$W = (W_1+W_2+W_3+W_4+W_5+W_6+W_7)$

X = mean diameter of soil clods retained on the largest aperture sieve, mm

Cone Index (%), ASABE, 2012
Apparatus
Cone Penetrometer

Procedure
To find out Cone index is an indication of soil hardness and is expressed as force per unit area required for penetrating a cone into the soil. We measured cone index by using cone penetrometer up to a depth of 134 mm. The diameter and height of cone were measured and then surface areas of cone was calculated by using the following formula 3.7.

Formula used

Surface area of cone, $A = \pi rl + \pi r^2$ …. (3.7)

Where,
r = Radius of cone
l = Slant height of cone

Results and Discussion
The various results obtained during the experiment is shown and discussed in this chapter below:

Soil Parameters
Moisture Content (%)
The moisture Content of the various treatment were determined in percentage and shown in Table 10. It is clear from the table that the reduction in the moisture content was observed in various tillage treatments as compared to the no tillage condition which may be due to removal of the moisture by the atmospheric condition of the soil get pored by tillage operation. Also, it was observed that the minimum moisture content was found in the treatments T_2 that may be due to the combine effect of cultivator + rotavator. The grahical representation of the moisture content of the various texture is shown in Figure. 2.

Table 10: Moisture content of various tillage treatments

S. No.	Trials	Treatment			
		T_o	T_1	T_2	T_3
1.	R_1	11.69	8.65	6.59	8.12
2.	R_2	10.22	8.26	6.78	7.8
3.	R_3	9.52	8.05	7.02	8.2
4.	Avg.	10.47	8.32	6.97	8.04

Bulk Density (g/cm^3)
The bulk density of the soil was determined by core cutter method for various tillage treatments, which is shown in Table 11. It is clear from the Table 11 that there is reduction in the bulk density after the various tillage treatments as compare to no tillage condition, which may be due to the effect of tillage making the soil airier and pores. The maximum bulk density was closed after tillage in treatment T_1 while the minimum value was observed in T_2 which may be due to rotary effect of rotavator making the more soil pulverization as compared to disc harrow. The graphical representation of which is also shown in figure 3.

Table 11: Bulk density for various tillage treatments

S. No.	Trials	Treatment			
		T_o	T_1	T_2	T_3
1.	R_1	1.55	1.29	1.2	1.29
2.	R_2	1.6	1.32	1.18	1.32
3.	R_3	1.52	1.34	1.2	1.28
4.	Avg.	1.55	1.31	1.19	1.29

Cone Index (%)
Soil cone index was determined with the help of the cone penetrometer for various tillage treatments and the value in percent reduction of soil cone index was determined and is shown in Table 12 and Figure 4. It is clear from the Table 4.3 that the maximum reduction of index was observed treatments T_3 follow treatment T_2 and T_1.

Table 12: Soil cone index of various tillage treatments

S. NO.	Treatment	SCI before tillage (kPa)	SCI after tillage (kPa)	Reduction of SCI (%)
1.	T_1	1464	1160	20.7
2.	T_2	1464	1020	30.32
3.	T_3	1464	940	35.79

Soil Pulverisation
The soil pulverisation was determined on the basis of soil mean mass diameter (mm) with sieve shaker method. The determined value of SMMD is shown in Table 13 and the graphical representation of which is shown in Figure 5. It is clear from the data that maximum of SMMD was observed in treatment T_1 followed by T_2 and T_3. It may be due to the reason that application of disc harrow in T_1 and operation in case of T_2 and T_3. Rotavator pulverize the soil more as compared to the disc harrow as shown in Table 13 and Figure 5

Table 13: Soil pulverisation of various tillage treatments

S. No.	Treatment	Depth of Operation (mm)	Smmd (mm)
1.	T_1	150	15.06
2.	T_2	130	3.10
3.	T_3	100	2.312

Soil Inversion (%)
The soil inversion is determined on the basis of number of weed in plot remaining over the soil surface before and after the tillage, which is shown in Table 14. It is clear from the Table 14 that there is positive effect of all tillage treatments over the soil inversion. The smaller number of weeds plots was observed in tillage treatment T_2 and T_3 as compare to T_1 which may be due to the more soil inversion by the rotavator as compare to disc harrow. The graphical representation of soil inversion is also shown in Figure 6

Table 14: Soil inversion of various tillage treatment

Trials	T_o	T_1	T_2	T_3
R_1	45	4	1	0
R_2	47	5	0	0
R_3	42	3	2	3
Avg	44	4	1	1
%	100	9.09	2.2	2.2

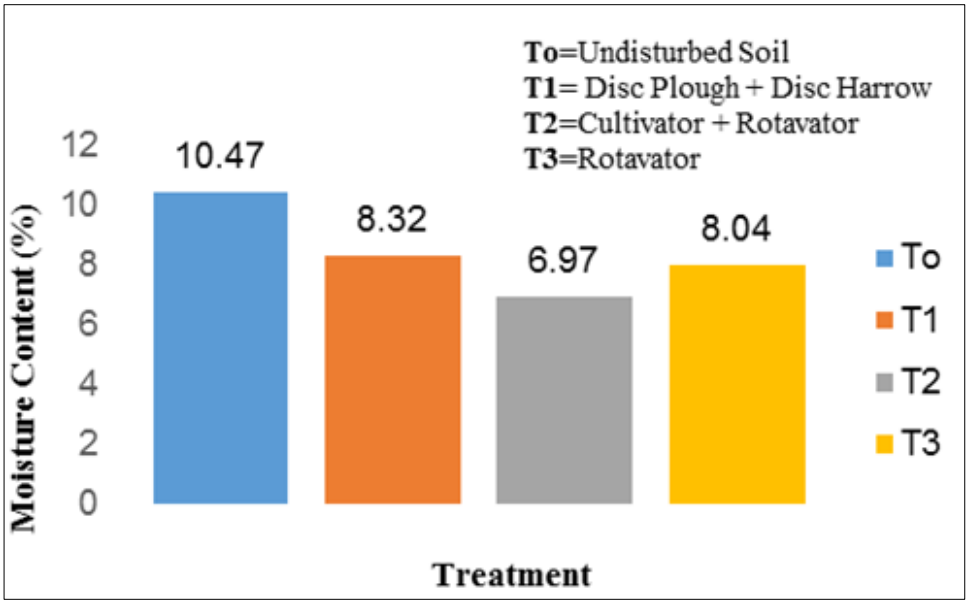

Fig 2: Moisture content of various tillage treatments

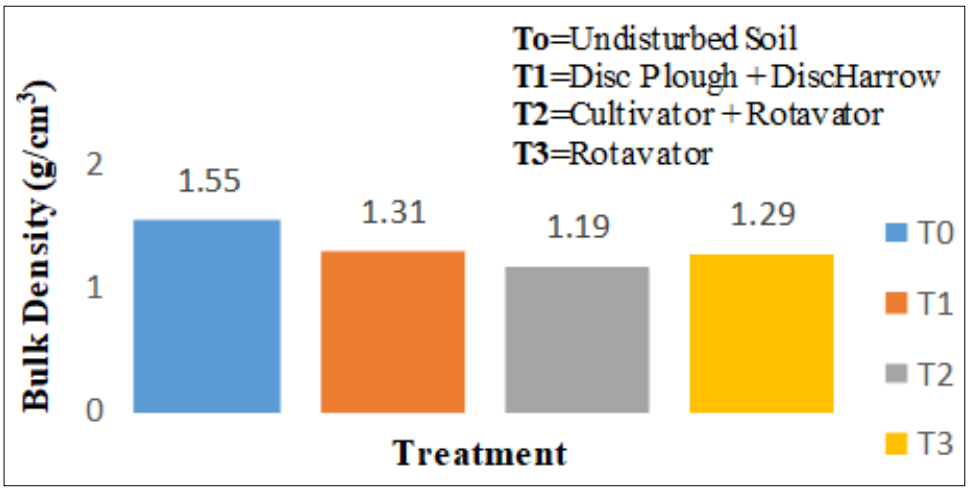

Fig 3: Bulk density of various tillage treatments

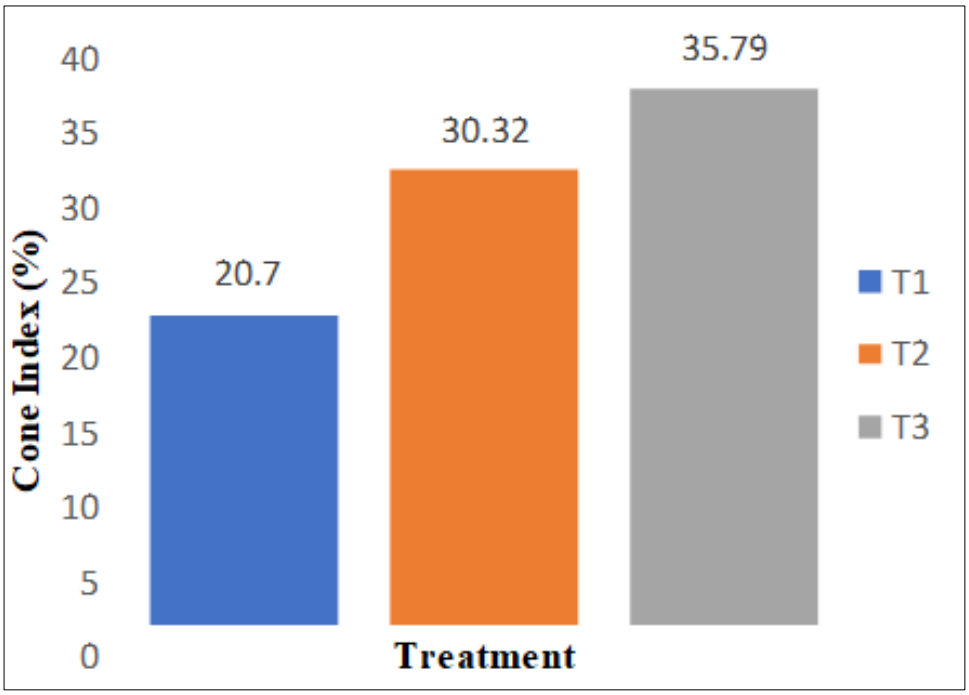

Fig 4: Cone index of various tillage treatments

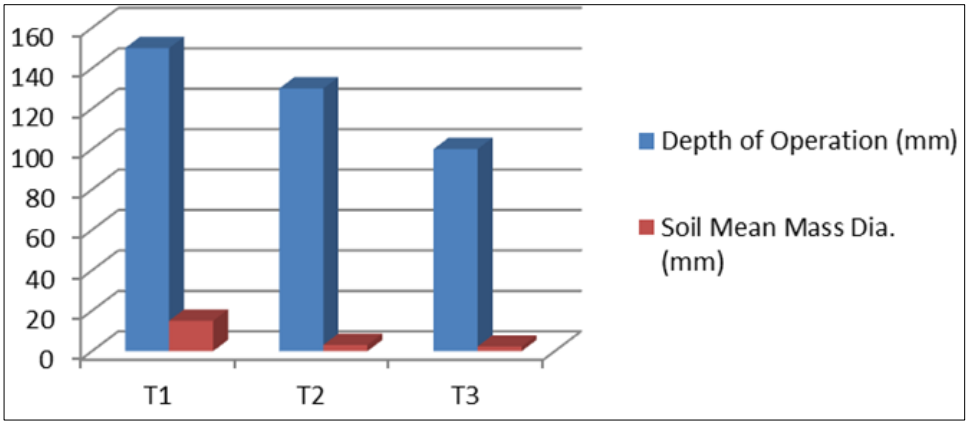

Fig 5: Soil mean mass diameter (SMMD) of various tillage treatments

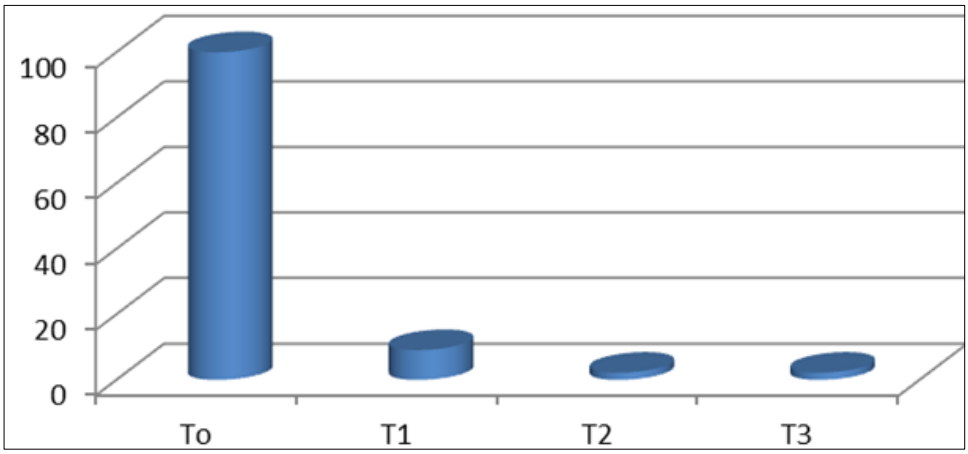

Fig 6: Soil mean mass diameter (SMMD) of various tillage treatments

Summary and Conclusion

It is clear from the obtained data that the minimum bulk density was observed in treatment T_1 after tillage while maximum value for cone index and soil mean mass diameter was found in treatment T_3 and T_2 respectively.

Hence it is concluded from the results obtained that there was positive effect of tillage on soil parameters. The treatment T_2 was found to be more effective as compared to treatments T_1 and T_3.

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