USDA Natural Resources Conservation Service

Irrigation Toolbox: Chapter 1

Lesson Plan 5

Water Movement Through Soil

Background

A knowledge of the soil, water, and plant relationship is necessary before you can fully appreciate the concept of water movement through soil and its effect on wetland determination. Soil, water, and plant relationships are important for meeting the three criteria for wetlands. Forces applied to the plant system allow water to enter root cells under normal conditions. Under saturated or very wet soil conditions, these forces are changed.

In normal unsaturated soil conditions, water moves in all directions in response to the attraction of soil particle surfaces for water. Cohesive forces form between water molecules which result in water occupying the small pores.

A review of soil structure and its effect on water movement through soil should be helpful in understanding the differences in wetland conditions. Soil structure influences the rate of water movement through soil as shown in Table 1. Soil structure also affects plant root growth and development (Figure 1).

Table 1

Soil Structure	Water Movement
Single Grain	Rapid
Granular	Rapid
Blocky	Moderate
Prismatic	Moderate
Platy	Slow
Massive	Slow

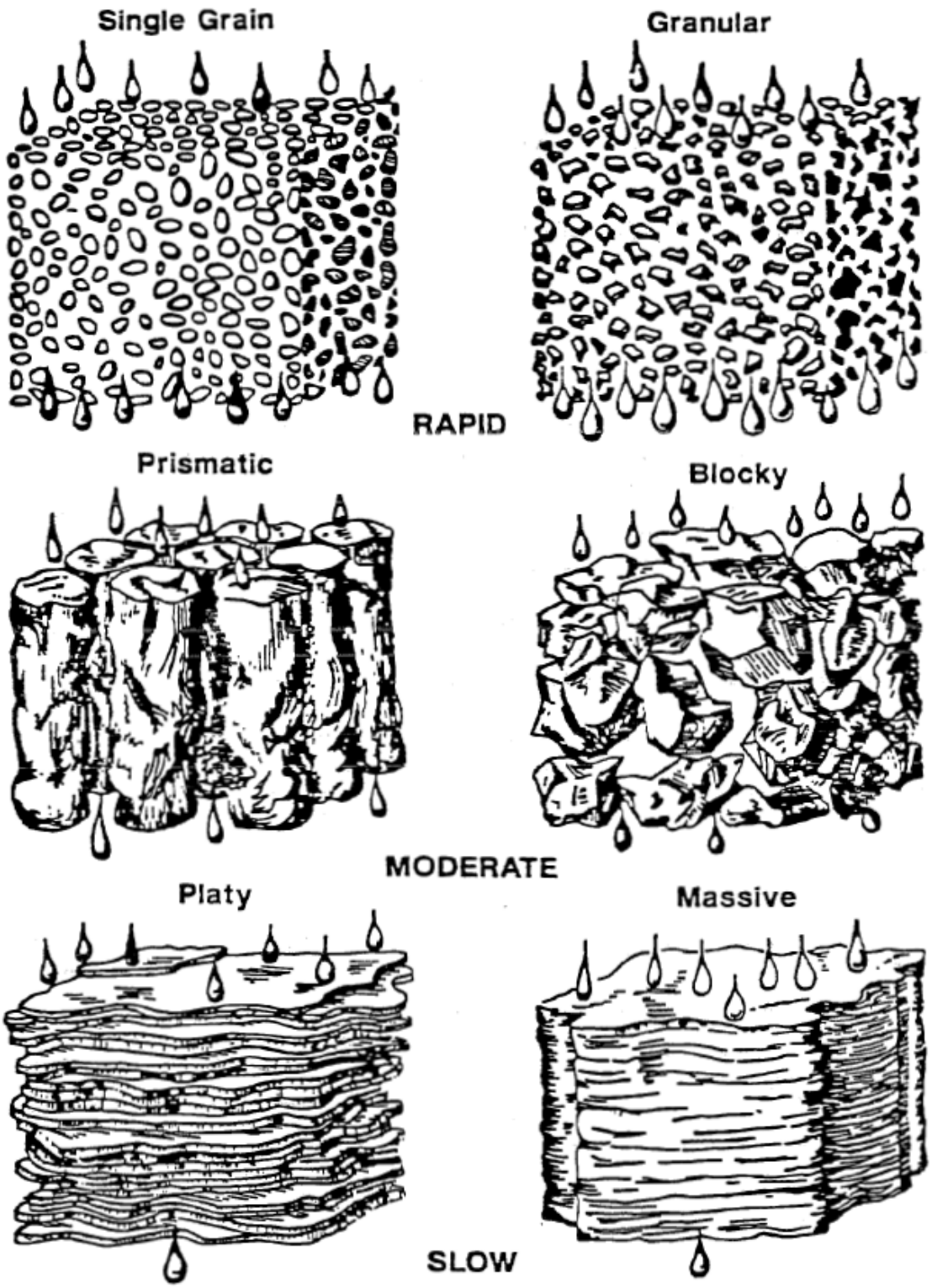

Figure 1. Type of soil strudure and their effect on downward movement of water.

Soil Water Movement

Movement of soil water is a dynamic process due of the various states, directions, and forces acting upon the water. Temperature can play an important part in the movement of soil water. In frozen soil, there is relatively little movement at all. Under extremely high temperatures, some water movement will occur through vaporization.

Saturated Soil

For saturated soil conditions, all soil pores are completely filled with water and there is no air. The lower portion of poorly drained soil may often be saturated, while the surface will only be saturated for a short time. Saturated Flow Saturated flow occurs both vertically and horizontally. In addition to the normal forces (unsaturated flow conditions) acting on the water particles, there are hydraulic gradients that move water from higher elevations to lower elevations.

Unsaturated Flow

Under this condition, the pore spaces are not completely filled with water. There is some air in the pore space. The micropores are filled with water and the macropores are filled with air and water. Movement of water in the pore space is by a suction (tension) gradient, and is from a low suction area to a high suction area. Another water movement method is from thick moisture films to thin moisture films. This condition is equivalent to capillary water (Table 2).

Vapor Equalization

Vapor water does not exist in the soil profile; so its existence does not impact the saturated or wet soil profile.

Table 2 Capillary Rise of Water				
	Grain Size		Average Capillary Rise	
Material	Millimeters	Inches	Centimeters	Feet
Gravel, Fine	5.00 – 2.00	0.20 – 0.08	2.5	0.08
Sand, Very Coarse	2.00 – 1.00	0.08 – 0.04	6.5	0.21
Sand, Coarse	1.00 – 0.50	0.04 – 0.02	14.0	0.46
Sand, Medium	0.50 – 0.20	0.02 – 0.08	25.0	0.82
Sand, Fine	0.20 – 0.10	0.008 – 0.004	43.0	1.40
Silt	0.10 – 0.05	0.004 – 0.002	106.0	3.50
Silt	0.05 – 0.02	0.002 – 0.0008	200.0	6.60