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Research Article

# EFFECT OF SOIL, WATER QUALITY AND TILLAGE DYNAMICS ON INFILTRATION RATE IN DIFFERENT SOILS

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**Abstract:** Water quality and soil compaction are the two important parameters that influences the normal infiltration rate for the applied water or rainfall. The infiltration rate of water into soil varies widely and can be greatly influenced by the quality of the irrigation water and degree of compaction. This experiment was carried out to know the impact of these two factors on sandy loam and clay soil. To obtain the representative values, a total of 96 locations were identified covering all the plots to measure the infiltration characteristics of the soils in no tillage condition and later in primary tillage condition. In each plot two sample readings were taken with different irrigation quality water such as fresh water, 2 EC, 4 EC, 6 EC *etc*. The infiltration rate is found to be varying from 0.21 to 0.31 cm/hr in combine harvested field and varying from 0.78 to 3.80 cm/hr in No combine harvested field after the application of tillage. This shows the variation of infiltration rate is more in sandy loam soil when compared with clay soil.

**Keywords:** Infiltration, Infiltration rate, Accumulated infiltration, Water Quality, Tillage

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## Introduction

Improvement The movement of water from the surface into the soil is called infiltration. The nearly constant rate that develops after some time elapsed from the start of irrigation is called 'Basic infiltration rate' (BIR) and the total quantity of water that enters the soil in a given time is called 'Accumulated infiltration'. Soil compaction and water quality are the two most common factors which influence the normal infiltration rate. The salinity of the water (total quantity of salts in the water) and its sodium content (carbonates & bicarbonates) relative to the calcium and magnesium content plays a major role in infiltration rate. A high salinity water will increase infiltration. A low salinity water or a water with a high sodium to calcium ratio will decrease infiltration. Both factors may operate at the same time. The infiltration rates are also affected by the porosity of the soil which is changed by cultivation or compaction. Tillage improves the infiltration rate by increasing the porosity of the top soil and breaks the subsurface hard pan. Because of subsequent irrigations, the soil settles back to its past condition and the effect of tillage is nullified over a period. Ryan *et al*. (1992) conducted a study and examined that increasing machinery use in agriculture had adverse effects on soil physical properties, especially with clay soils. Therefore, it is important to understand the infiltration rate behavior with the effect of soil compaction due to movement of heavy machinery and water quality into different soils.

## Theoretical Considerations

### Preparation of different irrigation quality water

To do this, sea water from Bapatla coast had been collected and mixed with fresh water to prepare different EC water such as 2, 4 and 6 EC required for the determination of infiltration characteristics of soils can be obtained by using the following equation

Amount of Sea water to be mixed with fresh water = (Required EC-fresh water EC)/(Sea water EC)x required quantity of water .. (1)

Assumptions

EC of sea water as 36.5

EC of Fresh water as 0.68

After thorough mixing of the above prepared water, EC was checked with portable EC meter

## Materials and Methods

### Study Area

In sandy loam and clay soils, four plots had been selected based on the topography of the field and other field conditions for infiltration rate measurement. To obtain the representative values, a total of 80 locations were identified covering all the plots to measure the infiltration characteristics of the soils. In each plot two sample readings were taken with different irrigation quality water such as fresh water, 2 EC, 4 EC, 6 EC *etc*. At first, the experiments were conducted in no tillage condition and later in primary tillage condition.

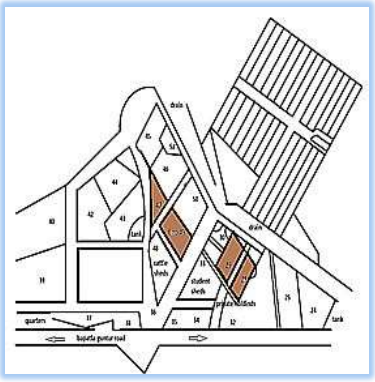

Fig-1 Layout of agricultural college farm, Bapatla

**Measurement of Infiltration Rates**

For measurement of infiltration rates, Double ring infiltrometer technique was used. In this method, the inner and guard cylinders were driven into the ground upto 10 cm depth uniformly on all the sides by striking with a falling weight type hammer on a wooden plank placed on top of the cylinders A point gauge was set at desired level to which the water is added to the inner cylinder from the container of known volume and graduated jar. Water added upto ¾ of the cylinder by pouring on a piece of folded jute matting or a stone to prevent puddling and sealing of the surface soil. At regular time interval in five multiplication factor upto 120 min, some quantity of water was added to maintain this depth to get a constant infiltration rate. Field type point gauge and stop watch were used to take out observations for infiltration rate. The following infiltration model was used for finding the infiltration rate data.

$$y = at^{\alpha} + b$$

Where

f is cumulative infiltration at any time t.

t is time in min.

a and b are constants

**Results and Discussion**

The data obtained by using different irrigation water qualities in No tillage and Primary Tillage condition of clay and sandy loam soils were analyzed by using Kostiakov equation infiltration model as shown in [Table-1, 2, 3]. The data analysis of above tables reveals that in NT and in PT condition, infiltration rates were decreased with use of poor-quality irrigation water. The infiltration rate decreased from 0.28 cm/hr to 0.14 cm/hr in NT condition and from 0.43 cm/hr to 0.08 cm/hr in PT condition of sandy laom soil. In case of sandy loam soils. With machine harvested field, the variation of infiltration rate using fresh water is 0.17 to 0.21 cm/hr, for 2 EC is 0.49 to 0.3 cm/hr, for 4 EC is 0.1 to 0.37 cm/hr and 6 EC is 0 to 0.62 cm/hr in clay soil from NT to PT condition. In manual harvested field, the variation of infiltration rate using fresh water is 0.28 to 0.78 cm/hr, for 2 EC is 0.66 to 0.32 cm/hr, for 4 EC is 0.3 to 0.23 cm/hr and 6 EC is 0 to 0.3cm/hr in clay soil. This clearly shows the effect of irrigation water quality on infiltration characteristics. Also, the graphs of measured infiltration rate and calculated infiltration rate by infiltration model against time were drawn for different soils. It was observed the quality of irrigation water has severe effect on clay soils compared to sandy loam soil. Due to the high cohesion forces between the clay particles the poor-quality water was not allowed to pass through clay soil.

Table-1 Measured basic infiltration rates of different irrigation water qualities in No Tillage condition of sandy loam soil.

| Elapsed time | Machine Harvested | | | | | Manual Harvested | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fresh Water Compacted | Fresh Water normal | 2 EC | 4 EC | 6 EC | Fresh water | 2 EC | 4 EC | 6 EC |
| 5 | 4.8 | 4.8 | 1.4 | 1.26 | 1.8 | 4.4 | 2 | 1.2 | 2.4 |
| 10 | 0.34 | 1 | 0.3 | 0.36 | 0.9 | 2 | 1.2 | 1.5 | 1.2 |
| 15 | 0.13 | 0.53 | 0.27 | 0.26 | 0.76 | 0.93 | 0.87 | 1.2 | 0.6 |
| 25 | 0.24 | 0.48 | 0.88 | 0.29 | 0.78 | 0.96 | 1 | 0.6 | 0.9 |
| 45 | 0.09 | 0.4 | 0.56 | 0.07 | 0.33 | 1.29 | 0.91 | 0.87 | 0.43 |
| 60 | 0.07 | 0.1 | 0.27 | 0.05 | 0.22 | 0.7 | 0.62 | 0.4 | 0.25 |
| 75 | 0 | 0.05 | 0.2 | 0.12 | 0.14 | 0.61 | 0.4 | 0.48 | 0.18 |
| 90 | 0 | 0.07 | 0.21 | 0.1 | 0.07 | 0.44 | 0.29 | 0.3 | 0.13 |
| 110 | 0 | 0.01 | 0.23 | 0.14 | 0.06 | 0.4 | 0.29 | 0.19 | 0.16 |
| 130 | 0 | 0 | 0.16 | 0.09 | 0.05 | 0.28 | 0.2 | 0.12 | 0.14 |

Table-2 Measured basic infiltration rates of different irrigation water qualities in PT Tillage condition of sandy loam soil

| Elapsed time | Machine Harvested | | | | Manual Harvested | | | |
|---|---|---|---|---|---|---|---|---|
| | Fresh Water normal | 2 EC | 4 EC | 6 EC | Fresh water | 2 EC | 4 EC | 6 EC |
| 5 | 8.40 | 6.60 | 7.20 | 2.10 | 1.20 | 3.00 | 0.60 | 0.00 |
| 10 | 2.70 | 3.30 | 1.80 | 0.60 | 0.90 | 0.90 | 1.20 | 0.90 |
| 15 | 1.40 | 2.00 | 2.00 | 0.70 | 0.60 | 0.60 | 0.60 | 1.80 |
| 25 | 1.32 | 1.14 | 1.20 | 0.36 | 0.84 | 1.32 | 0.60 | 0.60 |
| 45 | 0.77 | 1.23 | 1.53 | 0.23 | 0.53 | 0.47 | 0.60 | 1.07 |
| 60 | 0.43 | 0.60 | 0.73 | 0.00 | 0.30 | 0.35 | 0.35 | 0.75 |
| 75 | 0.40 | 0.40 | 0.90 | 0.04 | 0.30 | 0.28 | 0.20 | 0.52 |
| 90 | 0.57 | 0.27 | 0.60 | 0.15 | 0.20 | 0.20 | 0.27 | 0.40 |
| 110 | 0.52 | 0.19 | 0.64 | 0.10 | 0.11 | 0.14 | 0.16 | 0.19 |
| 130 | 0.43 | 0.16 | 0.48 | 0.08 | 0.09 | 0.12 | 0.09 | 0.12 |

Table-3 Measured infiltration rates of different irrigation water qualities in No Tillage condition of clay soil

| Elapsed time | Machine Harvested | | | | | Manual Harvested | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fresh Water Compacted | Fresh Water Normal | 2 EC | 4 EC | 6 EC | Fresh water | 2 EC | 4 EC | 6 EC |
| 5 | 0.40 | 3.80 | 0.0 | 1.80 | 4 | 1.00 | 2.20 | 1.10 | 1.20 |
| 10 | 0.40 | 1.90 | 1.8 | 0.30 | 2 | 1.00 | 1.95 | 0.99 | 1.80 |
| 15 | 0.13 | 1.40 | 0.2 | 0.20 | 1 | 0.93 | 1.80 | 0.60 | 1.00 |
| 25 | 0.19 | 1.48 | 0.4 | 0.48 | 1 | 0.84 | 1.80 | 1.44 | 0.60 |
| 45 | 0.36 | 1.20 | 0.3 | 0.40 | 0 | 0.36 | 2.30 | 0.77 | 0.23 |
| 60 | 0.04 | 0.88 | 0.3 | 0.15 | 0 | 0.60 | 1.63 | 0.70 | 0.11 |
| 75 | 0.08 | 0.83 | 0.2 | 0.16 | 0 | 0.40 | 0.90 | 0.94 | 0.08 |
| 90 | 0.04 | 0.67 | 0.1 | 0.10 | 0 | 0.39 | 0.68 | 0.32 | 0.00 |
| 110 | 0.23 | 0.60 | 0.1 | 0.05 | 0 | 0.36 | 0.74 | 0.35 | 0.00 |
| 130 | 0.17 | 0.49 | 0.1 | 0.09 | 0 | 0.28 | 0.66 | 0.30 | 0.00 |

Table-4 Measured basic infiltration rates of different irrigation water qualities in PT condition of clay soil

| Elapsed time | Machine Harvested | | | | Manual Harvested | | | |
|---|---|---|---|---|---|---|---|---|
| | Fresh Water normal | 2 EC | 4 EC | 6 EC | Fresh water | 2 EC | 4 EC | 6 EC |
| 5 | 2.40 | 7.2 | 4.80 | 10.20 | 6.60 | 3.60 | 3.00 | 8.40 |
| 10 | 0.90 | 1.5 | 2.10 | 4.20 | 4.20 | 2.10 | 1.50 | 3.00 |
| 15 | 0.60 | 1.0 | 1.80 | 3.20 | 2.60 | 1.40 | 1.00 | 2.20 |
| 25 | 0.60 | 0.8 | 0.96 | 2.76 | 2.66 | 1.44 | 1.14 | 2.64 |
| 45 | 0.53 | 1.0 | 0.73 | 2.13 | 2.77 | 0.73 | 1.13 | 1.90 |
| 60 | 0.50 | 0.6 | 0.60 | 1.50 | 0.97 | 0.70 | 0.80 | 1.33 |
| 75 | 0.36 | 0.5 | 0.72 | 1.24 | 1.48 | 0.68 | 0.48 | 0.52 |
| 90 | 0.23 | 0.3 | 0.57 | 0.93 | 0.90 | 0.33 | 0.33 | 0.70 |
| 110 | 0.30 | 0.3 | 0.44 | 0.74 | 1.09 | 0.38 | 0.33 | 0.35 |
| 130 | 0.21 | 0.3 | 0.37 | 0.62 | 0.78 | 0.32 | 0.23 | 0.30 |

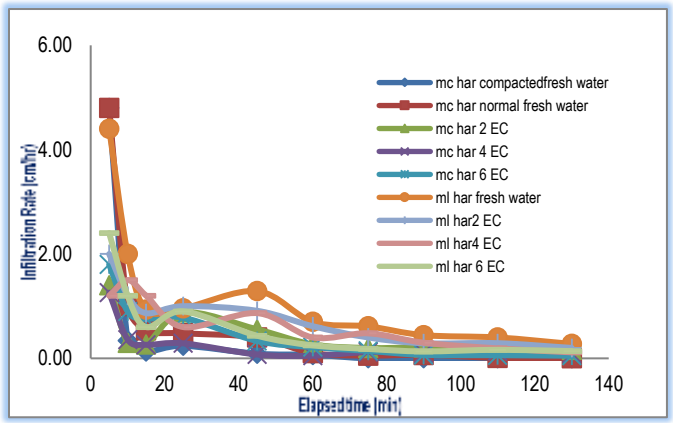


Fig-2 Measured basic infiltration rates of different irrigation water qualities in NT condition in Clay soil

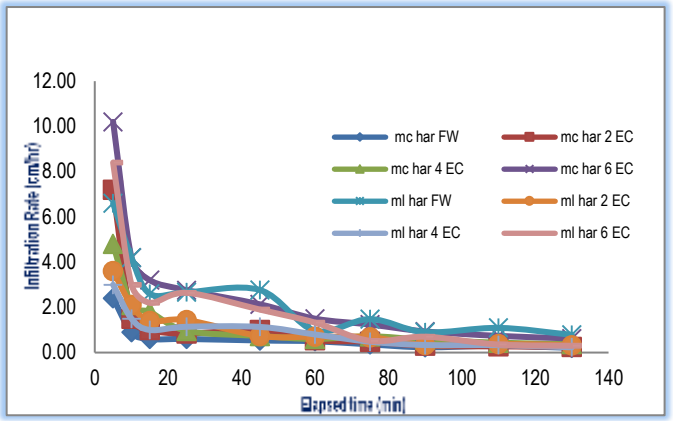


Fig-4 Measured basic infiltration rates of different irrigation water qualities in NT condition of Sandy loam soil

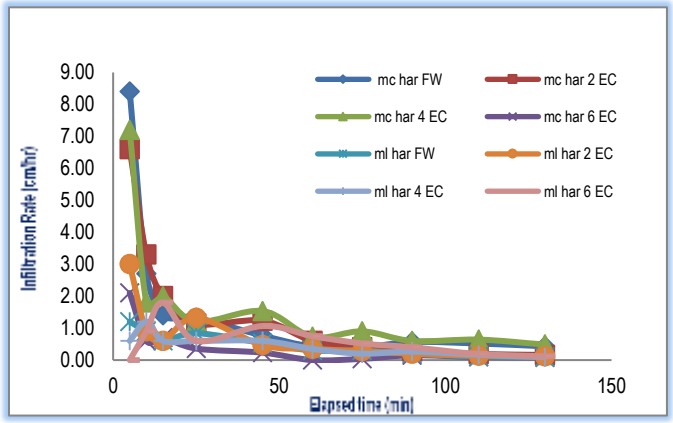


Fig-3 Measured basic infiltration rates of different irrigation water qualities in PT condition in Clay soil

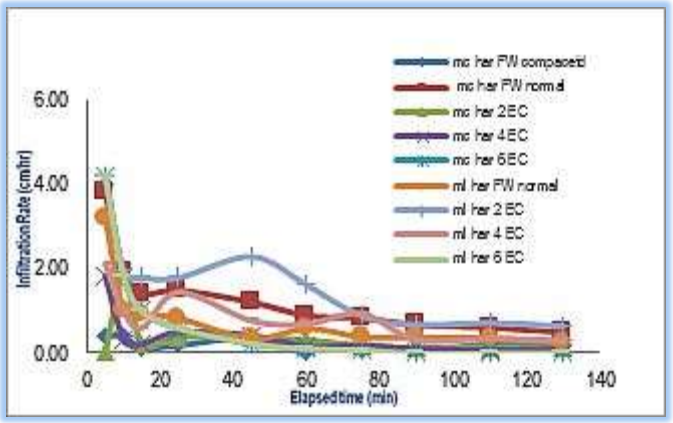


Fig-5 Measured basic infiltration rates of different irrigation water qualities in PT condition of Sandy loam soil

**Conclusion**

The research work shows considerable variation of soil, water quality and tillage dynamics on infiltration rate in clay, sandy loam soils. When a soil is irrigated with a high sodium water, a high sodium surface soil develops which weakens soil structure. The surface soil aggregates then disperse to much smaller particles which clog soil pores. The problem may also be caused by an extremely low calcium content of the surface soil, the infiltration rate is better with tillage in same condition of soil. From the research work, it was also found that the irrigation water quality and soil compaction significantly effect the infiltration rate in clay and sandy loam soils. This helps to better planning of tillage type and irrigation water to nullify the adverse effects of infiltration rate in different soil conditions.

**Application of research:** Study will be helpful for better management of different irrigation water qualities in conjunction with tillage methods and one of the important inputs for agriculture waste water management

**Research Category:** Waste water management, Soil Tillage

**Abbreviations:**

PT- Primary Tillage
NT- No Tillage
EC-Electrical Conductivity

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