J Krishi Vigyan 2019, 8 (1) : 297-300 DOI : 10.5958/2349-4433.2019.00117.X

Water Management through Puddling Techniques

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ABSTRACT

Paddy is the major cereal crop grown in India under stagnated water condition in agricultural fields. Puddling operation is carried out to create the stagnated water condition by creating an impervious layer in the sub soil surface. Puddling is a land preparation practice and it will decide the water usage in fields throughout the cropping period. To improve the puddling quality and stagnation of water, the puddling techniques *viz.,* T_1 = cage wheel, T_2 = rotavator, T_3 = cage wheel + rotavator and T_4 = power tiller with rotary tool were taken for the study. Since number of passes also influencing the puddling index, each treatment was analyzed for P_1 = single pass and P_2 = double pass. The implements were tested in silty loam soil and the parameters like puddling index and infiltration rate were measured using standard measurement procedures. Infiltration rate of field was reduced by increasing the puddling index with stagnated water condition. T_4P_2 technique had the highest puddling index of 70.91 per cent and lowest infiltration rate of 6.5 mm/d whereas T_1P_1 had the lowest puddling index and highest infiltration rate. In upland area, the power tiller attached with rotary tool was the most suitable method because infiltration rate observed minimum among all the treatments. When the infiltration rate reduces, the frequency of irrigation can be reduced resulting in saving of water during the crop period. In lowland paddy cultivation, usage of cage wheel with two pass allows infiltration of water resulting in proper drainage and reduces water stagnation.

Key Words: Infiltration rate, Management, Puddling, Puddling index, Rotavator.

INTRODUCTION

Land preparation is an important activity for providing favorable condition for crop cultivation. Unlike the other crops, grows in a stagnated water conditions and predominantly cultivated in fields with higher clay content. The behavior of clay soils is unpredictable as it becomes pasty in presence of moisture and forms the huge cracks when dry. Providing stagnated water condition for paddy cultivation is challenging. Puddling is an important operation that is carried out to create an impervious layer in the subsurface of soil to provide stagnated water condition then softens the soil for transplanting the paddy seedlings. In puddling, the soil is disturbed or churned in the presence of water and the disturbed soil particles occupy the pore space and thus create an impervious layer which reduces the percolation of water and facilitates the stagnation of water for paddy cultivation.

Behera *et al* (2009) found that peg type puddler with two passes produced highest puddling index as 30.13 per cent and rotary puddler with one pass produced 24.60 per cent. Singh *et al* (2012) identified that the cumulative infiltration rate was higher in bed and furrow transplanted rice (10.3-10.8 cm/min) than puddled flat treatments (5.5-5.9 cm/min).

Pradhan *et al* (2015) evaluated the performance of the power tiller with different cage wheel lug

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angle and diameter of cage wheel in the inceptisol. The cage wheel of 30° lug angle with 73 cm diameter given the maximum puddling index of 29.25 per cent. Power tiller drawn rotavator produced highest puddling index and lower percolation rate in hilly areas compared to animal drawn traditional country plough, rectangular blade puddler and disc harrow (Kumar *et al* 2015). Saimbhi (2016) stated that the rotavator operation was achieved the maximum puddling index of 84 per cent and the infiltration rate of 0.11 cm/h. Infiltration rate was decreased (0.85 mm/h) as the puddling index (71.5 per cent) was increased for rotavator puddling operation.

MATERIALS AND METHODS

Initially a soil sample was taken from the dry field and was analyzed using the Robinson pipette method and found that it was silty loam in nature. Different puddling techniques used by farmers were taken as different treatments *viz.,* T_1 = cage wheel, T_2 = rotavator, T_3 = cage wheel + rotavator and T_4 = power tiller with rotary tool. Since number of passes also influencing the puddling index each treatment was analyzed for P_1 = single pass and P_2 = double pass (Behera *et al* 2009). All the evaluation parameters were measured using the standard procedures. Different puddling techniques are shown in fig. 1. All the treatments were replicated thrice to increase the accuracy of experiment. For evaluation of treatments puddling index and infiltration rate were taken as dependent variables.

Measurement procedures

Puddling index

A sample of 200 ml puddle soil was collected at five locations of puddled field using PVC pipe. PVC pipe was first inserted in to the puddled soil after the final lap of each implement passes. Inserted pipe was clenched at the top, to hold the sample. Then the sample was collected in the 250 ml measuring cylinder. The sample was kept undisturbed for 48 h in measuring cylinder. After 48 h the soil level and total sample level was noted. Using the equation (1) puddling index was calculated.

$$PI = \frac{P_s}{P_t} \times 100 \quad \text{----------- (1)}$$

Where,

PI = Puddling index (per cent)

P_s = Soil level in the measuring cylinder after 48 h (ml),

P_t = Total sample level (ml)

Infiltration rate

A graduated scale was fixed inside of PVC pipe, like an infiltrometer (Fig. 2) at five locations of the puddle field. Pipes were filled with water then the initial value was noted. The water level was noted at every 3h then the infiltration rate for a day was calculated by dividing the reduction in water level with duration of measurement (Chinna, 2015).

Fig.1. Different puddling techniques

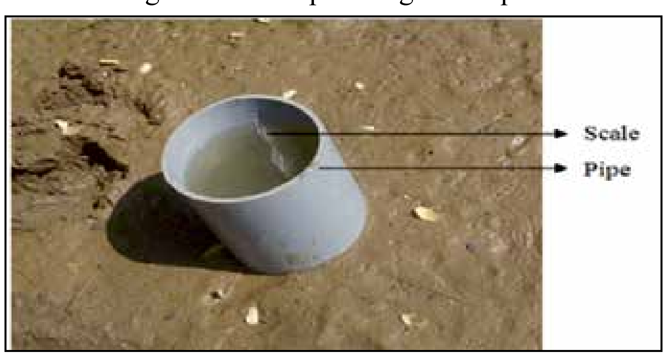

Fig. 2. Infiltration rate measurement

RESULTS AND DISCUSSION

Infiltration rate and puddling index

Infiltration rate on a silty loam soil was higher in cage wheel operation with single pass which recorded lowest puddling index was occurred. In cage wheel (T_1) single pass (P_1) operation puddling index is 49.29 per cent and the infiltration rate is 19 mm/d (Fig. 3). The infiltration rate decreased when the puddling index was increased in cage wheel (T_1) double pass (P_2) operation. In cage wheel with double pass, operation the infiltration rate was decreased to 17.5 mm/d and the puddling index is increased by 52.50 per cent.

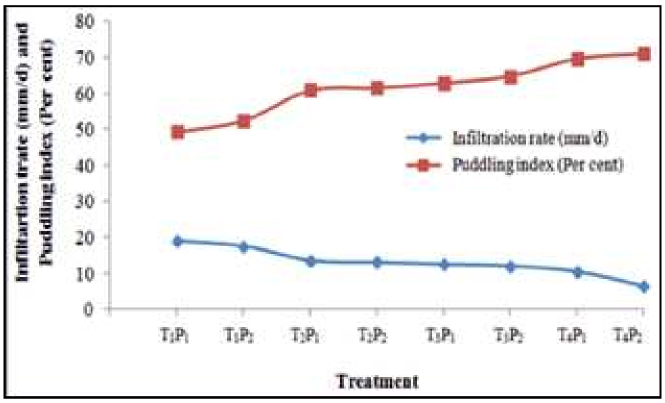

Fig. 3. Influence of different puddling techniques on infiltration rate and puddling index

In rotavator (T_2) single pass (P_1) operation the puddling index was 60.80 per cent and the infiltration rate was 13.5 mm/d. T_2P_2 operation recorded higher puddling index of 61.54 per cent and lowest infiltration rate of 13 mm/d compared with T_2P_1, it might be due to the increased soil disturbance. When the number of passes was increased with rotavator operation, puddling index was increased by 0.012 per cent only. Puddling index was increased by increasing the number of passes in the field. Infiltration rate was decreased by 0.5 mm/d from single pass to double pass in rotavator operation.

The cage wheel and rotavator (T_3) operation had the lower puddling index of 62.86 per cent in single pass (P_1) and the higher puddling index of 64.86 per cent in double pass (P_2). Maximum infiltration rate of 12.5 mm/d was measured in P_1 and the minimum infiltration rate of 12 mm/d was measured in P_2. Puddling index was increased in double pass for all the treatments, it might be due to more soil manipulation by the implement. The above results were in closely related to Verma and Devangan (2006), Behera *et al* (2009). Power tiller with rotary tool (T_4) operation was showing the highest puddling index of 70.91 per cent in P_2 and the second highest puddling index of 69.61 per cent in field in T_4P_1.

The infiltration rate was minimum in T_4P_2 treatment compared with other treatments. The experiments showed a inverse relation between puddling index and infiltration rate in all the treatments (Fig. 4). This might be due to the reason that higher degree of churning of soil with water results in higher puddling index and more number of layers of soil settlement like sand, silt and clay creating effective impervious layer and reduction in the infiltration rate.

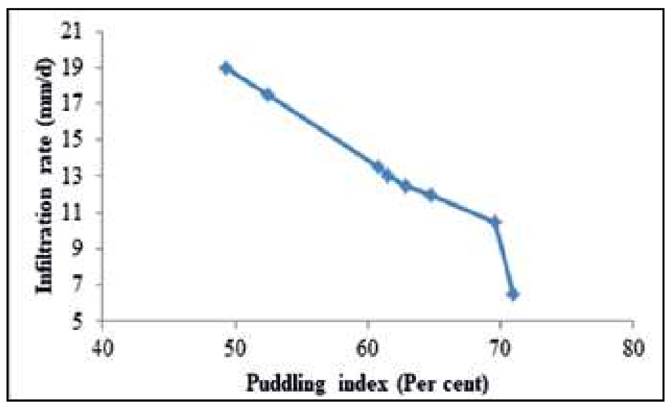

Fig. 4. Relationship between infiltration rate and puddling index

Sand having more weight than silt and clay particles, hence sand will settle down in the churned soil. After that silt and clay layers will follow. More amount of churning of soil will take more time to settle down, so the impervious layer may be effective in reducing infiltration rate.

It was concluded that, in upland area the power tiller attached with rotary tool is the most suitable method because infiltration rate was observed to be minimum among all the treatments. When the infiltration rate reduces, the frequency of water application can be reduced resulting saving of water. In lowland paddy cultivation, usage of cage wheel with two passes allows infiltration of water resulting in proper drainage and reduces water stagnation.

CONCLUSION

In silty loam soil infiltration rate increased with decrease in puddling index for all the implements used in puddling operation. Puddling index was higher in power tiller operated rotary tool for 10 cm depth, because the power tiller was not able to penetrate into the soil below 10 cm. In upland area the power tiller attached with rotary tool is the most suitable method because infiltration rate was observed minimum among all the treatments. When the infiltration rate reduces, the frequency of water application can be reduced resulting saving of water. In lowland paddy cultivation, usage of cage wheel with two passes allows infiltration of water resulting in proper drainage and reduces water stagnation.

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Received on 17/10/2019 *Accepted on 08/12/2019*