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SUSTAINABLE SOIL WATER MANAGEMENT OF THE SAHEL REGION, NORTH BURKINA FASO.

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ABSTRACT: *This study was carried out in Dori experimental station, north Burkina Faso. The study area is divided into three zones: degraded zone, valley zone and dune zone. Representative profiles in the three zones are characterized by sand, sandy loam and clayey texture. The electric conductivity (EC dS m^{-1}) ranged from 0.20 to 14.2 dS m^{-1} and $CaCO_3$ from 7.0 to 37.2 %.*

The infiltration rate (IR) was studied at nine locations with different soil textures, because soil is one of the main limiting factors for agriculture. Results showed that the values of IR varied from one zone to another and even within the same zone according to soil physical and chemical properties. The values of IR in the first zone ranged from 23.1 to 34.1mm hr^{-1}, rising in the second zone from 123.4 to 164.7 mm hr^{-1} reaching a maximum in the third zone from 310.4 to 474.3 mm hr^{-1}. It can be concluded that irrigation systems should be designed according to basic IR and convenient practices of farm management.

Key Words: *infiltration rate, soil physical and chemical properties, North Burkina Faso.*

INTRODUCTION

Burkina Faso country located in West Africa covers an area of 274.000 km^2 and has 13.6 million inhabitants. The country has no coast and is surrounded by the neighboring countries of Mali, Niger, Benin, Togo, Ghana and Cote d'Ivoire (Map1). Most Burkina be live in the countryside and 92% working as farmers in the year2000, but farming only contributed with 26% of the Gross National Product (GNP). The country is therefore heavily dependent on economical support from other countries. Burkina Faso has been classed as the second poorest country in the world (PUND, 2007). The rapid population growth intensifies the pressure on soil and water resources. The area under investigation was selected as one of the most promising areas for agricultural expansion in Burkina Faso due to its potentialities (INERA, 1994).

The climate of Burkina Faso is sunny, hot and dry with three different seasons occurred: a dry - cool period from November to February, a hot - dry period in March, April and May where temperature may reach 40 °C, and a wet period from June to October. In the southern part of the country the annual average rainfall is around 1000 mm, but in the northern sahelian zone it is only 250 mm (Some & Siva Kumar, 2004).

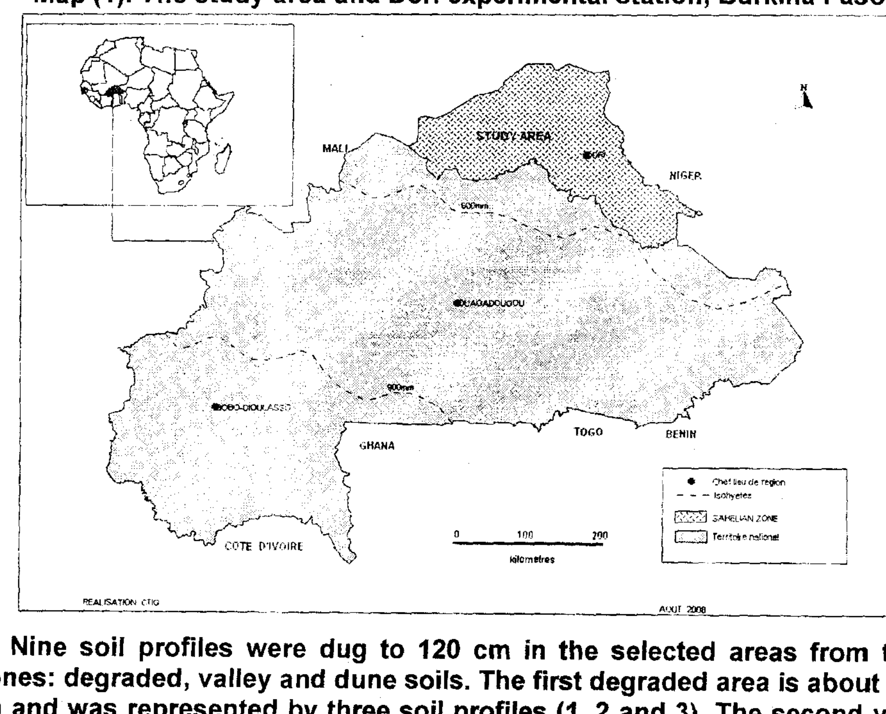
Soil degradation is a severe problem caused by a combination of sparse precipitation, immense logging of the already reduced forests, overgrazing by livestock and multiple bush fire. Since infiltration rate is the first step that expresses the movement of water into the soil (Kohnke, 1968), it was selected for this study. The entry of water depends on both the matric and gravitational potentials and on soil physical properties governing it. The importance of infiltration rate was discussed by Kramer (1969) and Hillel (1971) who pointed out that this process determines the amount of surface runoff, and water economy in the rooting zone.

The objective of the present study was to elucidate the state of agricultural development in the Sahel region of Burkina Faso.

MATERIALS AND METHODS

The study was conducted in the Sahel region, North Burkina Faso and Dori experimental station is located at a latitude of 14° 02' north and longitude of 2° 88' west, at an altitude of 288m high (Map 1).

Map (1). The study area and Dori experimental station, Burkina Faso.



Nine soil profiles were dug to 120 cm in the selected areas from three zones: degraded, valley and dune soils. The first degraded area is about 1000 ha and was represented by three soil profiles (1, 2 and 3). The second valley area is about 800 ha and was represented by profiles 4, 5 and 6. The third dune area is about 960 ha and was represented by profiles 7, 8 and 9. Infiltration rate was determined each soil profile site, under a constant head (10-cm), using a double ring infiltrometer, as described by Klute (1986). The cumulative depth of infiltrated water (D) and the infiltration rate (i) as a function of time (t) were expressed according to the two following equations (Philips, 1957 a& b):

$$D = At^{0.5} + Bt \qquad i = At^{-0.5} + B$$

Where i is the infiltration rate, where A and B are constants. Particle size distribution was determined with pipette method (Piper, 1950). Soil moisture retention was determined at 0.1 and 15.0 kPa (Klute, 1986). Total carbonate was determined using Collin's Calcimeter; total soluble salts, soil pH and soluble cations and anions of the saturated soil extract were determined according to the methods proposed by Richards, (1954). The relationship between IR and the soil factors, namely; sand, silt, clay, silt plus clay, $CaCO_3$, and total salinity were statistically represented according to Snedecor and Cochran (1989). The highest significant correlation or determination coefficient obtained from these calculations was chosen to express the most suitable function.

RESULTS AND DISCUSSION

1- Climate

Meteorological data of the study area, (Table 1) reveal the following:

The mean monthly minimum temperature varies from 15.0 – 30.0 °C, while the mean maximum temperature ranges from 32.2 – 42.7 °C. The highest temperature is recorded from May to June, while the lowest temperature is from December to February. The relative humidity reaches a minimum of 25.5 % in February and March and a maximum of 69.0 % in August. The mean monthly wind speed varies from 1.37 to 3.92 ms^{-1}, with a maximum during June, while the minimum wind velocity is reached in October. The average annual rainfall during the last forty years is 480.5 mm. During this period, the highest amounts of rain were recorded in 2003 (753.0 mm), in 1963 (748.0 mm) and in 1966 (736.0mm). There is, however, a considerable inter-annual variability in rainfall. The tendency is for a general decline in precipitation over the years. Therefore, rainfall decreased from 748 mm in 1963 to 259 mm in 1987. The driest period occurred between 1977 (279 mm) and 1987 (259 mm).

Table (1): Average Meteorological data of the studied area.

Month.	Temperature (°C)		Mean relative humidity (%)	Mean wind speed (ms^{-1})	Sun shine (hr)
	minimum	maximum			
Jan.	19.0	34.6	30.0	2.74	9.2
Feb.	16.1	32.2	25.5	2.94	9.3
Mar.	19.8	38.3	25.5	2.94	8.8
Apr.	26.5	34.7	28.0	2.74	8.9
May.	30.0	42.7	39.5	3.33	9.4
Jun.	26.8	39.6	51.0	3.92	9.0
Jul.	24.3	35.0	62.0	3.33	8.4
Aug.	23.8	35.3	69.0	2.35	8.3
Sep.	24.7	37.2	63.0	1.76	8.7
Oct.	24.8	38.9	46.5	1.37	9.3
Nov.	18.9	38.0	35.5	1.76	9.9
Dec.	15.0	33.1	33.5	2.35	9.3

2-Soil physical properties:

The degraded area represented by profiles 1, 2 and 3 displays numerous textural classes varying from loamy sand to clay, (Table 2).

Soil textural class varied from one layer to another within the same soil profile, and also between profiles. For instance, the soil profile was characterized by a sandy loam texture in the upper and bottom soil layers, and sandy clay loam in the middle soil layer.

The weighted means of soil fractions were 71.83, 7.99 and 20.18% for the texture sand, silt and clay percentages, respectively. Soil field capacity (0.1 bar.) ranged from 7.1 to 42.4 %, permanent wilting point (15.0 bar.) ranged from 2.7 to 16.5% and available soil water ranged from 3.8 to 22.7%. Table (2).

Table (2): Physical properties of the studied soil profiles.

Zone	Profile No	Depth cm	Particle size distribution (%)			Textural class	Bulk density Mg m^{-3}	$CaCO_3$ %	Moisture Content (%)		Availalable moisture (%)
			Sand	Silt	Clay				0.1 atm	15 atm	
Degraded Zone	1	0-25	75.1	9.4	15.5	SL	1.4	21.1	24.9	8.4	16.5
		25-55	70.8	7.1	22.1	SCL	1.4	18.6	34.4	12.4	22.0
		55-90	70.4	7.7	21.9	SL	1.4	17.4	31.8	11.8	20.0
	2	0-15	62.5	14.7	22.8	SCL	1.3	17.0	34.9	13.4	21.5
		15-50	64.8	12.8	22.4	SCL	1.3	21.8	34.5	14.5	20.0
		50-80	48.3	16.6	35.0	CL	1.3	24.0	37.4	16.1	21.3
		80-120	70.3	18.1	11.7	SL	1.4	19.7	26.3	10.3	16.0
	3	0-20	85.5	5.6	9.0	LS	1.4	20.6	15.6	5.7	9.9
		20-40	84.5	4.8	10.7	LS	1.4	19.6	16.2	6.2	10.0
		40-60	56.9	11.7	31.5	SCL	1.3	24.7	30.1	9.7	20.4
		60-90	53.5	13.9	32.6	SCL	1.3	23.7	31.0	8.3	22.7
		90-120	43.7	19.0	37.4	CL	1.2	26.8	32.9	12.7	20.2
Valley Zone	4	0-20	92.3	4.3	4.3	S	1.5	11.7	7.7	3.5	4.2
		20-40	90.2	2.5	7.3	S	1.5	19.4	13.3	5.9	7.3
		40-80	55.2	12.8	31.9	SCL	1.2	36.9	33.4	14.8	18.6
		80-120	51.2	15.9	32.9	SCL	1.2	25.0	33.4	12.5	20.9
	5	0-20	85.8	4.3	9.9	LS	1.5	25.7	19.1	7.1	12.0
		20-50	77.1	11.0	11.9	SL	1.5	14.7	25.5	9.7	15.9
		50-90	73.8	12.4	13.8	SL	1.4	16.2	26.9	10.2	16.7
	6	0-20	83.5	9.0	7.6	LS	1.5	12.6	17.2	7.0	10.2
		20-50	74.5	13.3	12.2	SL	1.4	22.6	29.0	11.8	17.3
		50-80	70.0	14.7	15.3	SL	1.4	24.3	31.4	11.2	20.2
		80-120	45.1	19.6	35.2	CL	1.3	37.2	42.4	16.5	25.9
Dune Zone	7	0-20	97.4	1.2	1.4	S	1.6	12.4	6.6	2.7	3.8
		20-60	97.6	0.7	1.7	S	1.6	12.6	7.8	3.2	4.6
		60-150	97.4	2.3	0.3	S	1.6	7.0	9.7	4.1	5.6
	8	0-20	92.1	3.1	4.8	S	1.5	26.5	12.8	5.7	7.1
		20-50	88.8	2.4	8.9	S	1.5	26.8	10.9	4.5	6. 4
		50-80	94.2	4.2	1.6	S	1.5	27.2	10.8	3.7	7.1
		80-120	93.8	3.1	3.2	S	1.5	34.0	7.7	3.0	4.7
	9	0-30	97.3	1.2	1.5	S	1.5	13.1	13.0	5.4	7.6
		30-60	96.5	2.6	0.9	S	1.5	17.2	8.2	3.4	4.8
		60-110	97.7	1.0	1.3	S	1.5	12.5	7.1	3.0	4.1

CL: Clay SCL: Sandy clay loam LS: Loamy sand SL: Sandy loam S: sand

It is important to notice that water entry into soil is affected by both the soil properties and water quality.

Data in Table (3) represent the changes in infiltration rate of the chosen locations. The results indicated that the IR process can be divided into three stages. It began with a higher value called the instantaneous intake rate which decreased over time until it reached an almost constant value, called the basic or final IR. Data in Fig. (1) shows that the basic IR for soil profile (1) was 26.6 mm hr^{-1} and the cumulative infiltration was 213.8 mm after 5 hours. The low IR of this profile might be attributed to the particle size distribution and other physical properties in the different layers. This behavior was attributed to the fact that fine textured soil layers have more micro pores than the coarse textured layers. These discrepancies are related to the variations in soil fractions content. In this regard, water movement is affected by soil texture, (El-Samanoudy, 1979).

Table (3): Infiltration parameter and classes of different soil profiles

Profile NO.	Equations	Initial intake rate	Basic(IR) $cmhr^{-1}$	Class of intake rate
1	$D = 0.933 * t^{0.5} + 0.0174 * t$ $I = 27.996 * t^{-0.5} + 1.044$	29.4	2.7	M
2	$D = 0.296 * t^{0.5} + 0.0483 * t$ $I = 8.875 * t^{-0.5} + 2.895$	11.8	3.4	M
3	$D = 0.453 * t^{0.5} + 0.025 * t$ $I = 13.58 * t^{-0.5} + 1.52$	15.1	2.3	M
4	$D = 0.572 * t^{0.5} + 0.189 * t$ $I = 17.16 * t^{-0.5} + 11.34$	28.5	12.3	R
5	$D = 0.86 * t^{0.5} + 0.25 * t$ $I = 25.77 * t^{-0.5} + 14.98$	40.8	16.5	R
6	$D = 0.851 * t^{0.5} + 0.25 * t$ $I = 25.52 * t^{-0.5} + 14.86$	40.4	16.3	R
7	$D = 1.825 * t^{0.5} + 0.74 * t$ $I = 54.75 * t^{-0.5} + 44.25$	99.0	47.4	VR
8	$D = 2.792 * t^{0.5} + 0.436 * t$ $I = 83.76 * t^{-0.5} + 26.18$	109.9	31.0	VR
9	$D = 2.597 * t^{0.5} + 0.49 * t$ $I = 77.91 * t^{-0.5} + 29.3$	107.2	33.8	VR

M= moderate R= rapid VR= very rapid

With respect to soil profile (2), its area is characterized by sandy clay loam in the upper two soil layers, 0 – 15 and 15 – 50 cm, while the third layer is clay-textured. The weighted mean of soil fractions are 62.22, 15.75 and 22.03% for the sand, silt and clay, respectively, and the IR was 34.1 mm hr^{-1}. These findings are in agreement with those obtained by Agrawal *et al.* (1974).

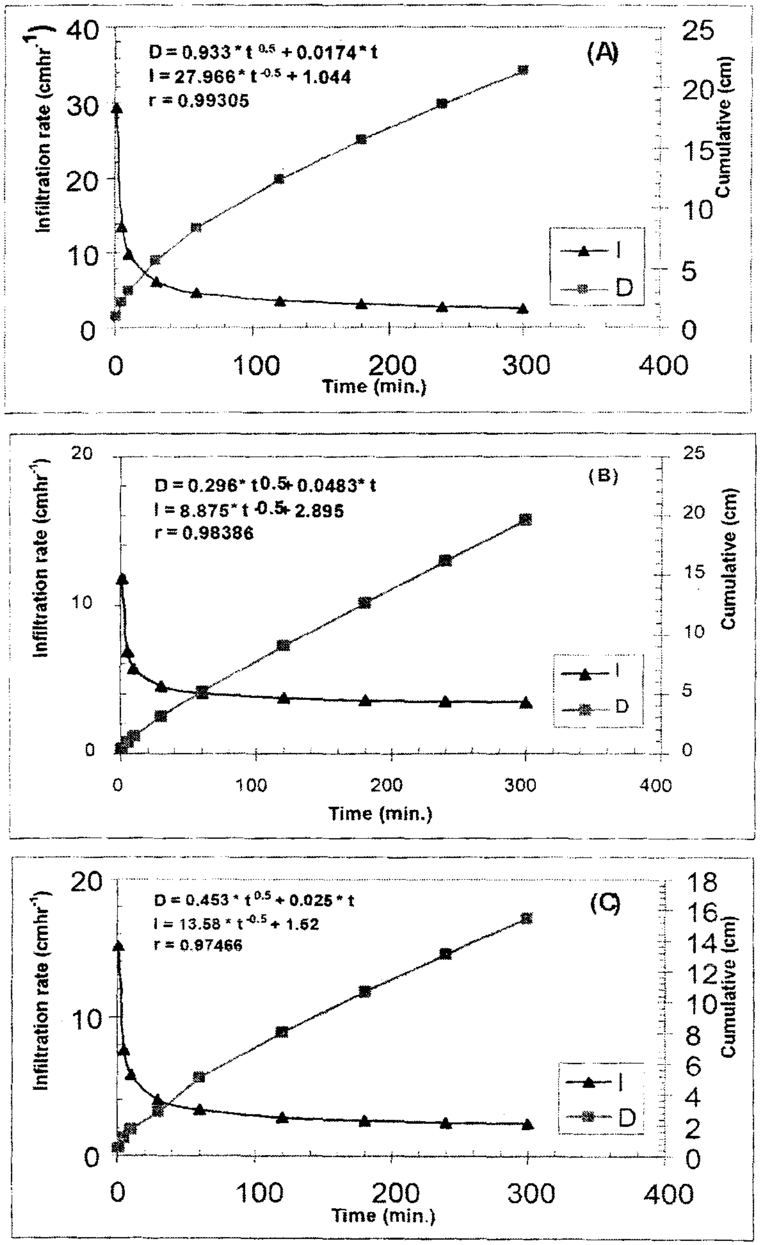


Fig. (1) Instantaneous and Cumulative Infiltration in the studied soils of Degraded region for profile 1 (A), 2 (B) and 3 (C)

Concerning soil profile (3), data in Table (2) reveal that the third and fourth soil layers (40-90 cm depth) are similar to the upper two soil layers in soil profile 2, i.e. sandy clay loam but the upper two soil layers (0-40 cm) are loamy sand. It was also noticed that the high clay percentage of 37.0% was found in its deepest layer; therefore the IR is lower than for the other soil profiles. This is also reflected in soil moisture retention as data reveal that the ability of pores to retain water is high in the bottom soil layer but the reverse is true in the upper soil layers (0 – 20 and 20 – 40 cm). By comparison between soils profiles (1, 2 and 3) in the first zone (degraded) they can be grouped in one category according to basic IR as they display moderate infiltration (26.6, 34.1 and 23.1 mm hr^{-1}). This behavior is supported by the negative correlation between clay content and IR which is highly significant,(Hillel ,1980), (Nasser ,1980) and (Talaat ,1991). Therefore, the surface irrigation could be a suitable system for this zone.

In the second valley area represented by soil profiles 4, 5 and 6, data in Tables (2, & 3) and fig(2) indicated that these soil profiles were characterized by sandy to sandy clay loam in texture, a high sand content except in the bottom soil layers of profile (4). The weighted mean of sand, silt and clay were 65.9, 77.5 and 65.1 %for sand, 10.7, 10.2 and 15.0% for silt and 23.5, 12.3 and 19.9% for clay were found in soil profiles 4, 5 and 6 respectively. The data also indicated that field water capacity was high in the bottom soil layers (31.37 to 42.39%). On the other hand, the upper soil layers had an opposite trend. Therefore, the IR was distinguished as moderately rapid to rapid depending mainly on the nature of the soil surface. Thus, the initial IR was high at first, but the final IR was limited by the conductivity of the transmission zone of subsurface layers.

This can be explained on the premise that when the soil surface is compacted and of lower conductivity it will act as a hydraulic barrier which impedes IR and reduces both the initial and final IR (Hillel,1971).

In general, the results in Table(3) and fig(2A,B&C) pointed out that the initial IR is high 285.0, 407.0 and 404.0 mm hr^{-1} for the profiles 4, 5 and 6, with low finial IR 123.0, 165.0 and 163.0 mm hr^{-1} as affected by the high clay content. These findings clarified that sand content in the upper soil layers increased the water movement due to the relative increase in soil micro-pores (Grismer, 1986).

These results indicated that the zone represented by the soil profiles 4, 5 and 6 which have rapid IR, could be suitable to drip irrigation system. Regarding the third dune area represented by soil profiles 7, 8 and 9, the data in (Tables 2&3) and fig(3A,B&C) indicated that the soil profiles had a homogenous sandy-textured nature. The sand content ranged from 88.7 to 97.7%, silt contents ranged from 0.7 to 4.2% and clay content ranged from 0.3 to 8.8%, respectively. Accordingly, the values of field water capacity and plant available water were low.

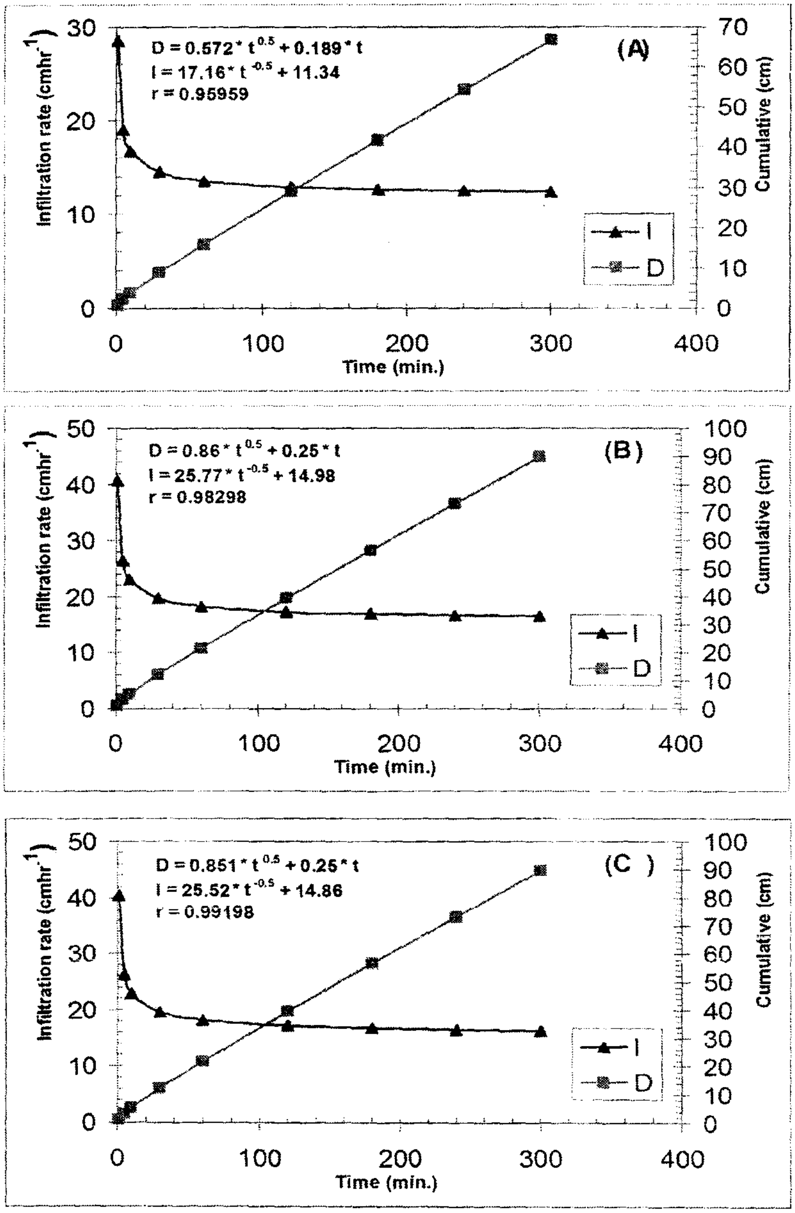


Fig. (2) Instantaneous and Cumulative Infiltration in the studied soils of Valley region for profiles 4 (A), 5 (B) and 6 (C)

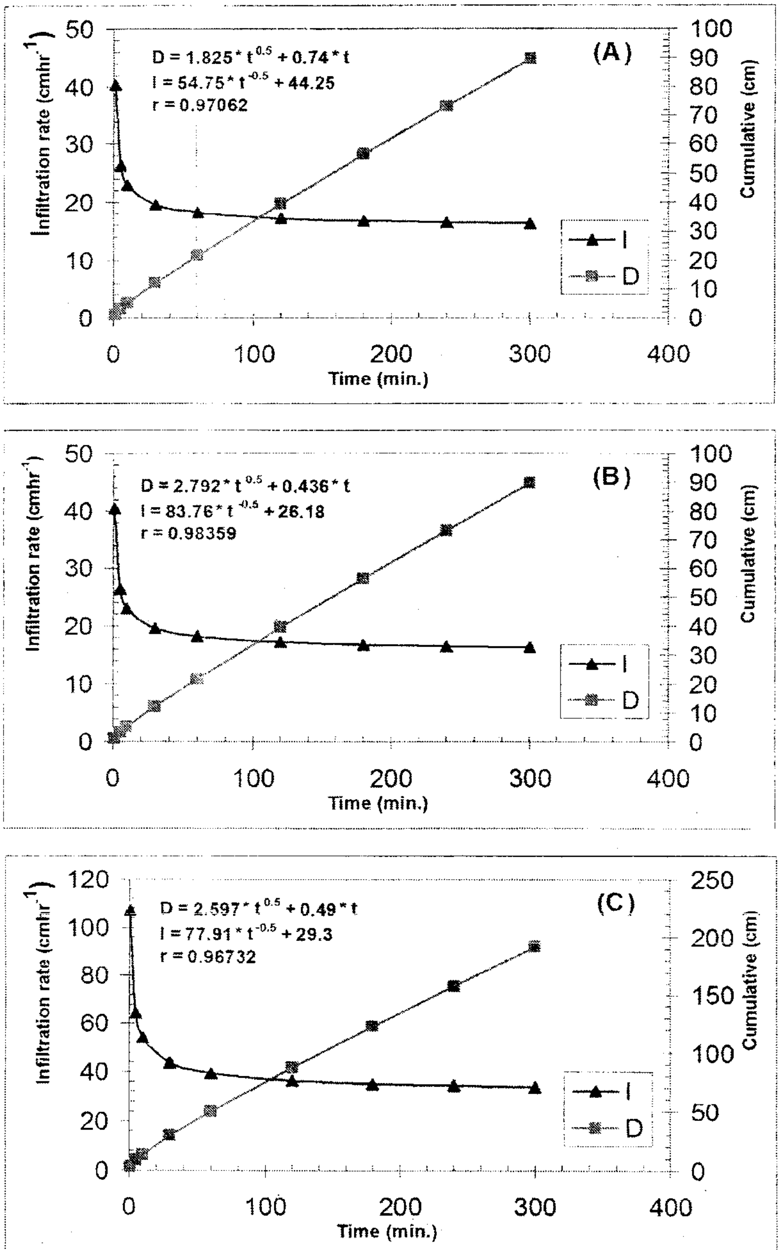


Fig. (3): Instantaneous and Cumulative Infiltration in the studied soils of Dune region for profiles 7 (A), 8 (B) and 9 (C)

Soil IR values in Table (3) were 474.0, 310.0, and 338.0 mm hr^{-1} for the three soil profiles. This was described as a very rapid IR. These discrepancies are related to the variation of soil fraction sand and silt (Soni *et al.*, 1988). Drip irrigation could be the most suitable system for this area to avoid deep percolation and seepage of irrigation water.

3- Soil chemical properties

Table (4) indicates that total soil salinity of the profiles representing the first zone (degraded) ranged between 0.4 to 11.9 dSm^{-1} (none- saline to saline).

The EC of profile 1and 3 were lower than profile 2. The concentrations of cations and anions were low. These findings may be attributed to the two upper soil layers having a sandy texture. The opposite was true for profile 2, which had a finer texture.

Table (4): Chemical properties of the studied soil profiles.

Profile No.	Depth cm	pH	EC $dS.m^{-1}$	Cations $meql^{-1}$				Anions $meql^{-1}$			
				Na+	K+	Ca++	Mg++	CO_3^-	Hco_3^-	Cl^-	So_4^{--}
1	0-25	8.7	1.0	7.8	0.6	2.7	1.1	0.0	2.2	6.0	4.0
	25-55	8.4	1.1	8.5	0.7	2.4	1.1	0.0	1.4	7.0	4.3
	55-90	8.5	1.4	10.0	0.6	3.5	2.5	0.0	1.8	9.0	5.8
2	0-15	8.0	11.9	68.0	3.2	32.8	16.7	0.0	1.8	70.0	48.9
	15-50	7.8	5.7	46.6	1.31	8.8	3.4	0.0	1.8	35.0	23.1
	50-80	8.1	2.4	16.0	0.5	7.5	2.6	0.0	2.2	18.0	6.3
	80-120	7.6	2.4	17.8	0.4	4.5	2.6	0.0	1.4	17.0	6.9
3	0-20	8.4	0.4	3.8	0.3	1.1	1.0	0.0	3.0	2.0	1.3
	20-40	8.4	0.5	4.0	0.4	1.1	0.5	0.0	2.8	3.0	0.1
	40-60	8.2	0.7	4.8	0.4	1.1	1.0	0.0	3.0	3.0	1.2
	60-90	7.9	0.8	5.2	0.4	1.8	1.0	0.0	1.2	4.0	3.1
	90-120	8.1	1.3	7.8	0.6	4.3	1.7	0.0	2.2	7.0	5.2
4	0-20	8.7	0.3	3.7	0.3	0.7	0.2	0.0	1.4	2.0	1.3
	20-40	8.2	1.0	7.0	0.4	3.1	0.3	0.0	2.0	5.0	3.8
	40-80	7.8	2.7	21.5	0.4	5.6	0.4	0.0	1.4	19.0	7.5
	80-120	7.8	2.6	21.0	0.4	5.3	0.2	0.0	1.4	18.0	7.5
5	0-20	7.8	1.2	9.2	0.5	2.7	1.3	0.0	2.4	8.0	3.4
	20-50	8.1	1.1	9.2	0.4	2.9	1.0	0.0	3.0	7.5	3.0
	50-90	8.0	1.5	10.4	0.5	3.8	1.7	0.0	3.0	7.0	6.7
6	0-20	8.4	0.4	4.6	0.4	0.9	0.3	0.0	1.4	3.5	1.3
	20-50	8.5	0.5	5.3	0.4	1.0	0.4	0.0	1.4	4.0	1.9
	50-80	8.5	0.6	5.3	0.5	1.2	0.5	0.0	1.3	4.0	2.4
	80-120	8.5	0.7	5.20	0.5	1.4	0.7	0.0	1.3	4.0	2.6
7	0-20	7.9	0.4	1.9	0.3	1.3	0.7	0.0	0.4	2.2	1.6
	20-60	8.3	0.2	0.9	0.2	0.8	0.5	0.0	0.4	1.2	0.8
	60-150	7.4	0.3	1.2	0.2	0.9	0.6	0.0	0.4	1.3	1.1
8	0-20	8.1	12.0	75.2	2.6	30.3	12.5	0.0	2.4	78.0	40.1
	20-50	7.8	7.0	40.8	0.3	21.0	10.1	0.0	3.0	57.0	12.2
	50-80	7.9	3.5	26.6	1.1	5.9	3.6	0.0	1.8	25.5	9.9
	80-120	7.8	5.6	39.0	1.5	11.0	6.5	0.0	2.4	36.0	19.6
9	0-30	7.8	0.3	3.35	0.3	0.8	0.4	0.0	1.6	2.0	1.2
	30-60	8.3	0.3	3.30	0.2	0.5	0.2	0.0	2.0	2.0	03
	60-110	8.5	0.3	3.4	0.3	0.6	0.3	0.0	2.0	2.0	0.5

In the second Valley area with profiles 4, 5 and 6, EC ranged between 0.3 to 2.7 dSm^{-1} ,soluble sodium between 3.7 to 21.5 $meql^{-1}$ and calcium from 0.7 to 5.6 $meql^{-1}$.In the third dune area, EC values ranged between 0.2 to 14.2 dSm^{-1} (salt-free to extremely saline). Sodium content ranged between 0.8 to 91.3 $meql^{-1}$ and calcium between 0.5 to 33.2 $meql^{-1}$.

STATISTICAL ANALYSIS

Table (5) presents the statistical relationship between IR and some soil parameters. A highly significant positive linear correlation was found between sand for the different profiles and their IR. Also, highly significant negative exponential correlation was found between silt, clay and silt plus clay and soil infiltrability.

Table (5): Correlation coefficient, coefficient of determination (CD) and regression equation for the relation between basic IR (Y) and the studied soil variables (Xi)

Soil Variable	Type of relation	Simple Correlation Coefficient	Regression equation	CD %
Sand X1	Yx1	0.91081**	$Y=-55.73+0.965x$	82.9
Silt X2	Yx2	0.87325**	$Y=46.556e\text{-}^{15.058x}$	76.3
Clay X3	Yx3	0.94101**	$Y=42.595e\text{-}^{11.142x}$	88.6
Silt+Clay X4	Yx4	0.92609**	$Y=54.344e\text{-}^{13.049x}$	85.8
$CaCO_3$ X5	Yx5	0.59707*	$Y=96.186e\text{-}^{26.149x}$	35.7
EC X6	Yx6	0.79258**	$Y=16.163e\text{-}^{13.528x}$	62.8

** Significant at 1% level.
* Significant at 5% level

This generally indicated that sand, clay, silt plus clay and total salinity were the most important factors affecting on soil infiltration. Similar findings were obtained by Hillel (1980) and Talaat (1991). Moreover, the obtained results in Table (5) indicated low significant negative correlation between soil IR and $CaCO_3$, but a highly significant negative correlation is found with total salinity. This behavior could be related to the adverse effect of salinity and possibly exchangeable sodium on soil structure and dispersion of soil colloids which plugs soil pores and thus sharply reduces IR (Abu-Sharar *et al.*, 1987; Levy *et al.* 1999; Bauder *et al.* 2001).

CONCLUSION

The use of IR parameters, soil texture, and available water as indicators to the suitability of an irrigation system must be coupled with the data of irrigation frequencies for plants which might be grown under this region.

This study demonstrates the dependence of infiltration on soil variables; particularly particle size distribution. For instance, the predominance of sand stimulates rapid infiltration, while fine particles, i.e. silt and/or clay diminish infiltration. Silt and clay can plug soil pores and form soil aggregation, which increases the soil micro-pores thus preventing water movement through soil matrix. Undoubtedly, total salinity may contribute to false aggregation, especially when Na^+ is the predominant soil cation. High exchangeable Na^+ puddle soil, minimizing macro-pores, thus enhancing low permeability and infiltration. This was reflected on the infiltration rate of the 3 studied zones.

REFERENCES

ABU-SHARAR, T. M., F.T. BINGHAM and J.D. RHOADES (1987). Stability of soil as affected by electrolyte concentration and composition Soil Sci Soc. Am.J. 51: 309-314.

AGRAWAL, M. C., R. P. AGRAWAL and R. S. CHAUDHRY (1974). Infiltration characteristic of soil as related to soil physical properties. J. Ind. Soc. Soil. Sci. 22: 285-289.

Bauder, J. W. (2001). Interpretation of chemical analysis of irrigation water and water considered for land spreading. personal communication. Montana State University, Bozeman, Montana.

EL-SAMANOUDY, I. M. (1979). Hydraulic conductivity of subsoil layers as affected by weight of overlaying layers. M.Sc. Thesis, Faculty of Agriculture, Cairo, University, Egypt.

GRISMER, M. (1986). Pore size distribution and infiltration. Soil Sci. 141:211-217.

HILLEL, D. (1971). Soil and Water physical Principles and Processes. Academic Press, New York.

HILLEL, D. (1980). Applications of Soil Physics. Academic Press, New York.

INERA (1994). Analyse des contraintes et potentialités et proposition d'axes de recherche intégrée au Sahel. Première partie,Ouagadougou, Burkina Faso 76pp.

KLUTE, A. (1986). Methods of soil analysis. Part1. 2nd Ed. Agronomy 9.

KOHNKE, H. (1968). Soil Physics. McGraw-Hillel Book Co., New York.

KRAMER, P. J. (1969). Plant and Soil Water Relationship. A Modern Synthesis Mc. Graw Hill, Inc. New York.

LEVY, G. J., A. ROSENTHAL, J. TORCHITZKY, I. HAINBERG and Y. CEHN (1999). Soil hydraulic conductivity changes caused by irrigation with reclaimed waste waters. J. Environ. Quali. 28: 1658-1664.

Naser, H.M. (1980).Rate of Water intake as a Parameter for Proper Soil Management and Conservation.M.SC.Thesis, Fac.Agric.,Cairo Univ., A.R.E

PHILIPS, J. R. (1957a). The Infiltration equation and its Solution. Soil Sci. 83, 345-357.

PHILIPS, J. R. (1957b). The Theory of Infiltration: Sorpitivity and Algebraic Infiltration Equation. Soil Sci., 84,257-264.

Piper, C. S. (1950). Soil and Plant Analysis. Inter. Sci., publishers, Inc. New York.

PNUD (2007). Rapport mondial sur le développement humain 2007/2008. La lutte contre le hangement Climatique : un impératif de solidarité humaine dans un monde divisé.

RICHARDS, L. A. (1954). Diagnosis and Improvement of Saline and Alkali Soils. U.S. Dept. Agric. Handbook No. 60. U.S. Gov. Print. Off., Washington, D.C., USA.

Snedecor, G. W., and E. G. Cochran (1989). Statistical methods. The lowa State Univ. Press, Ame. lowa

SOME, L. and M.V.R. SIVA KUMAR (2004). Analyse de la longueur de la saison culturale en fonction de la date de début des pluies au BURKINA FASO. Compte rendu des travaux n°1. ICRISAT Centre Sahélien, Niamey, NIGER INERA Ouagadougou, BURKINA FASO.

SONI, P., S. NAILHANI and H.N. MATHU (1988). Infiltration studies under different vegetation cover Ind. J. of Forestry, 8: 170-173.

TALAAT, A. M. (1991). Factors affecting infiltration rate in some Egyptian soils. M.Sc. Thesis, Faculty of Agriculture, Suez Canal University, Egypt.

التنمية المستدامة لمنطقة الساحل بشمال بوركينا فاسو في مجال إدارة المياه

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الملخص العربي

أجريت الدراسة بمنطقة دورى بشمال بوركينا فاسو حيث قسمت منطقة الدراسة الى ثلاث مناطق ، كل منطقة يمثلها ثلاث قطاعات تربة :-

أ- Degraded zone (يمثلها القطاعات ٣،٢،١)

ب- Valley zone (يمثلها القطاعات ٦،٥،٤)

ت- Dune zone (يمثلها القطاعات ٩،٨،٧)

أجريت التحليلات الفيزيائية والكيميائية للتربه فى مناطق الدراسة الى جانب قياس معدلات الرشح بالقطاعات التسعه للتربة بمنطقة الدراسة .

- وقد دلت النتائج على :-

١- تتميز مناطق الدراسة بقوام يتراوح ما بين الرملى الى الطينى .

٢- ملوحة التربة تتراوح ما بين ٠,٢ الى ١٤,٢ ديسيمينز/م ، ونسبة كربونات الكالسيوم ما بين ٠,٧% الى ٣٧,٢ % .

٣- دلت نتائج معدلات الرشح فى منطقة الدراسة الأولى أنه كان منخفضا و يتراوح ما بين ٢,٣ – ٣,٤ سم/ ساعة ، والمنطقة الثانية كان مرتفعا مابين ١٢,٣ - ١٦,٥ سم/ ساعة ، فى حين كان سريع جداً بالمنطقة الثالثة مابين ٣٣,٨ – ٤٧,٤ سم/ساعة .

لذلك يوصى بالأخذ فى الإعتبارات نتائج معدلات الرشح فى وضع برامج التنمية بالمنطقة من رى وصرف وزراعة المحاصيل المناسبة طبقاً لبيانات المناخ بالمنطقة .