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INFLUENCE OF SEA WATER ON HYDRAULIC CONDUCTIVITY OF TWO SOIL TYPES OF KERALA

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High saline waters are often not recommended for irrigation purposes on normal soils because of the impending danger of their becoming saline or alkali depending upon the concentration and composition of dissolved constituents and soil physical conditions. In subhumid regions, when irrigation is practiced on a standby or supplemental basis salinity is usually of little concern, because rainfall is generally sufficient to leach out any accumulated salts. Besides, if soils have good drainage characteristics in subhumid regions, it further reduces the chances of their becoming saline even with high saline waters.

Hydraulic conductivity of a soil is the most important single parameter required for any drainage design. It is known to vary with the nature of fluid as well assoil characteristics. In this report an attempt has been made to study the influence of different concentrations of sea water on hydraulic conductivity of two soil types of Kerala, namely, a lateritic soil and a red soil. It is expected that information provided herein will be useful from both agricultural and engineering standpoints.

Materials and Methods

AH experiments were conducted on undisturbed soil cores collected from the experimental farms of College of Agriculture, Vellayani, Kerala. Two types of soils were studied, namely, a lateritic soil and a red soil. In all, six different concentrations of sea water were employed to study the influence of quality of sea water on the hydraulic conductivity of these two soils. They were: (a) fresh water (tap water) (b) 50 per cent fresh water and 50 per cent sea water (on volume basis) (c) sea water (d) 1.5 times concentrated sea water (e) 2.0 times concentrated sea water (f) 2.5 times concentrated sea water. The sea water was collected from Kovalam. Sodium and potassium in the sea water were estimated using a flame photometer. Calcium and magnesium were determined by the ver–senate method. Chloride and bicarbonate were estimated by titrating against the the standard solutions of $AgNO_3$ and H_2SO_4 respectively. Sulphate was measured using barium chloride method (Richard 1954). The different concentrations of sea water were obtained either by evaporation or dilution with fresh water.

To start with, all the undisturbed soil cores were saturated with the respective type of water by capillary rise. The hydraulic conductivity of the saturated cores was determined by constant head method (Black, 1965) wherein a constant flux was obtained under a small positive head of 2 cm in each case. Darcy's equation which when stated verbally, indicates that the flow of a liquid through a porous medium is in the direction of and at a rate proportional to the

driving force acting on the liquid (being the hydraulic gradient) and also proportional to the property of the conducting medium to transmit the liquid, was employed tocalculate hydraulic conductivity of saturated soil cores. Thus, if q represents the flux, AH the hydraulic head difference, L the length of the soil core, then K the hydraulic conductivity is given by the following relationship:

i.e.. $$q = K \frac{\Delta H}{L} \quad \text{.....} \quad (1)$$

$$K = -q \frac{L}{\Delta H} \quad \text{.....} \quad (2)$$

If q is measured in cm/s, L in cm and AH also in terms of cm, then the dimension for hydraulic conductivity is length per time, ie., cm/s in cgs units.

Each experiment was conducted at least thrice "and the average value was attributed to the type of water used to determine the hydraulic conductivity. All experiments were conducted at a room temperature of 25 $\pm$ 5°C.

Result and Discussion

Table 1 presents some of the physico-chemical characteristics of the two soils, namely, a lateritic and a red soil that have been used in the present investigation, The textural class for both soils is sandy loam. The average soil bulk density of the two soils is nearly the same. Both soils are acidic in nature— a characteristic that is often ascribed to the soils of humid tropical conditions. They are generally deficient in available nutrients. Table 2 gives the composition of sea water used in the experiment.

Table 3 presents data in respect of hydraulic conductivity of lateritic and red soils in relation to the quality of sea water. In general, hydraulic conductivity decreased with increase in the salt content of the sea water in both the soils. However, the reduction in hydraulic conductivity was more pronounced in the case of lateritic soil as compared to red soil in relation to the quality of sea water (Singh and Bhumbla, 1968). The magnitude of reduction was about six fold in the case of lateritic soil in comparison with about 2.5 fold in red soil as the quality of water changed from fresh water to 2.5 times concentrated sea water (Kanwar and Kanwar, 1969).

The hydraulic conductivity was maximum with fresh water in both the soils studied. However, it decreased by 6% in the case of lateritic soil, and by 15% in the case of red soil, when a mixture of equal volumes of fresh and sea water was employed to determine hydraulic conductivity of the soils. When sea water alone was used, the further reduction in hydraulic conductivity was about 50 per cent for lateritic soil and about 25 per cent for red soil. However, the rate of reduction in hydraulic conductivity became less as the concentration of sea water was increased in both the

Table 1
Some physical and chemical characteristics of red and lateritic soils

		Red soil	Lateritic soil
Coarse sand	(%)	40.7	31.5
Fine sand	(%)	25.3	19.2
Silt	(X)	18.0	17.0
Clay	(%)	12.4	29.3
Gravel	(X)	5.07	63.47
Particle density	(g/cm^3)	2.58	2.19
Bulk density	(g/cm^3)	1.48	1.50
Total porosity	(%)	43.53	30.83
Org. carbon	(%)	0.47	0.21
Total CaO	(%)	00.017	0.022
Total Fe_2O_3	(%)	5.56	5.67
R_2O_3	(%)	11.0	14.64
pH	(%)	5.1	5.6
Total nitrogen	(%)	0.024	0.092
Total P_2O_5	(%)	0.07	0.042
Total K_2O	(%)	0.034	0.031

Table 2
Composition of the sea water used.

Sources	ppm
Total salts	34840
Sodium	10590
Magnesium	1280
Calcium	412
Potassium	358
Chloride	19343
Bicarbonate	150
Sulphate	2690

Table 3
Mean values of hydraulic conductivity of red and lateritic soils under different treatments (cm/h)

	Quality of water	Lateritic soil	Red loam soil
1	Fresh water	15.1	10.8
2	50% sea water + 50% fresh water	14.1	9.2
3	Sea water alone	7.2	7.0
4	1 ½ times concentrated sea water	3.7	5.9
5	2 times concentrated sea water	2.8	5.2
6	2 § times concentrated sea water	2.4	4.8

soils, it lends credence to the fact that sea water being dominant in Na ions is able to disperse the soil clay in a more effective and efficient manner at its original concentration. Conseqnently, the amount of space occupied by macropores decreased drastically thereby resulting in an increase in the tortuousity of the flow channels of the porous medium and, hence, an abrupt fall in the hydraulic conductivity of the soils.

It can be inferred from the data presented in Table 3 that a further increase in the salt concentration of sea water beyond its original concentration does bring out more effective dispersion of the soil clays but the effect continues to lessen in its magnitude. However, it is interesting to observe that the hydraulic conductivity values of the soils when measured with sea water alone was appreciably high indicating thereby the good drainage behaviour of the soils studied. It may further imply that use of sea water alone for irrigating salt tolerant crop like coconut on these soils may not pose a considerable danger of adverse effects on the physical properties of soils. However, a word of caution is that more research is needed to establish the veracity of the above observations.

Summary

The effect of the quality of sea water on the hydraulic conductivity of two soils of Kerala, namely, a lateritic and a red soil, was studied by conducting laboratory experiments on the undisturbed soil core samples. It was observed that the hydraulic conductivity decreased with increase in the salt content of the sea water used in both the soils. However, the effect was more pronounced in the case of lateritic soil as compared to red soil.

സംഗ്രഹം

പല സാന്ദ്രതയിലുള്ള കടൽ വെള്ളം ഉപയോഗിച്ച് ചെമ്മണ്ണിലും, വെട്ടുകൽ മണ്ണിലും ഹൈഡ്രോളിക് കണ്ടക്ടിവിറ്റി അളന്നുനോക്കിയപ്പോൾ, കടൽവെള്ളത്തിന്റെ സാന്ദ്രത കൂടുന്നതനുസരിച്ച് ഹൈഡ്രോളിക് കണ്ടക്ടിവിറ്റിയുടെ അളവ് കുറയുന്നതായി കണ്ടു. പക്ഷെ ചെമ്മണ്ണിനെ അപേക്ഷിച്ച് വെട്ടുകൽ മണ്ണിലാണ് ഈ വ്യതിയാനം കൂടുതലായി കാണുവാൻ കഴിഞ്ഞത്.

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