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Study on Penetration Resistance Using Soil Cone Penetrometer In Ploughed and Unploughed Land

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Abstract: **-- The effect of tillage on soil resistance to penetration was determined on Agricultural Engineering College and Research Institute, Kumulur, TNAU, Trichy. Mould board plough is used for ploughing the soil and cone penetrometer is used to know about the penetration resistance of soil. The results showed that penetration resistance of the ploughed land is lower than the unploughed land in all the levels of depth. Increase in depth of field was increased the penetration resistance of ploughed and unploughed land.**

I. INTRODUCTION

Tillage is the operation for topsoil and it doing soil loosening, weed control, burial of crop residues, preparation of a seedbed, preparation of a level surface to facilitate other operations, improvement of water infiltration, reduction of evaporative water loss and incorporation of manure. During tillage, the soil is loosened from an initial compact state by dragging a metal implement through it. For loosening to occur, the soil must reach either shear failure or tensile failure (Hettiaratchi, 1988). Because tillage implements may compress the non-tilled soil ahead of them, it is possible that the resulting aggregates are denser than they were in the original soil, even though the porosity of the tilled layer is increased (Arvidsson and Dexter, 2002). Penetration resistance, a function of several soil mechanical properties, provides a rapid method to characterize the variability of soil strength or hardness within the soil profile (Koolen and Kuipers 1983). According to Abdulla and Mohamed (1998) tillage operation changes the soil surface in a number of ways, such as roughing or smoothing of the surface. Campbell and Henshall (1991) argued that, undisturbed soil seems to be harder and more resistant to root penetration than tilled soil. Alnahas (2003) observed that high soil strength reduces and even stops root growth or penetration to the soil. Hence the objective of this study is to know about the penetration resistance in the soil before and after ploughing.

II. MATERIALS AND METHODS

The study has been conducted using in Agricultural Engineering College and Research Institute, Kumulur, TNAU, Trichy (10.92° N, 78.82° E). Mould board plough is used for ploughing the soil and cone penetrometer is used to know about the penetration resistance of soil.

2.1. Mould board plough:

The mould board plough does the following functions like cutting, lifting, turning and pulverization. The mould board plough is best suited for turning and covering crop residues. The essential parts of a typical mould board plough bottom are share, mould board, landside and frog (Kepner et al., 2005).

2.2. Cone penetrometer:

The soil cone penetrometer is recommended as a measuring device to provide a standard uniform method of characterizing the penetration resistance of soils. The force required to press the 30o circular cone through the soil, expressed in kilopascals, is an index of soil strength called the cone index. Two cone base sizes are recommended: 323 mm2, 20.27 mm diameter with 15.88 mm diameter shaft for soft soils; and 130 mm2, 12.83 mm diameter with 9.53 mm diameter shaft for hard soils (ASAE standard, 2004). The graduations on the driving shafts are 1 cm apart and are used to identify the depth of hand operated devices. The hand operated soil cone penetrometer has proving ring reading in millimeter which should be calibrated to the force applied on the handle of cone penetrometer.

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2.2.1. Calibration of cone penetrometer:

The readings in the proving ring of the cone penetrometer are in mm. To convert the reading into force, known force is to be applied on the cone penetrometer and corresponding readings noted and given in table – 1. The values noted are plotted in graph to get the calibration curve for the cone penetrometer (Fig. 1).

Table – 1: Soil cone penetrometer calibration table

S. No	Weight (kg)	Proving ring reading (x 0.002 mm)
1.	4	55
2.	5	70
3.	6	80
4.	7	95
5.	8	110
6.	9	125
7.	10	140
8.	11	145
9.	12	160
10.	13	175
11.	14	185
12.	15	200
13.	16	210
14.	17	225
15.	18	235

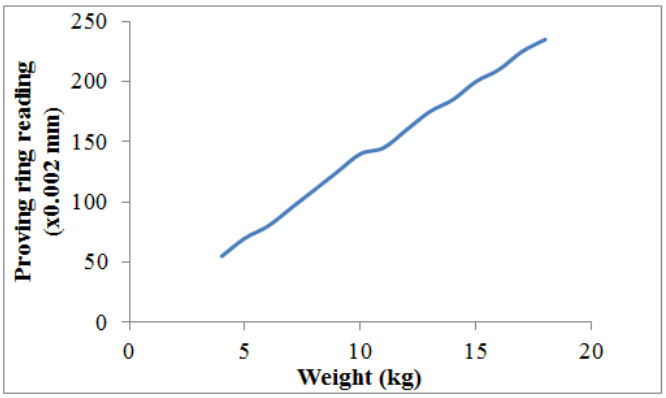

Fig. 1. Calibration Curve of Cone Penetrometer

2.3. Procedure for penetration resistance test:

The cone penetrometer was pressed in five places of field randomly before and after ploughing. The readings were plotted in the graph the respective penetration resistance values were noted.

III. RESULT AND DISCUSSION

The penetration resistance values of the field before and after ploughing are given in table-2. At 2 cm depth the average penetration resistance of the unploughed land and ploughed land is 19.7 kgf/mm2 and 3.2 kgf/mm2, respectively. It is found that penetration resistance is higher in unploughed land than the ploughed land (Fig. 2). This might be due to the soil compaction destroyed by the implement operated in the land.

Table - 2. Penetration resistance values of the field before and after ploughing

Replication	Depth (cm)	Penetration resistance in unploughed land (kgf/mm2)	Penetration resistance in ploughed land (kgf/mm2)
I	2	14.0	2.5
	5	20.0	3.1
	10	25.0	4.0
	Average	19.7	3.2
II	2	15.0	2.2
	5	25.6	2.8
	10	32.0	4.0
	Average	24.2	3.0
III	2	13.0	3.0
	5	24.0	4.5
	10	32.0	5.2
	Average	23.0	4.2

The relation between the depth and penetration resistance is presented in Fig. 2. At the depth of 10 cm the penetration resistance is 44% higher than the resistance measured in the 2 cm in unploughed land. It might be due to the hardness of layer below the ground surface. The above results were in close relation to the authors Oduma et al., (2017), Alnahas (2003) and Saber and Mrabet (2002).

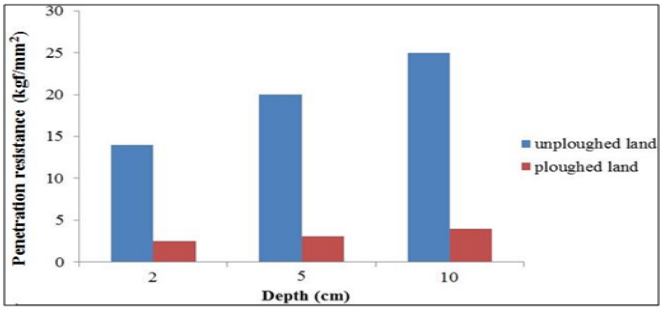

Fig. 2. Penetration resistance in ploughed and unploughed land at different depths

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IV. CONCLUSION

The penetration resistance of the ploughed land is lower than the unploughed land in all the levels of depth. Increase in depth of field was increased the penetration resistance of ploughed and unploughed land.

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