Determination of the Water Intake Characteristic of the Three Major Soils in Imo State

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ABSTRACT
The water intake characteristics for the three major soil groups in Imo State were determined using the field infiltrometer tests methods. The results show that Alluvial soils have an average intake rates of 12.5cm/hr. The ferralitic soils have 6.2cm/hr while the hydromorphic soils have the least value of 2.2cm/hr. The intake depths obtained using an hour interval were 4.9cm for the alluvial soils, 5.6cm for the ferralitic soils and 6.0cm for the hydromorphic soils. Consequently, the regression line equations were developed for the three major soils for the estimation of the intake rates, intake depths and intake time during water application processes by the farmers in Imo State.

Key words: Intake characteristics, soil groups, alluvial soil, hydromorphic soils, ferralitic soils, intake rates.

INTRODUCTION

The applications of water to the soil by irrigation methods are common in most of the agrarian world (Hensen et al, 1980). This is the process by which water is applied to the soil for the development of crops. The rate of application however, depends on the water intake characteristics of the soils. These intake characteristics include the intake rates, intake depths and the intake time. The soils textures and structures affect the water intake rates (Arora, 2006). Water is applied to the soil for the purpose of supplying the moisture needed by plants for growth (Ojha, 2003). It is one of the external factors required by the crops for survival (Garg 2005). The main objective of any agricultural development is to increase the crops yields using an increased water availability (Arora, 2006). The volume of water a soil can hold depends on the particles sizes of the soils, the continuity of the soil pores, the hydraulic gradients (Micheal, 1981) and the available storage volume (Holtan et al, 1967).

The intake rate of the soils affect both the movement of water into the soil and water storage and are said to be dependent on water availability. The general intake depths associated with the soils is time dependent as stated by Kastiakov, (1932), Holtan et al (1967) and Hensen et al (1980). Consequently, the intake depth in evaluated using the following expressions.

$$I = KT^n \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where
I = The intake depth in cm
K = The initial intake rate in cm/hr
T = The intake time in hours
N = The exponent. The value n represents the rate at which the intake rate decreases with time. When equation (1) is differentiated with respect to time (t), the intake rate of the soil can be obtained using the expression.

$$dI/dt = KnT^{n-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Equations (1) and (2) indicate that both the intake rate and intake depth are time dependent. In any water application process, the surface characteristics of both the surface and subsurface layers (textures and structures) are important (Smith 1984). The soils aggregates, presence of crop residues, mulch and high organic matter content help to improve both infiltration and percolation processes (Orjha 2003). The infiltration and intake processes are the major ways by which water can be added into the soil (Arora, 2006). One of the major problems associated with irrigation in the inability of the farmers to apply adequate water required by plants due to the presence of fine textures with the attendant low intake rates. It is necessary to add that unless sufficient water enter the soil and stored at the crop root zone, the growth and development of crops will be significantly reduced. The soils intake rates enable the farmers to prevent under and over irrigation processes.

TABLE 1
FIELD TESTS USED IN THE STUDY

S/No	Location	Soil Group	No of test
1.	Oguta	Alluvial	5
2.	Owerri	Ferralitic	5
3.	Okigwe	Hydromorphic	5

MATERIALS AND METHODS

Five field tests were carried out at Oguta for the alluvial soils, Owerri for the ferralitic soils and Okigwe for the hydromorphic soils. The infiltrometer tests were carried out as described by Kastiakov (1932) and revised by Michael (1981) using the representative soil samples at every location. The results of the tests show that the average infiltration rates of the alluvial, ferralitic and hydromorphic soils. The results of the infiltration tests were plotted on a log-log graphs given the intercepts (K) and the exponent (n). The values of K and n were also determined mathematically using the least square methods.

The values of "K" and "n" were used to drive the regression line equations for the three major soils. The regression line equations can also be used to estimate the intake rate, intake depth and intake time for the soils.

TABLE 2
AVERAGE INFILTRATION RATES FOR THE THREE MAJOR SOIL GROUPS IN IMO STATE

S/No	Time (mins)	Alluvial soils (cm/hr)	Ferralitic soils (cm/hr)	Hydromrophic soil cm/hr
1.	5	250	190	132
2.	10	254	182	120
3.	15	220	156	108
4.	20	200	144	94
5.	25	188	132	80
6.	30	144	108	72
7.	35	132	82	60
8.	40	100	70	68
9.	45	84	58	48
10.	50	64	40	46
11.	55	56	36	40
12.	60	56	36	40

RESULTS AND DISCUSSION

The results of the particles size analysis for three major soils were presented on Table 3. The results of the infiltration rates of the three major soil groups were also shown on Table 2. The results of the intake characteristics of the alluvial, ferralitic and hydromorphic soil groups were presented on Table 3. The K-value for alluvial soils was 29cm/hr, 20cm/hr for the ferralitic soil and 13.2 cm/hr for the hydromorphic soils. The alluvial soils have the highest intercept K of 29cm/hr while hydromorphic soil has the least value of 13.2 cm/hr. Alluvial soils have the highest initial intake rate of water followed by the ferralitic and hydromorphic soils. Similarly, the alluvial soil have the highest average intake rates of 12.5cm/hr followed by the ferralitic soils with 6.2cm/hr and the hydromorphic soils with the least value of 2.2cm/hr (Table 3). The intake value of the alluvial soils is about six times higher that of the hydromorphic soils and two times the ferralitic soils. The water intake depth of alluvial soil is 5.6cm, ferralitic soil 4.9cm and hydromorphic soils have the highest water intake depth of 6.5cm. The hydromorphic soils may have high water storage potentials than alluvial and ferralitic soils.

TABLE 3
INTAKE CHARACTERISTICS FOR ALLUVIAL, FERRALITIC AND HYDROMORPHIC SOILS

S/No	Soil group	Intake rate	Intake depth	K-value	n-value	Regression line equation
1.	Alluvial	12.5	4.9	29.0	0.43	$I = 29T^{-0.43}$
2.	Ferralitic	6.2	5.6	20.0	0.31	$I = 20T^{-0.31}$
3.	Hydromorphic	2.2	6.6	13.2	0.17	$I = 13.2T^{-0.17}$

The higher intake rates for the alluvial and ferralitic soils may be as a result of the large pore spaces (voids) associated with the consolidated coarse grained sandy soils and the recent alluvium deposit. The voids allow easy passage of water and adequate circulation of air across the soil sections. The intake rates of the hydromorphic soils are low due to finer textures and small pore spaces that impede the passage of water and air. However, the hydromorphic soils have the highest intake depths of 6.6cm, an indication, that the hydromorphic soils can store water more than ferralitic and alluvial soils.

TABLE 4
PARTICLE SIZE ANALYSIS OF THE THREE MAJOR SOILS

SOIL GROUP	DEPTH	SAND %	SILT %	CLAY %
Alluvial	0 – 20	75	23	2
	20 – 40	73	20	5
	40 – 60	73	22	7
	60 – 80	70	21	10
Ferraltic	0 – 20	65	30	5
	20 – 40	63	28	9
	40 – 60	60	25	10
	60 – 80	56	24	12
Hydromorphic	0 – 20	44	35	21
	20 – 40	40	32	25
	40 – 60	42	30	29
	60 – 80	40	28	31

CONCLUSION

The water intake characteristics of the alluvial, ferralitic and hydromorphic soils in Imo State were determined. This is for the purpose of applying water effectively for agricultural productions. The alluvial and ferralitic soils have higher intake rates but lower intake depths. The water storage potentials for the hydromorphic soils is higher than alluvial and ferralitic soils. It is necessary to recommend that farmers in Imo State should ensure that the water application rates do not exceed the intake rates of the various soils in order to prevent unnecessary water losses, erosions, flooding and poor agricultural yields.

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