Original Research Article

Effect of Zai Pit Technology on the Infiltration Capacity of the soil

ABSTRACT

Agriculture in India has a facing number of problems which include an increase in population, depletion of water availability, runoff, and cultivated land. An increase in population and depletion of groundwater resources is a major problem for food security and stability. Irrigated lands now produce 4% of the food supply which doesn't meet the required supply. Zai pit technology provides a window of opportunity for farmers to improve crop performance in harsh & changing climates. This method increases the amount of water stored in the soil profile by trapping rainwater. It retains moisture and holds water long enough to allow it to infiltrate. It promotes the efficient use of limited quantities of organic matter and ensures the concentration of water & soil fertility. The methodology follows estimation of infiltration rate for both Zai pit technology and furrow irrigation method. Zai pit technology increases the infiltration rate of the soil from 1.45 to 2.25 cm/hr and furrow irrigation decreases the infiltration rate of the soil from 2.24 to 1.1 cm/hr. By using the Zai pit of technology convert unbarred land into berried land.

Keywords: Zai pit technology, furrow irrigation, and infiltration rate

Highlights

- Infiltration is the process by which water on the ground surface enters the soil. Infiltration rate is a measure of the rate at which soil can absorb rainfall or irrigation.

Introduction:

The population of India is expected to stabilize at around 1640 million by the year 2050. Moreover, every year the population will increase but the cultivated lands will not increase, to meet the required food supply. So, it is necessary to convert the barren lands into cultivable lands with better land and water management to provide the required food supply. Gross per capita water availability will decline from 1820 cu. m/ year in 2001 to as low as 1140 cu.m/year in 2050 (Abedinpour *et al* 2002). An increase in population and depletion of groundwater resources is a major problem for food security and stability. Irrigated lands now produce 4% of the food supply which doesn't meet the required supply. Therefore, it is necessary to choose a

suitable irrigation method that converts the uncultivated land into cultivated land for getting an optimum yield that meets the requirement with available water by applying the best irrigation management practices. Furthermore, good management and timely application of water may result in preventing land degradation Mohammad (Nabil Elnesr .2015.).

Infiltration is the process by which water on the ground surface enters the soil. Infiltration rate is a measure of the rate at which soil can absorb rainfall or irrigation. It is measured in inches per hour or millimeters per hour. If the soils have a low infiltration rate, then the runoff will be more, and also the water holding capacity of the soil will be low. If the precipitation rate exceeds the infiltration rate, the runoff will usually occur unless there is some physical barrier. To overcome the above problem, the infiltration rate should be increased. To avoid all the above problems, a new sustainable land and water management technique is introduced which is called the Zai pit method.

Zai pit method:

Zai pit is traditional land rehabilitation technology. Zai pit technology provides a window of opportunity for farmers to improve crop performance in harsh & changing climates. This method increases the amount of water stored in the soil profile by trapping rainwater. It retains moisture and holds water long enough to allow it to infiltrate. It promotes the efficient use of limited quantities of organic matter and ensures the concentration of water & soil fertility (Sawadogo 2011).

Zai technology also reactivates biological activities in the soil and eventually leads to an improvement in soil structure. This eventually leads to less desertification.

The poorly available organic matter is placed at the bottom of the pit and not broadcast over the whole field. The organic material used attracts termites, which play a crucial role as they dig channels in the soil and by doing so improve its “architecture”. The termites also digest the organic material, making nutrients more easily available to the crops planted or sown in the pits.

Materials and Methods:

The present study is conducted at the College of Agricultural Engineering, Madakasira, which was located in Anantapuram district of Andhra Pradesh, it is located in an arid ecological zone, and mainly it is designated as a rain shadow region. The area has a Latitude of 13°56'56.89" N and a longitude of 77°18'42" E. The annual rainfall of Madakasira is 532 mm and it is found to

the drought-prone area. The average air temperature is 28.42 ºC, whereas the maximum air temperature is 40.3ºC and the minimum air temperature is 15.5 ºC.

(i) Planning of Experiment

The experimental field with a total area of 196m^2 was selected for experimentation. The total area was divided into 2 plots i.e., one plot for Zai pit technology and another plot for furrow irrigation method. One plot for Zai pit technology having a 98m^2(7 m×14m) area was selected for experimentation. Another plot for furrow irrigation having a 98m^2(7 m× 14m) area was selected for experimentation. The spacing for the tomato crop was selected at about 80×80cmfor experimentation.

(ii) Field Preparation

FYM (Farm Yard Manure) was applied to the furrow irrigation site and the field was plowed well to bring to an optimum tilth. The plowing provides the opening of soil, crushing of clods, destroying the weeds, and utilizing the micronutrients for crop growth. The Zai pit consists of dug holes excavated in grids, with a diameter of 15-20 cm and a depth of 10-15 cm or more, filled with manure. They are spaced 70 to 80 cm apart (Amin Taheri 2011). The spacing of pits within a row, as well as the space between rows of pits, varies between 60 and 100 cm. At the beginning of the rains, 200- 600 g of dung or compost are added to the pits.

(iii) Transplanting

The seedlings were transplanted into the field after 30 days of seedlings prepared (Amiri, E 2016). Light irrigation was done immediately after transplanting. Gap filling was done on the fourth day of transplanting.

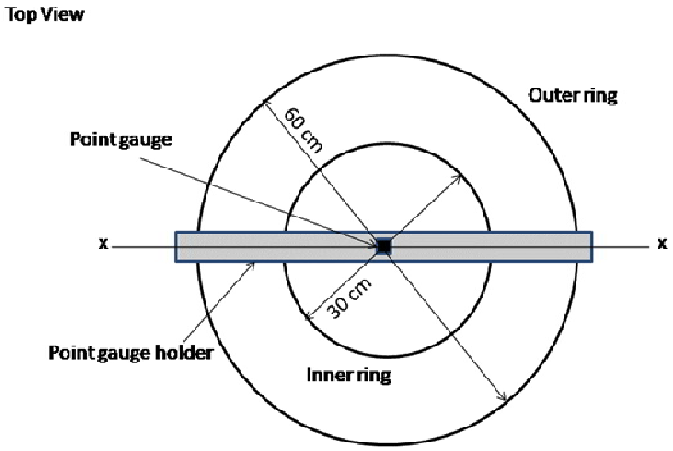
Image 1 . Zai pit and furrow methods

(iv)Harvesting

Harvesting of tomatoes was done manually at 60, 75, and 95 days after transplanting. Harvested fruits were weighed and collected in trays and marketed in Madakasira Town.

(v)Infiltration characteristics

The infiltration rate is measured using the double ring infiltrometer as described by Micheal (1978) in each experiment field. The standard double ring infiltrometer set consists of pair concentric rings (Fig.1). The diameter of the inner ring is 30 cm and the outer ring is 60cm having a depth of 30 cm. The double ring infiltrometer is made of a 14 gauge rust-resistant galvanized steel sheet. The purpose of the outer ring is to have the infiltrating water acts as a buffer zone against infiltrating water straining away sideways from the inner ring. The inner ring is used for measuring the infiltration rate of water. One side (Bottom side) of two rings is sharpened for easy insertion of rings into the soil. The other side is made hard and small elbow projections are provided diagonally opposite each other at six places. These projections are useful for easy carrying of rings and are also used as guides while inserting infiltrometer into the ground. The rings were driven at about 10cm deep into the soil by using a falling weight type hammer striking on a wooden plank placed on top of the ring uniformly without undue disturbance to the soil surface (Dianyu. 2015).



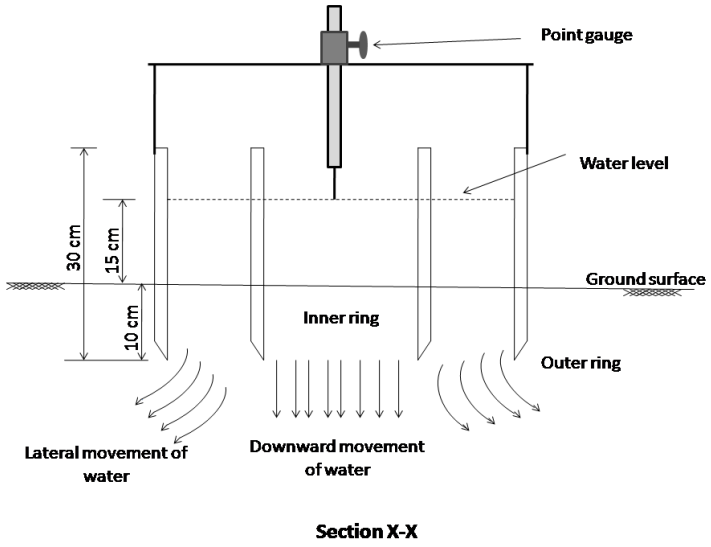


Fig.1.Double Ring Infiltrometer

(vi) Installation of Infiltrometer

For accurate installation of infiltrometer, the land was neatly cleaned by removing small obstacles such as stones or twigs, etc. The rings are driven into the ground by a falling weight-type hammer striking on top of the rings or by light blows with an ordinary hammer and using a short wooden plank to prevent damage to the edges of the metal rings. To avoid the disturbance of the soil, the vibrations are avoided by standing one or two persons standing on the ring. After installing the inner ring, place the outer ring with the cutting edge facing down and exactly concentric with the inner cylinder. With the help of a driving plate and impact absorbing hammer slowly insert the outer ring. Both cylinders are installed about 10cm deep in the soil. Care is taken to keep the installation depth of the rings the same in all experiments. This is accomplished by marking the outside of the rings at the 15cm level and driving the rings up to the mark.

Measurement of infiltration rate from Double Ring Infiltrometer

For measuring the infiltration rate of the soil, fill the outer ring with water, then immediately in the inner ring to approximately 10cm. To avoid the seepage of water from the inner ring to the outer and vice-versa, the water levels in both the cylinders are kept approximately the same. After filling the water, immediately determine the water level in the inner ring with the help of a point gauge. The water level in the inner ring as indicated on the point gauge is measured starting from small time intervals (5 min). The time interval is gradually increased to 10 min, 20 min, 30 min, 40 min, and 1 h. The water is refilled into both rings when the water level reaches near to 5 cm mark. Care is taken to fill the container each time before

adding water to the rings. This process is continued until the infiltration reaches a constant infiltration rate. The readings have been taken in three trials at each experimental setup. The infiltration rate is calculated by the following formula (Nyikahadzoi. 2012)

$$\text{Infiltration rate (cm/h)} = \frac{\text{Initial water depth} - \text{final water depth}}{\text{Time required, h}}$$

Results and Discussion:

Measurement of Infiltration rate in furrow irrigation method

Infiltration was measured in three stages i.e. before planting, before harvesting, and after harvesting. The obtained values are shown in Figure 2. From Figure 2, it was observed that the infiltration rate in the furrow irrigation method is in decreasing trend *i.e* 2.24, 1.275, and 1.1 cm/hr during the three stages of crop. This was due to the compactness of the soil surface by the application of irrigation water in the form of flood irrigation in furrows (Mutua-Mutuku, M *et al* 2015)

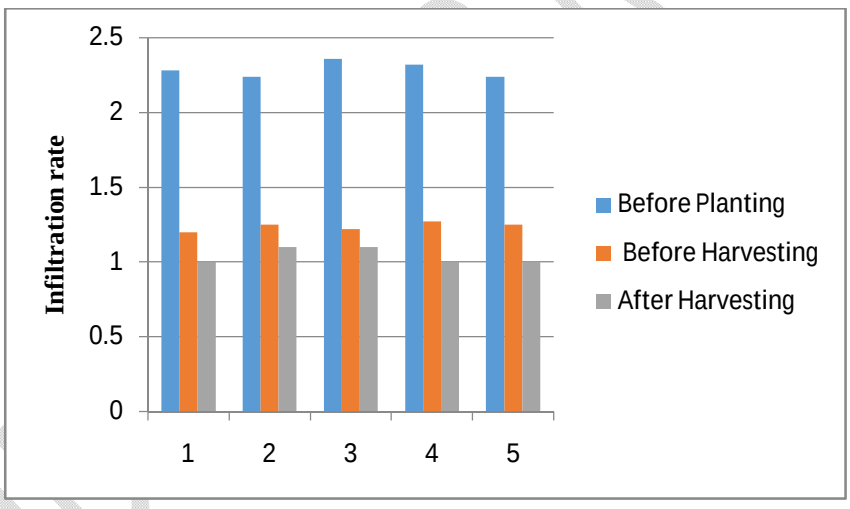


Fig.2. Infiltration rate in furrow irrigation method

Measurement of Infiltration rate in Zai Pit method

Infiltration is measured in three stages i.e. before planting, before harvesting, and after harvesting. The obtained values are shown in Figure3. From Figure 3, it was observed that the infiltration rate in Zai Pit technology is in an increasing trend i.e.1.45, 1.675, and 2.2 cm/hr (Santhosh, D.T.*et al* 2017) during the three stages. Organic matter present in the pits attracts the micro-organisms so that it travels toward the organic manure, so that pore space is increased (Danjuma, M.N. 2015).

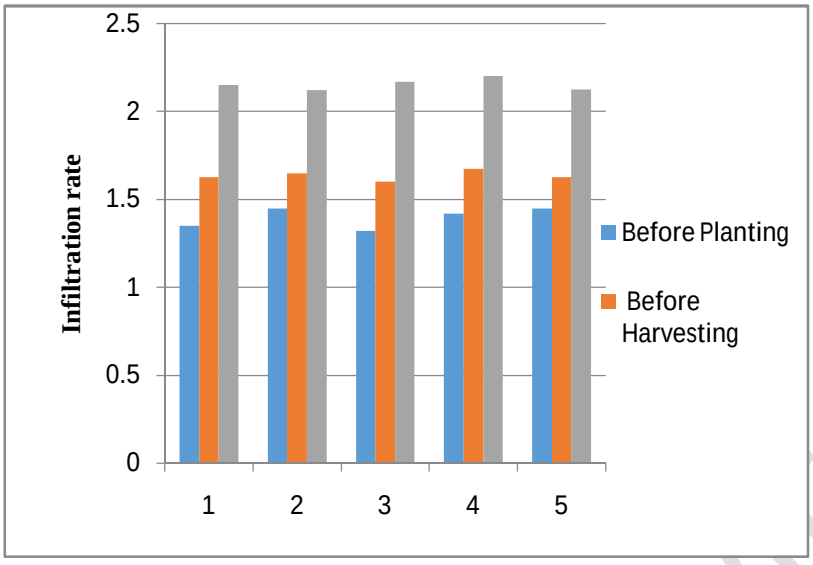


Fig.3. Infiltration rate in the Zai Pit method

Comparison of the yield of tomato crop between Zai pit technology and furrow irrigation.

The tomato crop was harvested manually in both methods and the yield was calculated and presented in the below table.1

Table 1: Comparison of the yield of tomato crop between Zai pit technology and furrow irrigation method.

S.No	Crop	Type of method	Yield (kg/ha)
1	Tomato	Zai pit technology	4081.63
2		Furrow irrigation method	2040.81

Conclusion:

The Zai concept captures rainfall and runoffs, promotes the efficient use of limited quantities of organic matter, and ensures the concentration of water and soil fertility at the beginning of the rainy season. The use of the Zai pit method increases the amount of water stored in the soil profile by trapping rainwater. It retains moisture in-situ and holds water long enough to allow it to infiltrate. Zai pit improves soil fertility in completely barren soils where nothing could grow before. With continuous cultivation with Zai pit technology for 3 years, barren land can be

converted into cultivated land. Zai technology also reactivates biological activities in the soil and eventually leads to an improvement in soil structure. The infiltration rate was increased from 1.45 to 2.25 cm/hr in Zai pit technology and the infiltration rate was decreased from 2.24 to 1.1 cm/hr.

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