Andrew Altevogt
SSC 107
October, 26 1995

Laboratory Exercise 7 -- Infiltration into Field Soils

Abstract

Water infiltration into a sandy-loam was explored under field conditions. The total amount of water which infiltrated over the duration of the experiment (80 minutes) was 50.5 liters. The infiltration rate appeared to be approaching steady-state towards the end of the experiment. The approximate steady-state rate was 0.03 cm/min.

Materials and Methods

All methods and materials were followed according to the laboratory outline with the following additions. The infiltrometer was initially filled by rapidly pouring out buckets and bags of water and attempting to get the water level in the infiltrometer up to the level of the constant head device. Readings from a tensiometer installed inside the infiltrometer at a 53 cm depth were taken at recorded time intervals throughout the experiment. A neutron probe access tube was also installed and readings were taken before water had been added to the infiltrometer and 78 minutes after water had been added.

Results

Infiltration results are presented in Table 1 and Figures 1 and 2. The volume of water which entered the soil was calculated by determining the change in height of water in the reservoir (Δz) and multiplying by $\pi(D/2)^2$, where D is the measured diameter of the reservoir (76.8 cm). This volume was then divided by the cross sectional area (A = 14641 cm^2) of the infiltrometer and the length of the time interval over which Δz was measured, in order to obtain the infiltration rate for each time interval. It should be noted that the first measurement of Δz was not taken until 10 minutes into the experiment because the flow from the reservoir had to be turned off and restarted during this interval. The total infiltration (V/A) over the 80 minutes which this experiment was conducted was 3.45 cm.

Tensiometer readings taken throughout the infiltration experiment are presented in Table 2. Neutron probe data were not available for this report.

Discussion

As can be seen from Figure 2 there was a great deal of oscillation in the recorded infiltration rate over the time intervals sampled. The data does appear to follow an "average" trend toward steady state. It is believed that this oscillation is due to the operation of the constant head device in the infiltrometer. Instead of filling the infiltrometer (and thus draining the reservoir) at a constant rate the valve on the constant head device would remain closed for a while and then open for short time leading to the behavior seen in Figure 2. By visual inspection of Figure 2 it appears that the infiltration rate was beginning to approach a steady state (in a pseudo-logarithmic fashion) toward the end of the experiment. A gross approximation of this rate is 0.03 cm/min. This would correspond to the steady state infiltration rate in a "sandy and silty" soil (class notes, p 6.8).

A detailed analysis of the matrix head data is not possible as the first strong response of the tensiometer was seen over the last time interval of the experiment. It is however interesting to note that it took the tensiometer, at a depth of 53 cm, 90 minutes to detect the infiltrating water.

Conclusions

Although it was not possible to accurately determine a steady state infiltration rate the value which was determined (albeit not very accurately) does correspond reasonably to reported values. Using a more sensitive constant head valve could have eliminated much of the uncertainty associated with the determination of the infiltration rate. Collecting data over a longer time period (2-3 hours) would have also mitigated this problem and would have allowed us to better capture the response of the tensiometer to the wetting front.

Sample Calculations

Infiltration:

$$\frac{V}{A} = \frac{\Delta z (D/2)^2 \pi}{L^2}$$

for the first time interval:

$$\frac{V}{A} = \frac{(1.8cm)(76.8cm/2)^2 \pi}{(121cm)^2}$$

$$\frac{V}{A} = \frac{8338cm^3}{14641cm^2}$$

$$\frac{V}{A} = 0.57cm$$

Infiltration Rate:

$$\frac{V}{At} = \left(\frac{V}{A}\right)\frac{1}{t}$$

for the first time interval:

$$\frac{V}{At} = (0.57cm)\frac{1}{10\min}$$

$$\frac{V}{At} = 0.057cm/\min$$

Tables

Time (min)	^{2}z (cm)	^{2}V/A (cm)	V/A (Cumulative, cm)
10	1.8	0.57	0.57
15	1.2	0.38	0.95
20	0.6	0.19	1.14
25	1	0.32	1.46
30	0.7	0.22	1.68
35	0.8	0.25	1.93
40	0.5	0.16	2.09
45	0.7	0.22	2.31
50	0.4	0.13	2.44
55	0.6	0.19	2.63
60	0.4	0.13	2.75
70	1.3	0.41	3.16
80	0.9	0.28	3.45

Table 1. Volume of water entering infiltrometer (ΔV) per infiltrometer unit area (A) with time (t).

Time (min)	□$_m$ (mbar)
17	-682
23	-679
28	-674
33	-665
38	-662
41	-656
48	-652
54	-639
58	-633
63	-627
72	-621
82	-615
90	-556

Table 2. Matrix potential as a function of Elapsed time.

Figures

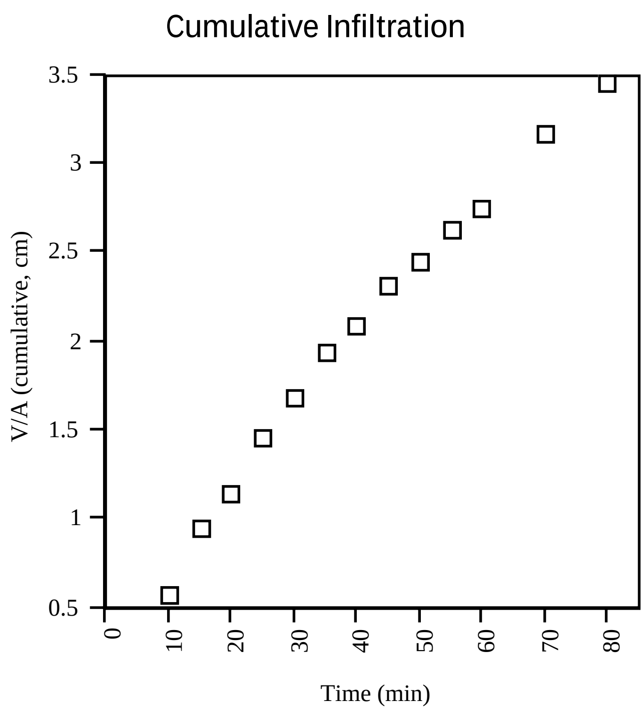

Figure 1. Cumulative infiltration.

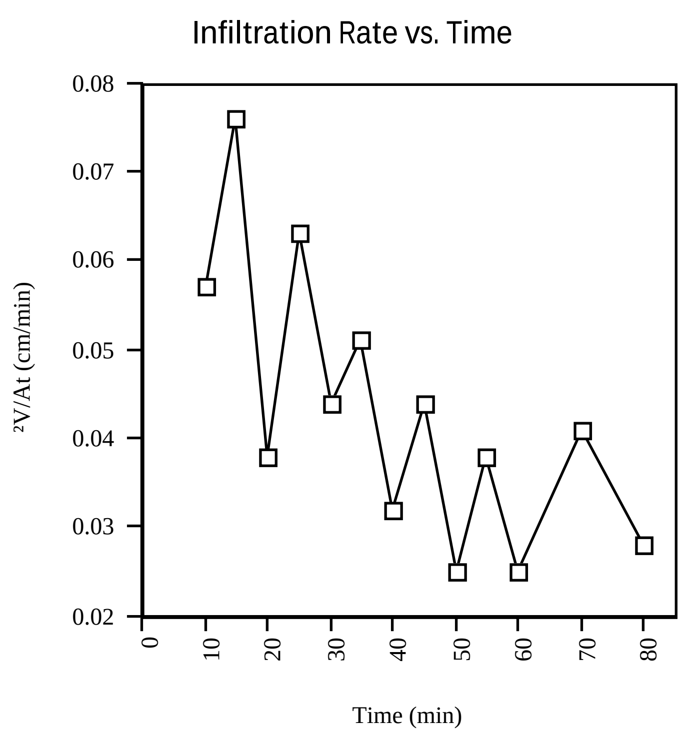

Figure 2. Infiltration rate versus time.