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WATER INFILTRATION OF TERRACE SOILS

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Abstract

Water infiltration of three major soil series of the Madhupur tract was measured in the field on rabi season using a double ring cylinder infiltrometer. Two or three different processes were recognized during infiltration upto 300 min and the steady infiltration process occurred at the time of 0-60 or 2-60 min. The infiltration rate was the highest for the Tejgaon series (Deep Red-Brown Terrace Soil) followed by the Gerua series (Shallow Red-Brown Terrace Soil). The Chhiata series (Shallow Grey Terrace Soil) showed a distinctly low infiltration rate compared with the Tejgaon and Gerua series. The basic infiltration rate of the three soil series was classified as moderately low or low according to the classification of USDA Soil Conservation Service.

Key words : Water infiltration, Terrace Soils, Infiltration rate.

Introduction

Terrace Soils of Bangladesh are distributed on the Madhupur and Barind Tracts and occupy 8% of the national land (Saheed, 1984). Terrace Soils have a high potentiality for the cultivation of upland crops throughout the year. For the sustainable crop production, improvement of water use efficiency for crops is one of the most important agricultural problems to be solved in the terrace area. In the current paper, water infiltration of major Terrace Soils was studied to get basic information on the infiltration and the effective use of water supplied as rainfall or irrigation water.

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Materials and Methods

Soils

Three Soil series of Gerua, Tejgaon, and Chhiata representing Shallow Red-Brown, Deep Red-Brown and Shallow Grey Terrace Soils, respectively, were used. All the soils were selected from Gazipur District of the Madhupur Tract. They were located on high land and underlain by the Madhupur clay having a clay texture. Brief description of the soils is presented in Table 1.

Water infiltration measurement

The infiltration of water was measured in the field on January, 1991. A double ring cylinder infiltrometer was used and driven into the soil

Table 1. Brief description of the soils.

Soil Series	Location	Crop or Plant grown	Soil texture*	Porosity** (%)
Gerua	Tajariapara, Mirzapur	Sal	CL-C	45-50
Tejgaon	Shirichchala, Sripur	Mainly jackfruit	L-CL-C	45-52
Chhiata	Gazariapara, Rajendrapur	T. Aman	SiL-SiCL	42-48

* For A and B or E horizons in the descending sequence.
** The range of porosity in A and B or E horizons.

upto the depth of 15 cm. Water was poured into the inner and outer rings until about three-fourth of the rings. The decrease of the water level were recorded after 1, 2, 3, 4, 5, 10, 15, 30, 45, 60, 90,120, 150, 180, 210, 240, 270 and 300 minutes with the help of a hook gauge.

Cumulative infiltration of water is related to cumulative time by the following equation:

$$I = at^b$$

where,

I : cumulative infiltration (mm)

t : cumulative time (min)

a,b : constants.

Taking logarithm,

$$\log I = \log a + b \log t$$

a linear relationship is obtained.

Equation of the infiltration rate, IR (mm/min), is obtained by differentiation of the infiltration equation with time, t :

$$IR = dI/dt = abt^{b-1}.$$

If we express the infiltration rate in mm/hr, so described as follows:

$$IR = 60\ abt^{b-1}.$$

The basic infiltration rate, IR_b(mm/ hr), is defined as the infiltration rate when-dIR/dt is equal to IR/10 (USDA Soil Conservation Service, 1957). After arrangement of the equations, the following equation is obtained as calculating the basic infiltration rate:

$$IR_b = 60\ ab\ \{600\ (1-b)\}^{b-1}$$

Equations expressing the infiltration rate for the three soil series were calculated from the infiltration equations corresponding to the cumulative time of 0-60 or 2-60 minutes and are described as follows:

Gerua series $IR = 3.37\ t^{-0.48}$
Tejgaon series $IR = 5.88\ t^{-0.56}$
Chhiata series $IR = 2.85\ t^{-0.79}$

Results and Discussion

The linear relationship obtained for the three soil series are graphically shown in Fig. 1. The infiltration equations corresponding to the respective lines are given in Table 2.

According to the magnitude of the slope (b) of the logarithmic plot (Fig.1), the infiltration could be divided into two or three processes. Below 2 minutes the Tejgaon and Chhiata series showed the high slope compared with over 2 minutes, and it was attributed to the relatively rapid infiltration into the surface ploughed layer. This initial rapid infiltration process was not observed in the Gerua series which is under Sal forest and has the compact surface layer. The slope of the plot changed at between 60 and

Table 2. Infiltration equations obtained for the three soil series.

Cumulative time (min)	Soil series		
	Gerua	Tejgaon	Chhiata
0-2	$I = 6.48\ t^{0.52}$	$I = 11.17\ t^{0.71}$	$I = 10.47t^{0.58}$
2-60		$I = 13.36\ t^{0.44}$	$I = 13.58t^{0.21}$
90 - 300	$I = 3.01t^{0.71}$	nc*	$I = 8.52t^{0.32}$

* Not calculated because of the non-linear relationship in the logarithmic plot.

90 minutes. The slope was higher for over 90 minutes than for below 60 minutes in the Gerua and Chhiata series, and the same thing was applicable to the Tejgaon series. This phenomenon was rather strange and was attributed to the occurrence of lateral seepage

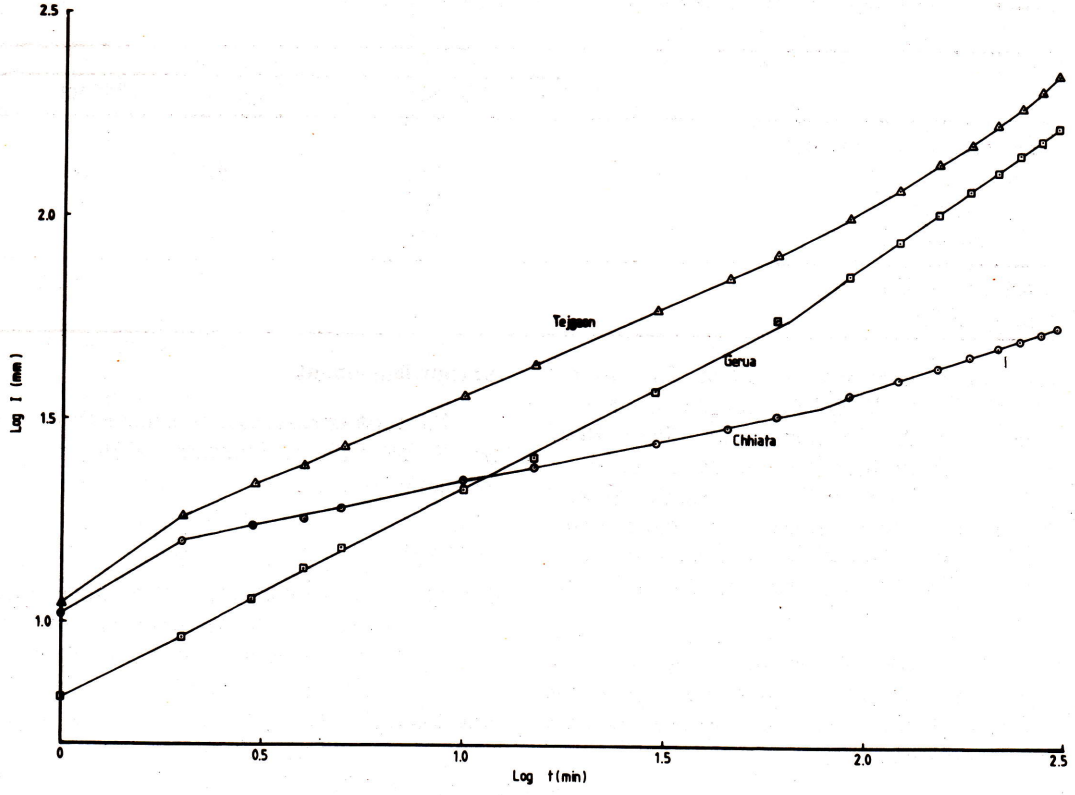

Fig. 1. Log I-Logt plots for the Gerua, Tejgaon and Chhiata series.

out of the outer ring, in addition to the downward movement of water, after passing 60 minutes. Therefore, the range of 0-60 or 2-60 minutes was regarded as the process of steady infiltration.

The infiltration rates calculated for 10, 30, and 60 minutes and the basic infiltration rate are listed in Table 3. The infiltration rate of the Chhiata series (Shallow Grey Terrace Soil) was the lowest at the respective times, and its basic infiltration rate was nearly one-tenth of that of the other two soil series of Red-Brown Terrace Soils. The quite low infiltration rate of the Chhiata series reflects the soil of a paddy field under continuous rice cultivation. The infiltration rates at 10, 30, and 60 minutes were a little higher for the Tejgaon series (Deep Red-Brown Terrace Soil) than for the Gerua series (Shallow Red-Brown Terrace Soil) supported by the more advanced stage of weathering of the Tejgaon series, but the basic infiltration rate was almost the same between the two soil series.

The Gerua and Tejgaon series may be classified as moderately slow and the Chhiata series as slow in their basic infiltration rates (Soil Survey Staff,1951).

Conclusions

The water infiltration rate of Terrace Soils is estimated to be moderately slow to slow. This may be due to the relatively low porosity that resulted in suppressing the percolation of water. This is favourable for rice cultivation but has an adverse effect on upland crops. So, the proper water management or the soil management practices such as removal of excess surface water and avoidance of wet soil condition are needed for the cultivation of upland crops. Formation of stable soil structure that supports good physical conditions and sustains crop production is the final aim of soil management.

Table 3. Infiltration and basic infiltration rates for the three soil series.

	Soil series		
	Gerua	Tejgaon	Chhiata
Infiltration rate (mm/min)			
at 10 min	1.12	1.62	0.46
30 min	0.66	0.88	0.19
60 min	0.47	0.59	0.11
Basic infiltration rate (mm/hr)	13.34	13.57	1.32

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