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Effect of Soil Physical Properties on Irrigation Scheduling and Crop Patterns in Wadi El- Sayda

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ABSTRACT

The current study was carried out in Wadi El- Sayda soils which are considered among the most promising potential areas for agricultural expansion in Egypt. It is located between longitudes 32° 39' 00" - 32° 50' 00" E and latitudes 24° 50' 00" - 25° 8' 00" N.Three soil units were selected according to soil profile depth and the main soil physical properties. Infiltration rate are conducted beside each soil profile and determined under constant head using double ring infiltration device. The obtained results reveal that the basic infiltration rates of studied soil range widely varied between 1.44 and 15.86 cm/h and classified between moderately slow and rapid class. Also the statistical relationship between each of the soil physical properties; total sand %, clay %, silt %; and infiltration rate. The data declared that the simple correlation coefficient between infiltration rate and each of clay % was negative and significant r = (- 0.628**) whereas, it was positively correlated with r = (+ 0.570**), for total sand and (+0.079**) for silt the obtained regression equation is a linear function. Results also show that the irrigation frequencies vary according to soil texture, crop type and growth season. Irrigation scheduling were calculated for different soil texture, they were ranged between one to two days for shallow soil profile, each two days for moderate soil profile and more than three days for deep soil profile. Also, they were varied between one to four days for the most vegetable crops, although they increased for old trees Data Palm for reach 20 days. Therefore, necessary to apply modern irrigation system (trickle or sprinkler). So it is recommend to pay attention towards that irrigation rate is always less than the basic infiltration rate. Crop coefficient, growth stages, planting data seasonal water consumptive use and total water requirement were calculated for some summer and winter seasons of some fodder crops and some fruit trees that could be grown in wady El-Sayda under recent conditions. It was found that seasonal crops with deeper active roots (30-50 cm) could be cultivated in (shallow and moderate), soil profile, while other crops with deepest root like fruit trees (more than 1 m deep)could be cultivated in the deep soil profile.

Key words: Infiltration rate, physical properties, irrigation frequencies. Irrigation scheduling, crop patterns, water requirements and evapotranspiration

Introduction

Man/land ratio in Egypt has become one of the highest values in the world. So, the agriculture expansion in the desert should be continuous by one of the main fetal objects of the national plan to meet the food requirements for the tremendous increase in population.

Undoubtedly the horizontal and vertical agricultural expansion in Egypt depend mainly on the rational use of the available water resources, and the main objective of water management is usually to capture and save the natural precipitation within the soil for crop production, and to reduce the evaporation rate.

As already known, infiltration rate is the first step that expresses the movement of water into and through the soil, Kohnke (1968). The importance of the infiltration rate value was discussed by Philips and Kitch (2011) who reported a review of methods for characterization of site infiltration with design recommendation. Diamond, and Shanley (2003) and Jagdale and Nimbalkar (2012) who found that constant infiltration rates of clay untilled and clay tilled soil were 1.2cm/hr and 1.6cm/hr. respectively.

While in sandy soil, infiltration rate was 8.53cm/hr and the initially infiltration rates were high and decreased with time up to constant infiltration rate. Osuji, *et al.,* (2010) found that infiltration rates tended to increase with coarser deep soil profile. However, soil profiles of most natural soil are seldom uniform; the effect of stratification on infiltration rate is often spectacular. In this accord, Talaat *et al.* (2008) found a highly significant positive relationship between sand content and final infiltration rate. Similar results were obtained by Humphrey and Fisher (1995), Abedel-Rohman, *et al.*, (2002 & 2009), Talaat, *et al.,* (2002) Abdel-Rahman, (2010).

Salinity of irrigation water is a significant factor in many of the irrigated lands and must be considered in developing optimum irrigation strategies. The time and amount of irrigation water application of various salinities along with crop selection based on salinity tolerance are some of the management variables which,

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effects on crop yield and amount in addition salinity of the water percolated below the root zone are necessary in establishing optimal management practices, Bauder (2001) and Bauder and Brock (2001).

This paper aimed to study the infiltration rate and soil available water in the newly reclaimed areas of Wadi El- Sayda to choose the best irrigation system, irrigation frequencies and crop patterns for different crops that might be considered to be potentially grown in these areas.

Materials and Methods

The current study was conducted and divided into three categories according to soil profile depth, namely. The first was shallow soil profiles (less than 50 cm) gravelly course to moderately fine texture. The second was moderately deep soil profiles (50-100 cm) gravelly course to moderately fine texture and the third was deep soil profiles (more than 100 cm).

Also, 14 infiltration tests were conducted beside each soil profile which determined under constant head using double ring infiltrometer, as described by Lili, *et al.* (2008). The cumulative depth of infiltrated water "D" in cm as a function of time was evaluated according to kostiakove (1932)

Kostiakove equation: $D = k t^n$ $i = k n t^{n-1}$

Where

i = is the infiltration rate, i.e. the steady state infiltration rate, k and n are constants.

The study also includes the determination of irrigation frequencies for various crops that might be considered potentially-grown in this area. These determinations were based on the infiltration tests and available soil moisture by using meteorological data collected from Egyptian meteorological Authority, Cairo, Egypt, (Table 1and 2) to compute ETo values using Penman-Montieth method as recommended by FAO Expert Consultation held in May (1990) in Rome, Italy, by using CROPWAT, software version 5.7 (Smith, 1996).

Montieth approach: (Allen *et al.,* 1998)

$$ETo = \frac{0.408\,\Delta\,(Rn - G) + \gamma\,(900/T+273)\,u2\,(es - e_a)}{\Delta + \gamma\,(1 + 0.34\,u_2)}$$

Where:

. ETo = reference evapotranspiration (mm day^{-1}),

Rn = net radiation at the crop surface (MJm^{-2} day^{-1}),

G = soil heat flux density (MJ m^{-2} day^{-1}),

T = mean daily air temperature at 2 m height (ºC),

U_2 = wind speed at 2 m height (m s^{-1}),

e_s = saturation vapor pressure (Kp_a),

e_a = actual vapor pressure (Kp_a),

e_s- e_a = saturation vapor pressure deficit (Kp_a),

Δ = slope vapor pressure curve (Kp_a $ºC^{-1}$),

γ = psychometric constant (Kpa $ºC^{-1)}$.

Also, crop coefficient (Kc) can be used to relate reference crop evapotranspiration (ETo) to maximum crop evapotranspiration (ETc) when water supply fully meets water requirements of the crop ETc = ETo * Kc (Doorenbos and Kassam, 1986).

Crop watt 4 windows as a computer program was used to calculated reference evapotranspiration every month according to Penman – Montieth equation to study evapotranspiration and measuring crop coefficient through stages for some field crops, vegetables fruit trees and fodder crops. Furthermore, leaching water requirements (LR) was calculated according to Doorenbos and Pruitt (1984). In addition, water consumptive use and total water requirement under furrow irrigation system (efficiency 55%) and drip irrigation system (efficiency 85%) when crop coefficient equal one . The following equation is applied, according to Doorenbos and Pruit (1984):

$$I = \frac{(P.\,Sa) * D}{(ETc) - Pe}$$

Where:

I = Irrigation interval, day.

P = Fraction of total available soil water.

Sa = Total available soil water, mm/m soil depth.

D = Rooting depth, m.

ETc = Crop evapotranspiration, mm/day.

Pe = Effective rainfall, mm.

All soil samples were analyzed for their content of clay, silt and sand (Gee and Bouder 1986), water content at 0.1 and 15 bar, according to Klute (1986). Undisturbed soil samples were taken to determine soil bulk density (Blak and Hartge 1986).

Results and Discussion

The meteorological data of the studied area were collected from Egyptian Meteorological Authority, Cairo, Egypt, and presented in Table (1) which reveal that the mean monthly maximum temperature varies from 16.7 to 40.8 ºC, the mean monthly minimum temperature varies from 7.0 to 22.5 ºC, the sunshine hours varies from 10.5 to 13.4 hr., the relative humidity ranges between 20 and 46 %, the mean monthly evapotranspiration ranges from 2.66 to 8.81 mm., the mean monthly surface wind speed varies from 14.21 to 199.8 Km/d,. The reference evapotranspiration, (ETo) varies from 8.81 mm/day in summer to 2.66 mm/day in winter.

The mean annual of evapotranspiration is moderate (2304.65 mm/year). In general, the study area is dominated by the Mediterranean climate that characterized by hot dry summer and relatively cold winter,

The weighted mean of soil fractions in shallow soil unit; total sand were ranged from 65.5 to 85.46%, 8.41 to 12.52%for silt and 6.13 to 21.98%for clay. While in moderately soil profile they were 75.62 to 89.23% for sand, 6.05 to 9.95% for silt and 4.7 to 15.88% for clay. Data also referred that the soil unit 3 represent the profiles 8,9,10 and 11. It is cleared that the texture class ranged between almost nearly homogeneous sandy loam in profiles No. 8 and No. 9 in addition two layers in two successive soil profile No. 11; (40-80 and 80-150). It is remarkably that there is a high clay content in profile No. 10 which classified as clay or clay loam textured, the weighted mean of soil fractions; clay is 52.1%; (0-25 cm) and 29.3 %; (80-150 cm), in soil layer respectively.

Table 1: Average meteorological data according to Kom Ombo Station, (Agricultural climatic lab.)

Month	Temperature*		Humidity %	Wind Seed Km/d	Sun Shine Hours	Solar Radiation MJ/m2/d	ETo mm/d	ETo mm/months
	Max °C	Min °C						
Jan	23.7	7.0	42.0	159.8	10.6	18.4	3.61	111.91
Feb	25.8	7.9	36.0	168.7	11.1	21.3	4.52	126.56
Mar	30.1	11.4	29.0	199.8	11.8	25.1	6.23	193.13
Apr	35.0	15.7	21.0	177.6	12.5	28.1	7.34	220.2
May	39.0	19.7	20.0	182.0	13.1	29.7	8.35	258.85
Jun	40.8	22.1	21.0	186.5	13.4	30.1	8.81	264.3
Jul	40.5	22.5	25.0	182.0	13.3	29.9	8.62	267.22
Aug	40.4	22.4	28.0	164.3	12.8	28.7	7.98	147.38
Sep	38.4	20.3	30.0	182.0	12.1	26.1	7.41	222.3
Oct	36.0	17.8	33.0	155.4	11.4	22.6	5.84	181.04
Nov	29.8	18.2	40.0	146.5	10.8	19.1	4.31	129.3
Dec	16.7	8.7	46.0	142.1	10.5	17.4	2.66	82.46
Mean	33.0	16.1	30.9	170.6	11.9	24.7	6.31	total 2304.65

** = Average of 30 years, (1981 – 2011).*

Bulk density is ranged from 1.47 and 1.52 gcm^{-3} in the first soil unit of shallow soil profile, they were reached 1.52 gcm^{-3} as a maximum values (in soil profile No.1 layer 0-20) while it reached 1.47 gcm^{-3} as minimum one. It is worth to mention that it was 1.52 gcm^{-3} in soil profile No. 1 in soil layer 20-45 cm but moderately soil profile ranged from 1.42 to 1.59 gcm^{-3} while they were ranged from 1.33 to 1.58 gcm^{-3}

Soil moisture contents fluctuate as the average of field capacity, wilting point and available water, 25.5, 6.20 and 20.30 % respectively in the shallow soil profile.

In the second soil profile which characterized by moderate, soil moisture contents fluctuate for the averages of field capacity, wilting point and available water, 25.3, 6.76 and 18.28 % , respectively.

In the third soil profile which characterized by deep, data indicated that values of bulk density were 1.33 and 1.58 gcm^{-3} for the soil profile No. 10 and No. 11, respectively.

Soil moisture contents fluctuate between averages values of 31.74, 13.26, and 18.48 % for the field capacity, wilting point and available water, respectively.

As regard to values of soil infiltration rate, cm/h, table (3) and figure (1 and 2) reveal that the basic infiltration rate of the studied soil profiles (1, 2, 3 and 4) for the first soil unit; (shallow soil profiles) values ranged between 2.92 and 5.12 cm/h; (moderate). This might be attributed to the summation of silt and clay fraction >15 %

The second soil unit; moderately soil profile depth, the values of infiltration rate, (IR) cm/h ranged between 5.6 and 6.66 cm/h (moderate to moderately rapid), This might be attributed to the high percentage of sand content, (over 78 %) and very low clay content in all soil layers.

Since the major of irrigation management or water applied is to achieve high application efficiency and uniform water, water distribution by reducing deep percolation and reduces environmental problems caused by unrational use of irrigation water, thus the obtained results indicate that drip irrigation is the most suitable system.

Table 2: Soil physical properties for different units of the studied area.

Soil Units	profile No.	depth (cm)	Particle size distribution%			Texture Class	ρb $g.m^{-3}$	$CaCO_3$ %	Moisture content at (%)		Available moisture%
			Sand	Silt	clay				0.1	15 atm.	
1	1	0 - 20	74.54	15.25	10.21	SL	1.47	44.53	28.20	5.60	22.6
		20 - 45	81.46	10.13	8.41	LS	1.52	42.64	24.80	6.80	18
	wm*		78.38	12.41	9.21				26.5**	6.20	20.30
	2	0 - 45	65.50	12.52	21.98	SL	1.47	44.53	30.50	9.80	20.7
	3	0 - 30	81.54	12.24	6.22	LS	1.49	43.77	23.60	5.70	17.9
	4	0 - 30	85.46	8.41	6.13	LS	1.50	43.40	23.00	5.60	17.4
2	5	0 - 15	81.90	8.38	9.7	LS	1.56	41.13	21.8	2.4	19.4
		15 - 45	91.88	2.71	5.4	S	1.59	40.00	20.9	2.1	18.8
		45 - 90	74.35	15.29	10.4	SL	1.42	46.42	26.8	7.4	19.4
	wm		81.45	9.95	8.62						
	6	0 - 15	76.10	10.76	13.1	SL	1.49	43.77	28.6	9.7	18.9
		15 - 60	77.86	6.92	15.2	SL	1.44	45.66	28.6	10.9	17.7
		60 - 90	72.02	9.73	18.3	SL	1.48	44.15	30.5	12.6	17.9
	wm		75.62	8.50	15.88						
	7	0 - 25	90.55	5.84	3.6	S	1.51	43.02	22.6	5.6	17
		25 - 55	91.94	4.63	3.4	S	1.53	42.26	21.4	4.5	16.9
		55 - 90	85.97	7.42	6.6	LS	1.49	43.77	24.1	5.6	18.5
	wm		89.23	6.05	4.70				25.03	6.76	18.28
3	8	0 - 20	74.238	12.94	12.8	SL	1.48	44.15	28.2	9.2	19
		20 - 60	70.94	13.61	15.5	SL	1.49	43.77	29.5	10.9	18.6
		60 - 95	74.38	10.38	15.2	SL	1.45	45.28	29.5	10.9	18.6
		95 - 150	80.78	5.46	13.8	SL	1.47	44.53	28.2	9.7	18.5
	wm		75.79	9.78	14.45						
	9	0 - 30	75.38	15.37	9.3	SL	1.46	44.91	27.7	7.4	20.3
		30 - 65	70.35	18.57	11.1	SL	1.47	44.53	29.1	8.6	20.5
		65 - 105	64.24	22.18	13.6	SL	1.47	44.53	30.5	9.8	20.7
	wm		69.46	19.03	11.54						
	10	0 - 25	25.59	22.27	52.1	C	1.33	49.81	46.4	30.9	15.5
		25 - 80	24.56	25.23	50.2	C	1.33	49.81	45.9	29.8	16.1
		80 - 150	41.07	29.61	29.3	CL	1.44	45.66	38.6	18.7	19.9
	wm		32.44	26.78	40.76						
	11	0 - 40	90.31	4.84	4.9	S	1.58	40.38	20.1	4.4	15.7
		40 - 80	74.72	9.56	15.7	SL	1.42	46.42	29.1	10.9	18.2
		80 - 150	75.31	10.38	14.3	SL	1.46	44.91	29.8	11.2	18.6
	wm		79.15	8.68	12.17				31.74	13.26	18.48

*S = Sand LS = Loamy sand SCL = Sandy clay loam C = Clay CL= Clay loam * = weighted mean*
*** = Average value*

Concerning the values of soil IR, cm/h, table (3) declared that the values of basic IR, 1.44 cm/hr, of soil profile No. 14 indicating that the basic IR was low. This is mainly rendered to the presence of higher clay content than the other soil profiles, (Fig. 9). Undoubtedly, this behavior is due to the heterogeneous condition, in soil layers, Moreover, the presence of clay content slightly impeded the downward water movement owing to their lower macro pores, Talaat, *et al*. (2008). Meanwhile the high values of basic soil IR, 15.86 cm/h are corresponding with high content of total sand; this finding is agreement with Abdel-Rahman, *et al*. (2010).

Regarding to the deep soil profiles; for the third soil unit, IR cm/h values are widely ranged from 1.44 to 13.28 cm/h (moderately slow intake rate to rapid) according to soil survey stuff,(1951). This is mainly rendered to the presence of higher clay content than another soil profile fig.(2). Furthermore, rapid intake rate consider with the high percentage of sand content (over 64 %) and (silt +clay) less than 25%.

The correlation and regression analysis between IR, cm/h (y) and sand, silt and clay content (x_1, x_2 and x_3) wear conducted. The data revealed that IR, cm/h was positively and significant with variable; (sand, x_1); (+0.570**) and; (silt, x_2); (+0.790**). Whereas variable; (clay, x_3); was negatively correlated, highly significant, (-0.628**). The corresponding regression equations were as follows;

Y; (IR) = - 4.038 + 0.030 X1; (Total sand).
Y; (IR) = 0.7710 + 0.126 X2; (silt).
Y; (IR) = 12.450 - 0.304 X 3. ;(clay).

In case of, data in table (2) showed that studied area is characterized by heavy texture (clay loam to clay texture in soil profile 14). Clay content varied from 29.12 to 52.34 %, silt content from 22.12 to 29.05 %, sand content varied from 24.73 to 41.83 % and bulk density ranged between 1.33 and 1.44 gm/cm^{-3}. Accordingly, soil moisture retention data reveal that the ability of pores to retained are considerably high in all soil layers compared to the other unites under study.

Table 3: Infiltration parameters of the studied areas**.**

Soil	profile	Infiltration parameters		Initial infiltration	Basic infiltration rate, i cm/h	
unit	No.	K	n	rate, cm/h	value	class
First	1	1.268	0.578	24.32	4.68	M
	2	2.659	0.46	73.39	4.2	M
	3	5.67	0.387	131.7	5.12	M
	4	1.385	0.499	41.47	2.92	M
Second	5	3.377	0.453	98.26	5.06	M
	6	2.933	0.513	90.28	6.84	MR
	7	3.102	0.521	90.28	7.66	MR
Third	8	2.221	0.647	86.22	13.28	R
	9	2.277	0.567	63.65	7.8	MR
	10	0.868	0.467	24.32	1.44	MS
	11	3.242	0.488	92.98	5.85	M

R = Rapid MR = Moderately Rapid MS = Moderately Slow M = Moderate

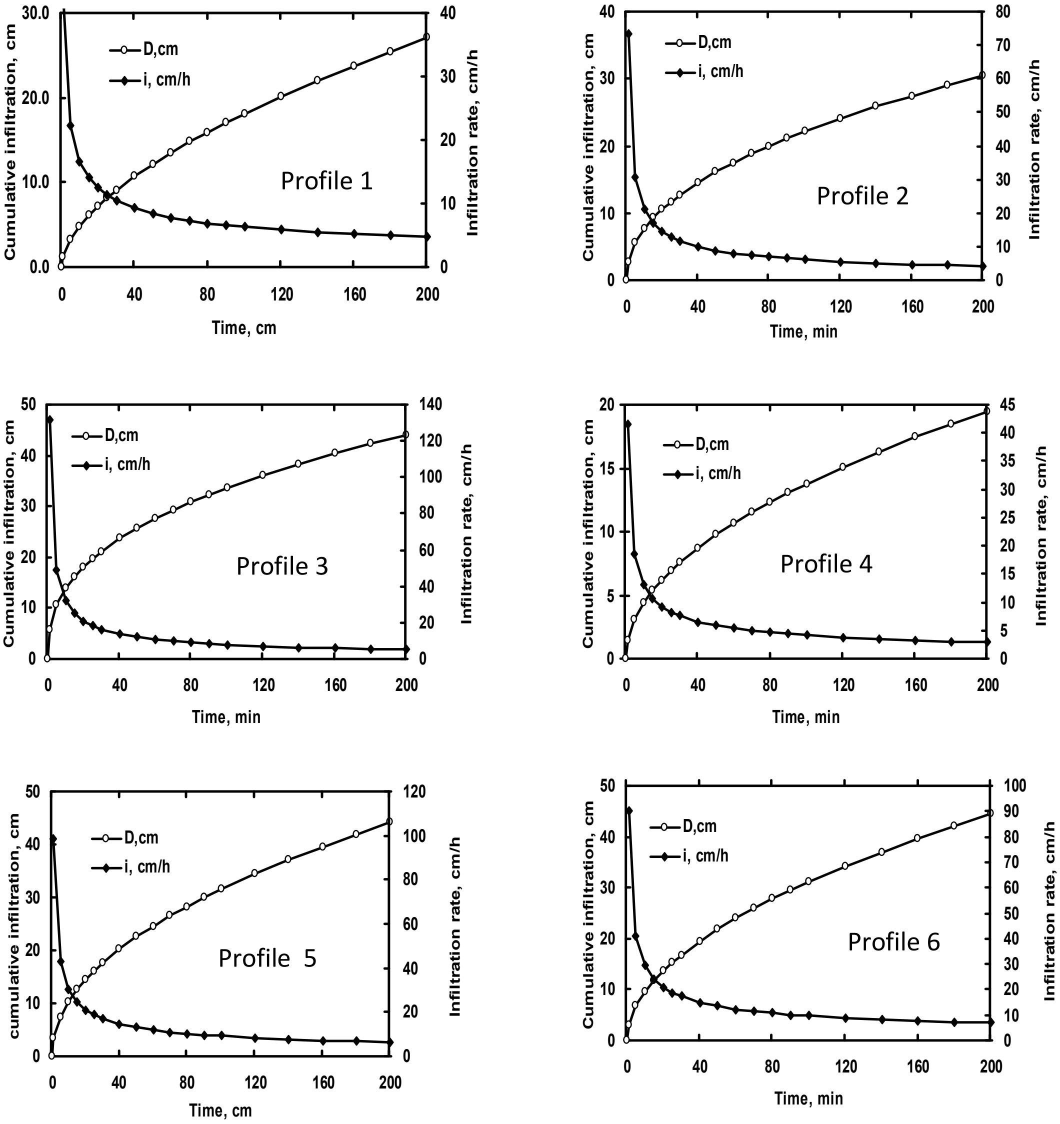

Fig. 1: Instantaneous and Cumulative Infiltration in the studied soil of Wadi El-Sayda in profile 1 to 6.

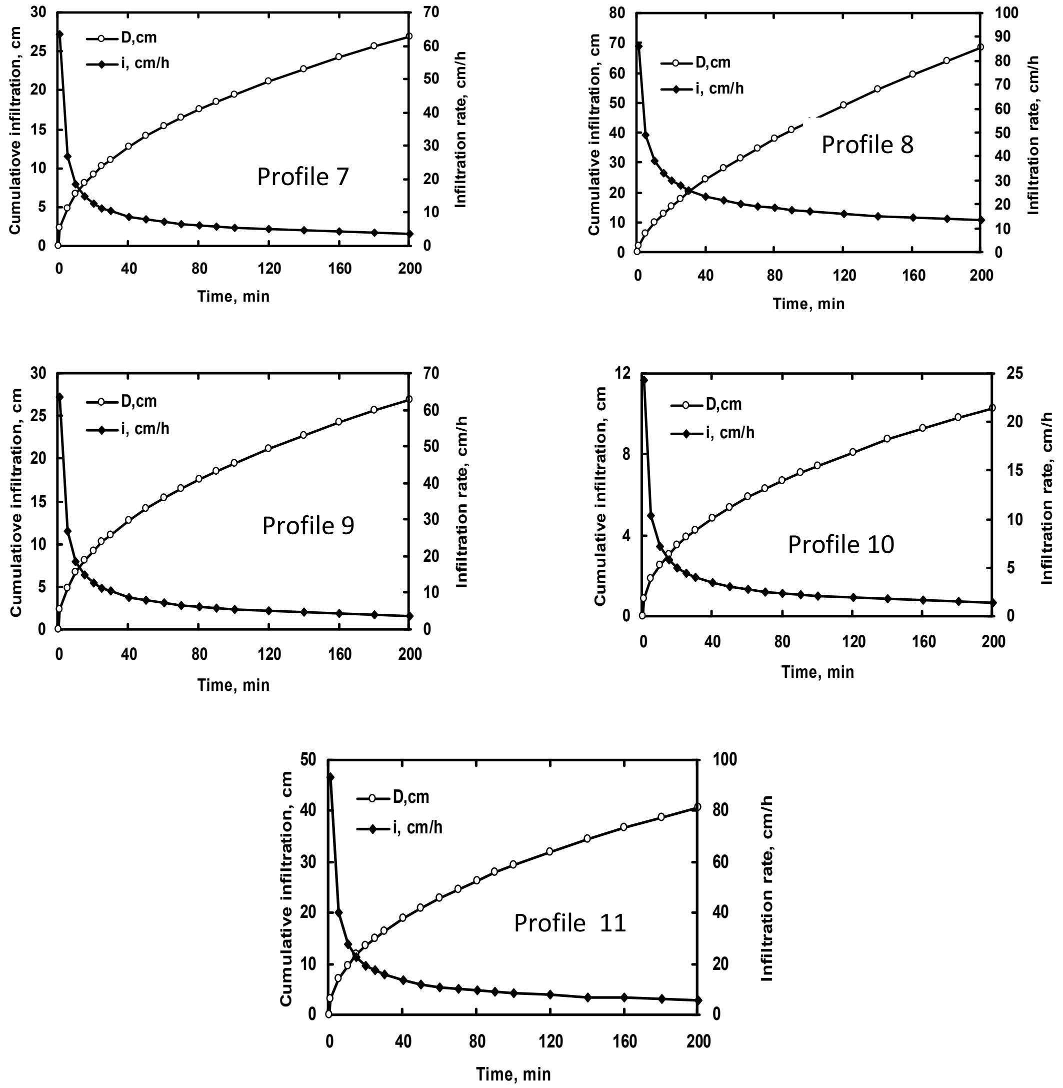

Fig. 2: Instantaneous and Cumulative Infiltration in the studied soil of Wadi El-Sayda in profile 7 to 11.

Since infiltration data are fundamental prerequisite for designing, evaluating and managing irrigation systems, and very important key process in the management of water resources for crop production in both irrigated and dry land agriculture, so irrigation design should be implemented and monitored more carefully increase water application efficiency and consequently decrease any loss of nutrients moving beyond the roots zone..

Irrigation scheduling is the process of determining when to irrigate and how much water to apply per irrigation. Proper scheduling is essential for the efficient use of water, energy, and other production inputs, such as fertilizers. It allows irrigation to be coordinated with other farming activities including cultivation and chemical application. Among the benefits of proper irrigation scheduling are improved crop yield and / or quality, water, and energy conservation and low production costs. Irrigation schedules are designed to either fully or partially provide the irrigation requirement.

The provision of irrigation water and its economic use is of prime importance in the production of crops under semi-arid and arid climates where the sources of irrigation water are limited. In addition, plants vary in the timing of their high need for water, this need by different plant species depends on how much moisture stress they are able to tolerate at any particular stage of growth. If water supply is acutely inadequate, care should be taken at least to provide water at the critical stages of growth. Thus the knowledge of sensitive stages of water deficit by plants is very important for judicious water management.

Wherever irrigation water is not sufficient and is restricted, irrigation to attain optimum production should be based on avoiding water deficits during the periods of peak water use from flowering (2) to early yield formation period (3), made without causing additional heavy yield losses by reducing water supply during the vegetative (1), late yield formation (late 3) and ripening period (4).

So, the irrigation for the most predominant field crops and trees that are considered to be potentially grown in the studied area is calculated. The calculations are based on two parameters; a) The depth of available water in the root zone and , b) The monthly consumptive use for each crop during its growth season which is obtained from Penman – Montieth Equation by climatic record, Allen *et al*. (1998).

Tables (4, 5 and 6) show that calculated irrigation frequencies vary according to soil texture, crop and growth season. For coarse, medium and fine textured soil barley, wheat, tomato and maize can be grown satisfactory using sprinkler irrigation system while in case of citrus, peaches and olives using drip irrigation systems is necessary. The irrigation frequencies ranged between 1-10 days for sandy textured soil, while in the clay textured soils they range between 5 to 30 days in the summer and winter seasons.

Needless to mention that surface irrigation under special conditions can be applied for all crops, in spite of the high IR, cm/h.

Table (4) shows crops could be grown and environmental circumstances of the studied area. It was found that crop coefficient for fruit trees and fodder crops is less than for field and vegetable crops although in winter or summer specially in mid stage. Contrarily, fruit trees and fodder crops have crop coefficient more than field and vegetable crops although winter or summer for different growth stages.

Table (5) clears that seasonal irrigation water consumptive use for field and vegetable crops is less where the values ranged between 293 and 921 mm/day in winter while they were between 577 and 1940 mm/ season in summer. Fruit trees need irrigation water ranged from 1119 to 1037 mm/season. So, it exceeds to be 2157 mm/day for fodder crops as clover. Water requirements under drip irrigation system (efficiency, 85%) were ranged between 1769 and 2393 m^3/fed for field and vegetable crops in winter while they were ranged between 2942 to 9892 m^3/fed for them in summer. Fruit trees exploited 5585 - 7902 m^3/fed while fodders (clover) reached 10862 m^3/fed. It is remarked that all values of water requirements increased when furrow irrigation system applied for all crops (Abdel Rahman; *et al.,* (2009).

Table 4: Crop coefficient, Growth stage and plant date for winter and summer crops that could be cultivated in wady EL-Sayda area

Crop	Crop coefficient				Growth stage				Planting	Total
	ini	dev	mid	end	ini	dev	mid	end	date	
Field crops	Winter crops									
Barley	0.3	0.73	1.15	0.4	20	25	60	30	01-Nov	135
Broad been	0.5	0.83	1.15	0.3	30	35	45	40	01-Nov	150
Chick pea	0.4	0.83	1	0.35	20	25	50	40	01-Nov	135
Sugar beet	0.35	0.78	1.2	0.7	35	60	70	40	01-Nov	205
Wheat	0.3	0.73	1.15	0.4	20	25	60	30	01-Nov	135
Vegetables										
Green Beans	0.5	0.78	1.05	0.9	20	30	30	10	01-Feb	90
Lettuce	0.7	0.85	1	0.95	30	40	25	10	01-Nov	105
Dry onion	0.7	0.88	1.05	0.75	20	25	70	40	01-Oct	155
Pepper	0.6	0.83	1.05	0.9	30	35	40	20	01-Oct	125
Potato	0.5	0.83	1.15	0.75	30	35	50	25	01-Oct	140
Squash	0.5	0.73	0.95	0.75	25	35	25	15	01-Dec	100
Field crops	Summer crops									
Corn	0.7	0.95	1.2	0.6	30	40	50	30	01-Apr	150
Sesame	0.35	0.73	1.1	0.25	20	30	40	20	01-Jun	110
Sorghum	0.7	0.85	1	0.55	20	35	40	30	01-May	125
Sugar cane	0.4	0.83	1.25	0.75	30	50	180	60	01-May	320
Vegetables										
Dry beans	0.4	0.78	1.15	0.35	20	30	40	20	01-Jun	110
Green beans	0.5	0.78	1.05	0.9	15	25	25	10	01-Aug	75
Molkhia	0.5	0.6	0.7	0.5	30	30	90	30	01-Mar	180
Okra	0.8	0.93	1.05	0.9	30	30	30	30	01-Apr	120
Peas	0.5	0.83	1.15	0.3	20	30	35	15	01-Apr	100
Pepper	0.6	0.83	1.05	0.9	30	35	40	20	01-Apr	125
Squash	0.5	0.73	0.95	0.75	20	30	25	15	01-May	90
Forages										
Alfalfa	0.95	0.95	0.95	0.95	90	90	90	90	01-Apr	360
Kerkrade										
70 % Canopy	0.7	0.68	0.65	0.7	60	90	120	90	01-Oct	360
50 % Canopy	0.65	0.63	0.6	0.65	60	90	120	90		360
20 % Canopy	0.5	0.48	0.45	0.55	60	90	120	90		360
henna										
70 % Canopy	0.7	0.68	0.65	0.7	60	90	120	90	01-Oct	360
50 % Canopy	0.65	0.63	0.6	0.65	60	90	120	90		360
20 % Canopy	0.5	0.48	0.45	0.55	60	90	120	90		360
palm date										
70 % Canopy	0.7	0.68	0.65	0.7	60	90	120	90	01-Oct	360
50 % Canopy	0.65	0.63	0.6	0.65	60	90	120	90		360
20 % Canopy	0.5	0.48	0.45	0.55	60	90	120	90		360

Table 5: Total water requirement for forages and tree in wady EL-Sayda area.

Crops	Total Etc	LR surface	LR drip	Total Water Requirement, mm		Total Water Requirement, m3/fed	
				surface	drip	Surface	drip
Field crops	Winter Crops						
Barley	399	0.016	0.011	737.25	474.63	3096.45	1993.46
Broad been	423	0.084	0.026	839.62	510.93	3526.4	2145.91
Chick pea	346	0.015	0.034	638.67	421.39	2682.42	1769.82
Sugar beet	921	0.018	0.013	1705.24	1097.8	7162.01	4610.76
Wheat	399	0.021	0.016	741.02	477.04	3112.27	2003.59
Vegetables							
Green beans	463	0.142	0.044	981.14	569.78	4120.79	2393.06
Lettuce	356	0.052	0.031	682.78	432.22	2867.66	1815.33
Dry onion	614	0.046	0.022	1170.19	738.6	4914.81	3102.13
Pepper	419	0.09	0.034	837.16	510.29	3516.08	2143.22
Potato	468	0.079	0.031	923.9	568.2	3880.37	2386.45
Squash	293	0.052	0.031	561.95	355.73	2360.18	1494.08
Field crops	Summer Crops						
Corn (Apr)	1141	0.079	0.031	2252.49	1385.3	9460.47	5818.25
Sesame	647	0.024	0.021	1205.29	777.5	5062.22	3265.52
Sorghum	848	0.032	0.017	1592.79	1014.9	6689.71	4262.58
Sugarcane	1940	0.079	0.031	3829.83	2355.37	16085.28	9892.55
Vegetables							
Dry beans	700	0.142	0.044	1483.37	861.43	6230.13	3618.02
Molkhia	887	0.084	0.031	1760.62	1076.91	7394.6	4523.04
Okra	919	0.084	0.031	1824.14	1115.77	7661.37	4686.21
Peas	661	0.09	0.026	1320.68	798.41	5546.85	3353.3
Pepper	896	0.09	0.034	1790.21	1091.22	7518.88	4583.12
Squash	577	0.052	0.031	1106.64	700.54	4647.87	2942.27
Forages							
Alfalfa	2157	0.07	0.019	4217.01	2586.8	17711.44	10864.54
	karkaden						
70 % Canopy	1537	0.05	0.031	2941.63	1866.08	12354.83	7837.55
50 % Canopy	1423	0.05	0.031	2723.44	1727.68	11438.47	7256.24
20 % Canopy	1119	0.05	0.031	2141.63	1358.59	8994.83	5706.06
	henna						
70 % Canopy	1537	0.08	0.039	3037.55	1881.62	12757.71	7902.8
50 % Canopy	1423	0.08	0.039	2812.25	1742.06	11811.46	7316.64
20 % Canopy	1119	0.08	0.039	2211.46	1369.9	9288.14	5753.57
palm date							
70 % Canopy	1537	0.03	0.01	2880.97	1826.5	12100.09	7671.3
50 % Canopy	1423	0.03	0.01	2667.29	1691.03	11202.62	7102.32
20 % Canopy	1119	0.03	0.01	2097.47	1329.77	8809.37	5585.03

Data cleared that irrigation intervals for different soil are less than 3 days for the 2nd unit, 2 days for the other unit. Irrigation frequencies calculated as 1-4 days for the majority of field crops and vegetables. They increased to be 20 day for Date Palm trees table (6)

In conclusion, the use of infiltration parameters as an indication to the suitability of an irrigation system must be coupled with the data of irrigation intervals for plants which might be grown in the area under study. These findings are concomitant with those reported by Giriappa, (1983).

Table 6: Calculated irrigation intervals (days) for various crops, fruit trees and vegetables considered to be grown in Wadi El-Sayda.

Crops	Irrigation systems & Deficit	Month	Period (days)	ETo (mm/day)	Kc (FAO)	ETc (mm/day)	ETc (mm/month)	Root depth (m)	Irrigation intervals (days)			
									Sand	Loamy sand	Sandy loam	Clay
Barley	Surface 0.25 Deficit	Nov.	15	4.31	0.3	1.29	19.40	0.3	2	2	2	2
		Dec.	31	2.66	0.7	1.86	57.72	0.5	3	2	3	2
		Jan.	31	3.61	1.15	4.15	128.70	0.7	2	1	2	1
		Feb.	28	4.52	0.9	4.07	113.90	0.85	2	2	2	2
		March	15	6.23	0.4	2.49	37.38	1	4	3	4	3
		Total	120				357.10					
Wheat	Surface 0.25 Deficit	Nov.	14	4.31	0.3	1.29	18.10	0.3	2	2	2	2
		Dec.	31	2.66	0.5	1.33	41.23	0.5	4	3	4	3
		Jan.	31	3.61	0.75	2.71	83.93	0.7	2	2	2	2
		Feb.	28	4.52	1.1	4.97	139.22	0.85	2	1	2	1
		March	31	6.23	0.6	3.74	115.88	1	3	2	3	2
		April	5	7.34	0.4	2.94	14.68	1	3	3	3	3
		Total	140				413.04					
Tomato	Drip 0.2 Deficit	Dec.	15	2.66	0.3	0.80	11.97	0.3	4	3	4	3
		Jan.	31	3.61	0.6	2.17	67.15	0.4	2	2	2	2
		Feb.	28	4.52	0.8	3.62	101.25	0.5	1	1	1	1
		March	31	6.23	1.1	6.85	212.44	0.6	1	1	1	1
		April	5	7.34	0.6	4.40	22.02	0.7	2	1	2	1

		Total	110				414.83					
Sugar beet	Spry 0.25 Deficit	Aug.	15	7.98	0.3	2.39	35.91	0.3	1	1	1	1
		Sep.	30	7.41	0.5	3.71	111.15	0.5	1	1	1	1
		Oct.	31	5.84	0.7	4.09	126.73	0.6	1	1	1	1
		Nov.	30	4.31	0.95	4.09	122.84	0.6	1	1	1	1
		Dec.	31	2.66	1.12	2.98	92.36	0.6	2	2	2	2
		Jan.	31	3.61	0.75	2.71	83.93	0.6	2	2	2	2
		Feb.	12	4.52	0.4	1.81	21.70	0.6	3	3	3	3
		Total	180				594.61					
Maize	Surface 0.25 Deficit	Ma.	15	8.35	0.3	2.51	37.58	0.3	1	1	1	1
		Jun.	30	8.81	0.7	6.17	185.01	0.5	1	1	1	1
		Jul.	31	8.62	1.05	9.05	280.58	0.7	1	1	1	1
		Aug.	31	7.98	0.7	5.59	173.17	0.9	2	1	2	1
		Sep.	18	7.41	0.3	2.22	40.01	1	4	4	4	4
		Total	125				716.35					

Table 6 : Cont.

Crops	Irrigation systems & Deficit	Month	Period (days)	ETo (mm/day)	Kc (FAO)	ETc (mm/day)	ETc (mm/month)	Root depth (m)	Irrigation intervals (days)			
									Sand	Loamy sand	Sandy loam	Clay
Olive	Drip 0.5 Deficit	March	31	6.23	0.65	4.05	125.53	1.2	3	3	3	3
		April	30	7.34	0.65	4.77	143.13	1.3	3	2	3	2
		May	31	8.35	0.65	5.43	168.25	1.4	2	2	2	2
		June	30	8.81	0.7	6.17	185.01	1.5	2	2	2	2
		July	31	8.62	0.7	6.03	187.05	1.6	3	2	3	2
		Aug.	31	7.98	0.7	5.59	173.17	1.7	3	3	3	3
		Sept.	26	7.41	0.7	5.19	134.86	1.7	3	3	3	3
		Total	210				1117.01					
Date Palm	Drip 0.05 Deficit	Jan.	30	3.61	0.55	1.99	59.57	3	14	13	14	13
		Feb.	31	4.52	0.55	2.49	77.07	3	11	10	12	10
		Mar.	31	6.23	0.55	3.43	106.22	3	8	8	8	8
		Apr.	28	7.34	0.55	4.04	113.04	3	7	6	7	6
		Ma.	31	8.35	0.55	4.59	142.37	3	6	6	6	6
		Jun.	30	8.81	0.55	4.85	145.37	3	6	5	6	5
		Jul.	31	8.62	0.55	4.74	146.97	3	6	5	6	5
		Aug.	30	7.98	0.55	4.39	131.67	3	6	6	7	6
		Sep.	31	7.41	0.55	4.08	126.34	3	7	6	7	6
		Oct.	31	5.84	0.55	3.21	99.57	3	9	8	9	8
		Nov.	30	4.31	0.55	2.37	71.12	3	12	11	12	11
		Dec.	31	2.66	0.55	1.46	45.35	3	19	18	20	18
		Total	365				1264.64					
Peaches	Drip 0.5 Deficit	April	30	7.34	0.5	3.67	110.10	1.2	3	3	3	3
		May	31	8.35	0.65	5.43	168.25	1.3	2	2	2	2
		June	30	8.81	0.65	5.73	171.80	1.4	2	2	2	2
		July	31	8.62	0.65	5.60	173.69	1.5	3	2	3	2
		Aug.	31	7.98	0.7	5.59	173.17	1.6	3	2	3	2
		Sept.	30	7.41	0.7	5.19	155.61	1.7	3	3	3	3
		Oct.	27	5.84	0.7	4.09	110.38	1.7	4	4	4	4
		Total	210									
Citrus	Drip 0. 5 Deficit	Feb.	10	4.52	0.45	2.03	20.34	1.2	6	5	6	5
		Mar.	31	6.23	0.6	3.74	115.88	1.3	3	3	3	3
		Apr.	30	7.34	0.7	5.14	154.14	1.4	3	2	3	2
		Ma.	31	8.35	0.75	6.26	194.14	1.5	2	0	2	2
		Jun.	30	8.81	0.8	7.05	211.44	1.6	2	2	2	2
		Jul.	31	8.62	0.7	6.03	187.05	1.7	3	2	3	2
		Aug.	31	7.98	0.65	5.19	160.80	1.7	3	3	3	3
		Sep.	30	7.41	0.6	4.45	133.38	1.7	4	3	4	3
		Oct.	16	5.84	0.45	1.83	42.05	1.7	9	8	9	8
		Total	240				1219.21					

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