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WATER RETENTION CHARACTERISTICS OF SOME ACID SOILS

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ABSTRACT

Nine soil profiles representing three soil types (Fluventic Dystrudepts, Fluventic Eutrodepts and Typic Hapludults) in the south eastern part (Nagajanka) of Jorhat district of Assam were studied for their water retention characteristics in relation to different soil properties. An increase in tension from 0.01 to 0.10 MPa released 0.66, 0.59 and 0.67 water (m^3/m^3) in Fluventic Dystrudepts, Fluventic Eutrodepts and Typic Hapludults, respectively. The available water of respective soil was found 0.217, 0.229 and 0.189 m^3/m^3. Most of the available water retained was released upto 0.2 MPa matric suction. Water retention at 0.03 and 1.5 MPa and available water displayed definite relation with various soil hydraulic properties.

Keywords: Water retention, MPa, suction, soil properties, Assam

INTRODUCTION

Soil moisture plays a cardinal role in sustaining ecological balance and agricultural development virtually the very existence of life on earth. Because of the growing shortage of water resources, it is important to use the available water most efficiently by proper management. The availability of water and its retention are governed by the properties of soil. Study of soil and its moisture retention capacity is essential for the efficient utilization of irrigation water. Hence, identification of key soil properties which influence the water retention capacity plays an important role in irrigation scheduling. No such information exists on soils of Nagajanka area that have tremendous potential of irrigation. It is assumed that judicious use of irrigation water based on moisture retention characteristics would undoubtedly increase the livelihood security of the area. Keeping all these aspects in view the present investigation is an attempt to study the water retention characteristics in relation to different properties of soil.

METHODS AND MATERIAL

The study was undertaken in Nagajanka area located between $26^0$37'20" to $26^0$37'45"N latitude and $94^0$22'00" to $94^0$23'00" E longitude. The climate is humid sub-tropic with annual rainfall 2250 mm. The study area comprises three soil types and one pedon from each type was undertaken for laboratory investigations. All the physical and chemical properties of soil were determined as per the methods described by Baruah and Barthakur (1998). Soil water retention at suction below 100 kPa was determined by pressure plate and more than 100 kPa by pressure membrane (Richards, 1954) apparatus.

RESULTS AND DISCUSSION

All the pedons had uniform conditions of drainage and aeration (reflected from common hue 10YR) and values of matric colour and chroma ranged from 4-6 and 2-8, respectively. The surface soils, in general, were darker in colour as compared to subsurface soil. This might be due to high accumulation of organic matter content. The surface and subsurface horizons were moderately heavier in texture (loam to clay loam) irrespective of soil types. There were variations in texture within the profiles at any of the soil types. Occurrences of mottles were observed in the lower layers of horizons with hue ranging from 2.5 YR to 7.5 YR. This is attributed to an alternate wetting and drying of lower horizons enriched with Fe and Mn content due to fluctuations of underground water. Khan *et al.* (2012) supported the same argument.

Soil reactions *viz.*, pH and EC had slight variations between uppermost and lowermost layers and found to increase down the soil profiles (Table 1). Increase in pH might be attributed to the reduced environment converting Fe^{3+} to Fe^{2+} form. The results might be accentuated by increased concentration of Fe_2O_3 towards the lower horizons. This conform the findings of Muller and Bocquier (1986). Increase in EC down the profiles might be due to leaching of soluble salts. Bulk density had a marginal range (1.47-1.53 Mg/m^3) and increased down the depth. **B.**

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Comparatively low bulk density in surface horizons may again be attributed to high organic carbon contents. Organic carbon contents were higher in surface horizons and decreased with depth. Similar trends were also observed in respect of available P_2O_5 and K_2O content of soil. Our earlier observations were similarly made (Medhi *et. al.* 2002).

Table 1: Physico-chemical characteristics of the some soil profiles

Horizon	Soil depth (m)	pH (1:2)	EC (1:2)	OC (%)	Avail. P_2O_5 (kg ha^{-1})	Avail. K_2O (kg ha^{-1})	BD (Mg/m^3)	Fe_2O_3 (mg/kg)	Sand (%)	Silt (%)	Clay (%)	Texture
Typic Hapludults												
A	0-0.18	4.67	0.023	0.64	31	137	1.49	1217.3	56	30	14	sl
Bc1	0.18-0.48	4.69	0.022	0.63	27	132	1.48	1197.3	53	33	14	sl
Bc2	0.48-0.80	4.68	0.021	0.63	26	129	1.48	1319.6	30	54	16	sil
C1	0.80-1.22	4.80	0.029	0.63	24	127	1.50	1598.9	19	53	28	sicl
C2	1.22-1.66	4.90	0.028	0.54	23	128	1.50	1834.6	18	54	28	sicl
Fluventic Dystrudepts												
A	0-0.18	5.03	0.028	0.69	35	133	1.47	1698.5	42	27	31	cl
Bw1	0.18-0.53	4.98	0.029	0.58	31	127	1.49	1597.6	18	50	32	sicl
BC1	0.53-0.81	5.10	0.028	0.51	31	123	1.50	1449.4	28	48	24	l
BC2	0.81-1.17	5.18	0.029	0.43	30	119	1.48	1369.7	54	32	14	sl
C1	1.17-1.41	5.22	0.030	0.45	24	121	1.52	1669.5	20	53	28	sicl
C2	1.41-1.57	5.21	0.026	0.41	24	121	1.52	1779.6	18	51	31	sicl
Fluventic Eutrodepts												
Ap	0-0.15	4.52	0.02	0.70	28	139	1.52	1369.4	56	25	19	sl
Bw1	0.15-0.41	4.50	0.02	0.65	24	134	1.51	1295.3	56	25	19	sl
Bw2	0.41-0.74	4.70	0.026	0.53	22	134	1.52	1563.8	42	29	29	cl
Bw3	0.74-1.27	4.80	0.027	0.53	23	128	1.52	1461.4	40	31	29	cl
Bc1	1.27-1.62	4.90	0.027	0.49	21	121	1.51	1873.7	48	16	36	sc
Bc2	1.62-1.80	4.90	0.026	0.44	19	121	1.53	1996.2	48	16	36	sc

sl : sandy loam, sil : silty loam, sicl : silty clay, cl : clay, l : loam, sl : sandy loam, cl: clay, sc: sandy clay

Water retentions data generated at different tensions (Table 2) revealed that irrespective of soil types and depths of sampling, increase in tension from 0.01 to 0.20 MPa released soil- bound water remarkably and the values decreased gradually with every increment of soil moisture tension thereafter. An increase in tension from 0.01 to 0.10 *MPa* released 0.66, 0.59 and 0.67 water (m^3/m^3) in Fluventic Dystrudepts, Fluventic Eutrodepts and Typic Hapludults, respectively. The available water of respective soil was found to be 0.217, 0.229 and 0.189 m^3/m^3. Similar observations were earlier recorded by Kaushal *et al.* (1996). It was seen that water retentions increased down the profile which was much conspicuous at lower tension level. This might be attributed to higher clay content at greater soil depth. Results further revealed that both available water and available water capacity was found to increase down the soil profile irrespective of soil types and depth. The moisture retention characteristics curve of surface soil changed very rapidly in the lower than the higher tension range (Fig. 1). Water retention at 0.03 and 1.5 *MPa* and available water had significant and positive relationship with clay (r = 0.784, 0.736 and 0.754), silt (r= 0.562, 0.596 and 0.582), organic carbon (r= 0.611, 0.583 and 0.589) and Fe-oxide (r= 0.585, 0.596 and 0.577), while negative with sand (r= -0.623, -0.698 and -0.684) and bulk density (r= -0.582, -0.598 and -0.639).

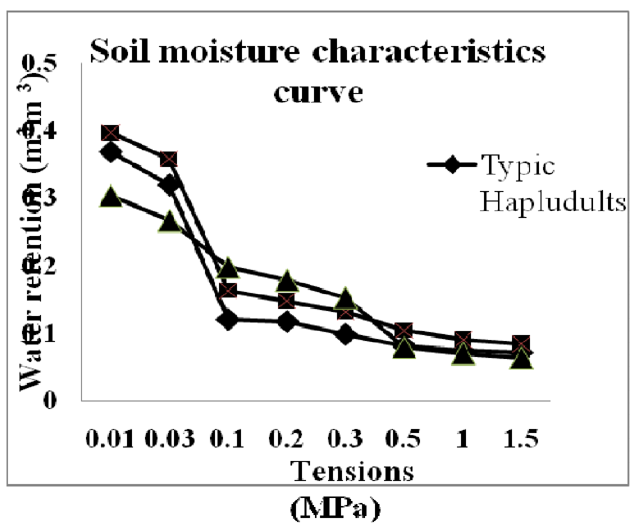

Fig. 1: Soil moisture characteristics curve of surface soil

Table 2: Soil water retention at different tensions (*MPa*)

Soil depth (m)	Water retention (m^3/m^3) by the soils at different tensions									
	Tensions (*MPa*)								Available water (0.03-1.5 *MPa*)	Available water capacity (10^2m^3)
	0.01	0.03	0.1	0.2	0.3	0.5	1	1.5		
Typic Hapludults										
0-0.18	0.368	0.319	0.120	0.117	0.098	0.081	0.074	0.071	0.248	4.46
0.18-0.48	0.371	0.352	0.138	0.112	0.093	0.086	0.079	0.077	0.275	8.25
0.48-0.80	0.394	0.369	0.154	0.137	0.113	0.079	0.074	0.071	0.298	9.54
0.80-1.22	0.409	0.398	0.129	0.114	0.106	0.092	0.087	0.073	0.325	13.65
1.22-1.66	0.407	0.387	0.123	0.109	0.092	0.087	0.076	0.069	0.318	13.99
Fluventic Dystrudepts										
0-0.18	0.397	0.358	0.163	0.148	0.132	0.104	0.091	0.084	0.274	4.93
0.18-0.53	0.377	0.339	0.158	0.139	0.115	0.098	0.087	0.084	0.255	8.92
0.53-0.81	0.409	0.348	0.167	0.153	0.113	0.08	0.076	0.071	0.277	7.75
0.81-1.17	0.377	0.331	0.156	0.149	0.113	0.079	0.061	0.06	0.271	9.75
1.17-1.41	0.372	0.331	0.152	0.148	0.121	0.086	0.079	0.071	0.260	6.24
1.41-1.57	0.374	0.328	0.152	0.146	0.116	0.076	0.068	0.063	0.265	4.24
Fluventic Eutrodepts										
0-0.15	0.304	0.267	0.198	0.179	0.153	0.08	0.071	0.064	0.203	3.04
0.15-0.41	0.303	0.251	0.199	0.183	0.109	0.078	0.069	0.064	0.187	4.86
0.41-0.74	0.324	0.229	0.22	0.201	0.151	0.089	0.084	0.071	0.158	5.21
0.74-1.27	0.318	0.249	0.209	0.183	0.132	0.09	0.081	0.071	0.178	9.43
1.27-1.62	0.337	0.298	0.23	0.216	0.149	0.096	0.087	0.073	0.225	7.87
1.62-1.80	0.388	0.349	0.249	0.206	0.161	0.089	0.081	0.073	0.276	4.96

Conclusion

It is obvious form the present discussion that all the soils were poorly drained owing to confinement of ground water near the soil surface at 1.5 metre below showing additionally an increase in water retention down the soil profile at low tension. Low cost lift pump may be explored to utilize the available ground water resource for irrigation purpose especially for small and marginal farmers. *In-situ* maintenance of soil organic carbon is a better option for sustained conservation of readily available moisture in soil.

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