



STUDY OF SOIL INFILTRATION RATES ON DIFFERENT SOIL CONDITIONS AT SELECTED SITES

P Anil Kumar¹, P V M Vardhan², S N Karishma³

Abstract- Infiltration rate in soil science is that the rate at which soil is able to absorb the amount of rainfall or irrigation. The rate decreases as the soil becomes saturated. This happens when the precipitation rate exceeds the infiltration rate, thus runoff will usually occur. The rate of infiltration can be measured using an infiltrometer. The study area aimed to determine the infiltration rates of different soils under different soil conditions at selected sites at Chandragiri mandal, Chittoor district, Andhra Pradesh. Experimental work was carried out on grey soil and red soil. Soil conditions considered for grey soil were ploughed, unploughed and compacted, for red soil ploughed, unploughed and compacted. In the present study, double ring infiltrometer was used for measurement. From the results it is observed that the infiltration rate is high for ploughed soil in comparison with the compacted soils. The present study will be useful for groundwater recharge and its estimation.
Keywords – Double Ring Infiltrometer, Groundwater, Infiltration Rate, Rangampet.

1. INTRODUCTION

Infiltration is the process by which water on the ground surface enters the soil surface. Infiltration is the downward entry of water into the soil. [11], [12] The velocity at which water enters the soil is infiltration rate. It is measured in centimetres per hour. The infiltration rate decreases as the cumulative time increases. Runoff will occur when the rainfall rate is more than the infiltration rate. [13] It is related to the saturated hydraulic conductivity of the near-surface soil. The rate of infiltration can be measured using an infiltrometer. It is different from the term percolation because percolation means movement of water in the soil mass. [8] From the definition it follows that the process of infiltration will stop unless percolation removes infiltrated water. Thus although the two phenomenon viz. infiltration and percolation are different they are closely related.

Infiltration is mainly caused due to two forces namely gravitational and capillary forces. [6] The water infiltrating into the soil moves downward through larger soil pores under the force of gravity. The smaller surface pores take in water by capillarity. The downward moving water is also sucked in by capillary pores. The gravitational water moves towards the ground water following the path of least resistance. When the capillary pores at the surface are filled and intake capacity reduced infiltration rate decreases. [9] As a trend the rate of infiltration is high in the beginning. It decreases rapidly in the initial stages and then slowly till it approaches a nearly constant rate. Clay particles in the soil may swell as they become wet and thereby reduce the size of the pores. In areas where the ground is not protected by a layer of forest litter, raindrops can detach soil particles from the surface and wash fine particles into surface pores where they can impede the infiltration process. [10]

Infiltration rate is varied for different soils at different conditions like ploughed, unploughed and compacted. [1] [3] [4] Usually the inter connected voids will be less for compacted soils so the infiltration rate is less as compare with other two conditions. For recommending the type and method of irrigation infiltration values are important for different type of soils. [5] The infiltration rate plays a vital role to the irrigation engineers as it influences the application rate of irrigation. [7] The types of crop for getting more yield NPK values are more important which will be tabulated with infiltration values. So that the farmer can choose the type of crop and fertilizers which are required to get more yield.

Infiltration is of great importance in watershed management for prediction of flooding, erosion and pollutant transport all depend on the rate of runoff which is directly affected, by the rate of infiltration. The quantification of infiltration is needed to determine the availability of water for crop growth and to estimate the amount of additional water needed for irrigation in the crop fields. Also, compaction effects the physical properties of soil by increasing its strength and bulk density, decreasing its porosity and forcing a smaller distribution of pores within the soil. [2] A loose, permeable, sandy soil will have a larger infiltration capacity than a compact, clayey soil. A soil with good underdrainage, i.e. the facility to transmit the infiltrated water downward to a groundwater storage would obviously have a higher infiltration capacity. Estimation of groundwater recharge is a key challenge for determining sustainable groundwater development and management.

¹ Assistant Professor, Department of Civil Engineering, Sree Vidyanikethan Engineering College, A. Rangampet-517102, A.P, India

² Under Graduate Student, Department of Civil Engineering, Sree Vidyanikethan Engineering College, A. Rangampet-517102, A.P, India

³ Under Graduate Student, Department of Civil Engineering, Sree Vidyanikethan Engineering College, A. Rangampet-517102, A.P, India

2. STUDY AREA

The geographical location of the study area Rangampet is located in Chittoor district of Andhra Pradesh state having latitude of $13^{\circ}37'N$ and longitude of $79^{\circ}17'E$ with an extent area of 120 Sq.km. Kottala and Naravaripalli are located near by Rangampet village. The area is at a distance of 25 km from Tirupati, a popular city in Andhra Pradesh state of India as shown in the figure.1 and the area covers three villages in Chandragiri mandal. The major portion of the district is covered by red soils. The occurring of rainfall in the district is from both South West and North East monsoons. The normal rainfall for south west monsoon is 438 mm and for North East monsoon is 396 mm. The average normal rainfall of the district is 934. The area experiences temperatures ranging from 35 to 40 degrees. Four regions as per type of soil and three soil conditions were selected for infiltration rate measurement. Two different soil types grey soil, and red soil were selected in which soil condition was of compact soil type, ploughed, and unploughed condition.

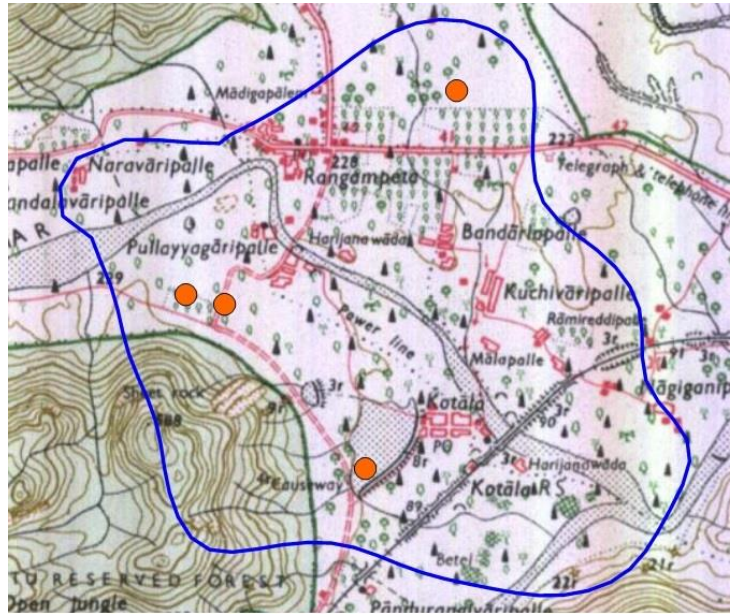


Figure1.location map of the study area

Table -1 Locations of different types of soil where the test has been conducted

| S.No | Location | Type of soil | Latitude | Longitude |
|------|---------------|--------------|----------------------|----------------------|
| 1 | Kottala | Grey soil | $13^{\circ}36'17''N$ | $79^{\circ}16'54''E$ |
| 2 | Rangampeta | Red soil | $13^{\circ}37'35''N$ | $79^{\circ}17'13''E$ |
| 3 | Naravaripalli | Red soil | $13^{\circ}36'53''N$ | $79^{\circ}16'17''E$ |
| 4 | Rangampeta | Grey soil | $13^{\circ}36'51''N$ | $79^{\circ}16'25''E$ |

3. METHODOLOGY

The infiltration test was measured by double ring infiltrometer the most commonly used infiltrometer at all sites in the present study area. In this two concentric rings inner and outer having diameters of 30 cm and 60 cm with 25 cm deep as shown in the figure 2. The two rings are inserted into the ground at about 15 cm deep in soil by using falling weight type hammer striking on a wooden plank placed on top of ring without disturbing the soil. Water is applied into both the rings to maintain a constant depth of about 5 to 12 cm. The outer ring provides water jacket to the infiltrating water from the inner ring. The depth of water in both inner and outer rings are kept same during the observation period. The measurement of the water volume is done on the inner ring only. The experiment is carried out till a constant infiltration rate is obtained. The readings were taken frequently at the beginning of the test but extended the interval between readings as the time goes on. Once the values of infiltration rate are constant, the basic infiltration rate has been reached.



Figure 2. Simple Double Ring Infiltrometer

4. RESULTS AND DISCUSSIONS

The infiltration depth at the selected time intervals was measured in all the selected sites under different soil conditions based on the double ring infiltrometer field observations. A total twelve experiments were conducted at Kottala, Rangampet and Naavaripalli villages. The infiltration curves were plotted against infiltration rate and time for different soils under different soil conditions.

From Figure 3, 4 and 5, It is observed that a high infiltration rate occurs for Grey ploughed soil and Red ploughed soil and low infiltration rates for Grey compacted soil and Red compacted soils. As the compacted soil will have low infiltration rate when compare to the ploughed and unploughed soil because of the machines used in the agricultural fields and while transportation. Compaction is one of the important parameter in infiltration process, as it decreases the infiltration rate and increases the runoff rate. The infiltration rate also depends on soil characteristics such as soil texture, hydraulic conductivity, soil structure, vegetation cover of the land etc. It was observed that initially infiltration rates were higher and decreased with time up to steady infiltration rate in all the sites where the test has been carried out.

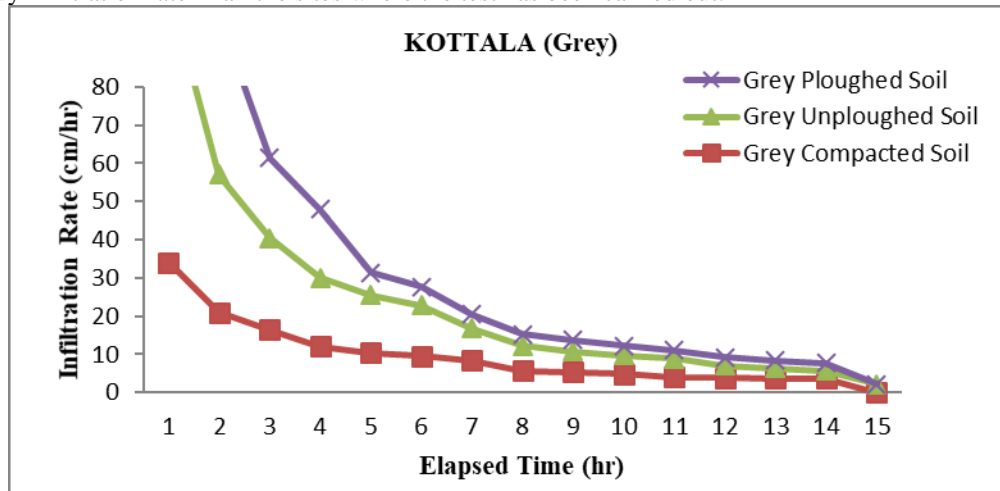


Figure3. Infiltration capacity curve for Kottala village

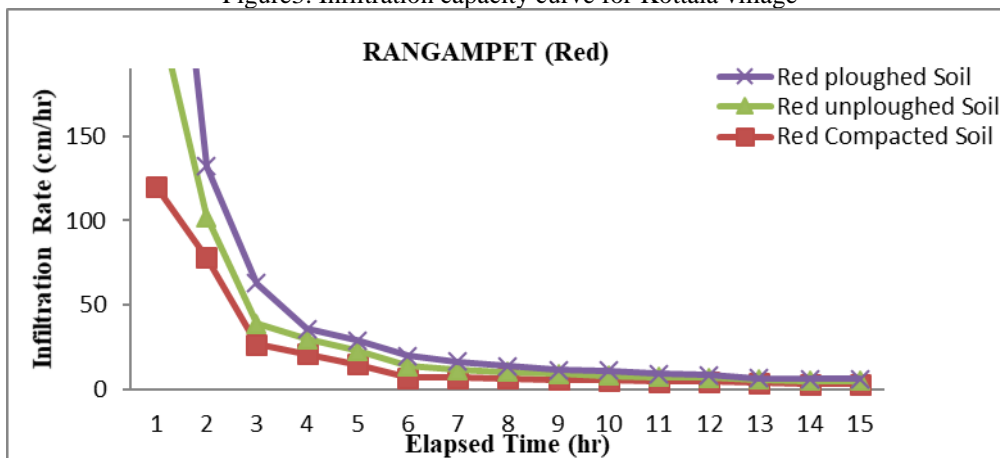


Figure4. Infiltration capacity curve for Rangampet village

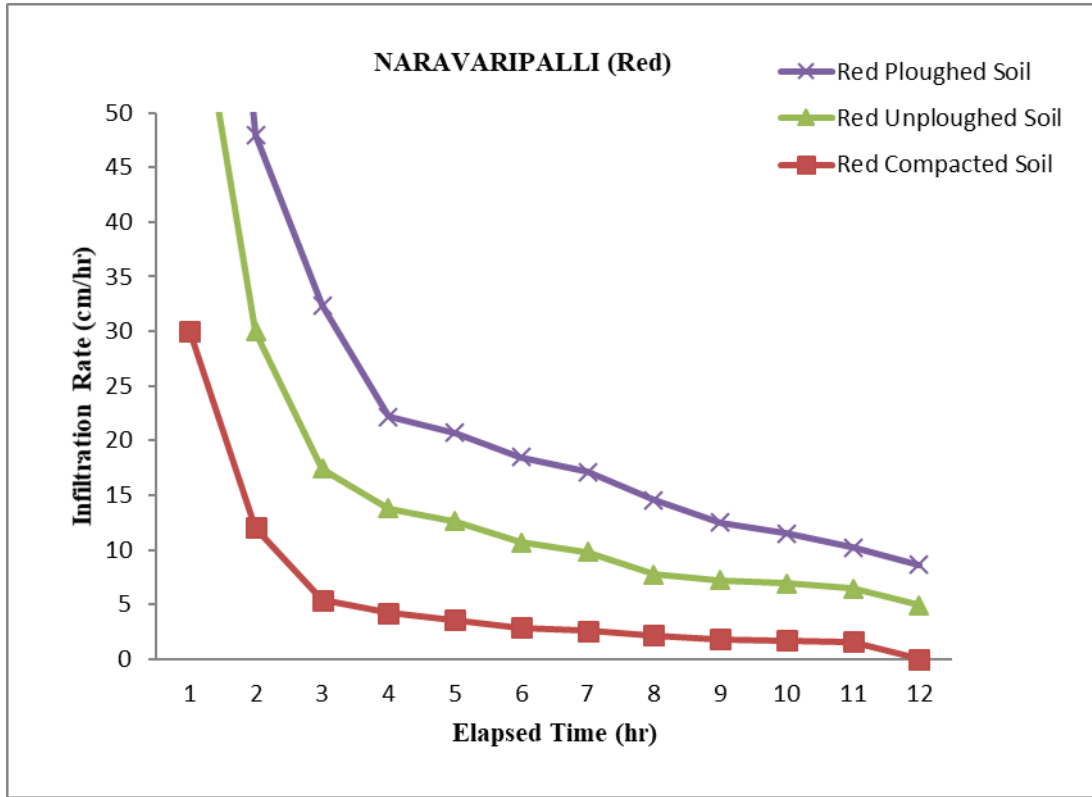


Figure5. Infiltration capacity curve for Naravaripalli village

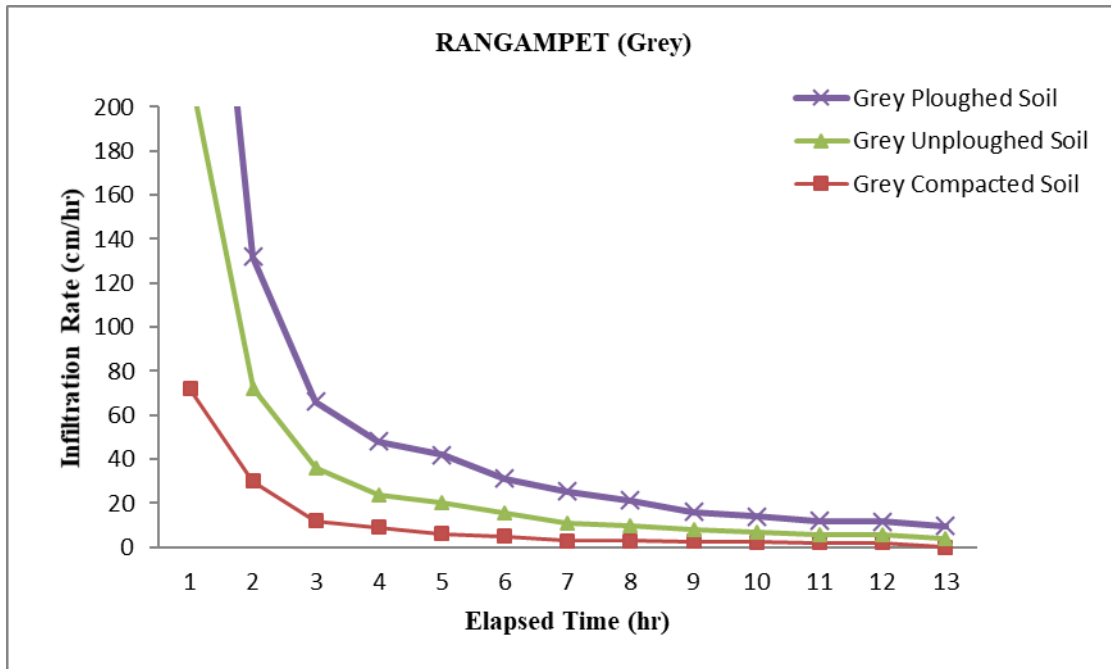


Figure6. Infiltration capacity curve for Rangampet village

5. CONCLUSIONS

From the present study it is found that the infiltration rate effected by different soil conditions. It provides increased understanding of the local soil infiltration and its variability. It was found that the result obtained from the test was varied from soil to soil and soil condition. It is concluded that the infiltration rate is high for ploughed soil when compared to the compacted soil and unploughed soil.

6. REFERENCES

- [1] Christopher O. Akinbile (2010) "Comparative Analysis of Infiltration Measurements of Two Irrigated Soils in Akure, Nigeria". *Advances in Applied Science Research*, 1 (1): 49-57.
- [2] Anjaneya Prasad M, Sundar Kumar P, Kaushik K H S, Bharath Kumar V, Sai Krishna P N and Vamshi Krishna G, (2015) "Determination of Infiltration Parameter Estimation Rates in a Small Region in Andhra Pradesh". *International journal of Earth Sciences and Engineering*, Volume 08, No. 02.
- [3] ChippkattiDevashreeDamodar, Gadekar Mayuri Martand, Kamble Aarti Shripati and PatilAnuja Subhash,(2017) "Infiltration Rates of Various Soils & it's Relationship with Runoff". *International Journal of Engineering Technology, Management and Applied Sciences*. Volume 5 Issue 4.
- [4] JagdaleSatyawanDagadu andNimbalkar P. T,(2012)"Infiltration Studies of Different Soils Under Different Soil Conditions and Comparison of Infiltration Models with Field Data".*International Journal of Advanced Engineering Technology*, IJAET/Vol.III/ Issue II/April-June/154-157.
- [5] M. A. Kalam I and M. Ramesh, (2016) "Determination of Infiltration Rate and Soil Indices using Double Ring Infiltrometer and Implementing it by IS and RS for Selected Areas in Zaheerabad, India".*Indian Journal of Science and Technology*, Vol 9(30), DOI: 10.17485/ijst/2016/v9i30/90330.
- [6] O Sarva Mangala, Pratibha Toppo and Shraddha Ghoshal,(2016) "Study of Infiltration Capacity of Different Soils". *International Journal of Trend in Research and Development*, Volume 3(2), ISSN: 2394-9333.
- [7] SreenivasuluDandagala, D Srinivasa Murthy, M V Subba Reddy, VinodhD Naveen A and Viswanth A, (2016) "A Comparative Study of Infiltration Rate at Selected Sites on Dosalavanka River Basin". *International Journal of Emerging Technology and Advanced Engineering*, Volume 6, Issue 9.
- [8] Shikha P. Shah, Prof. H. M Gandhi and Dr. R. K. Jain, (2015) "Review on Experimental Study of Influence of Soil Parameters on Infiltration Capacity". *IJRST –International Journal for Innovative Research in Science & Technology* | Volume 1 | Issue 12.
- [9] Gayatri Das and Mimi Das Saikia, (2016) "Experimental Study on Infiltration in Guwahati Using Double Ring Infiltrometer". *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 5, Issue 12.
- [10] C. L. Jejurkar and Dr. M. P. Rajurkar, (2012) "Infiltration studies for varying land cover conditions". *International Journal of Computational Engineering Research*, Vol. 2 | Issue No.1 | 072-076.
- [11] P Jaya Rami Reddy, *A Text Book of Hydrology*, 3rd Edition, Laxmi Publications Private Limited., New Delhi, 2011.
- [12] K Subramanya, *Engineering Hydrology*, 4th Edition, McGraw Hill Education (India) Private Limited., New Delhi, 2013.
- [13] Chow V T, Maidment and D R, Mays L W, *Applied Hydrology*, McGraw Hill International Editions, McGraw Hill Book Company, New York, 1998.