INFILTRATION RATE AND ITS RELATION IRRIGATION SCHEDUAL FOR WIND ERODED AREAS IN EL - SHEIKH ZEWIED, NORTH SINAI, EGYPT

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ABSTRACT

The current work was carried out at El-Sheikh Zewied, Agricultural Experimental Station of the Desert Research Center, North Sinai Governorate, to study the infiltration rates and other soil physical and chemical properties and their relation to irrigation schedule in the wind eroded areas. The area are divided into three zones, eroded zone, transport zone and depositional zone, each zone included three infiltration tests and three soil profiles, the distance between each test is about 50 m along the wind direction, the second zone (transport) is about 500 m from the first zone (eroded) and the third zone (depositional) is about 1500 m apart from the second zone.

Results show that the infiltration rates decrease gradually along the wind direction and the coarse sand fraction of soil texture also decreases gradually along the wind direction, while the reverse is true with fine sand fraction of soil texture. Similar trends were obtained with electric conductivity dS/m and cations and anions concentrations. Also, the obtained results show that for irrigation frequencies, of coarse and medium sand textured soil, watermelon, tomato and peaches can be grown satisfactorily using sprinkler or drip irrigation, except for barley and olives. In case of fine sand textured the irrigation frequencies are larger than 9 days, surface irrigation under special conditions was applied for all crops, in spite of the high intake rates.

Keywords: Soil physical and chemical properties, Infiltration rate, eroded zone, Transport zone, Depositional zone and Irrigation frequencies.

INTRODUCTION

Wind erosion is one of the natural and common phenomenon prevailing in the arid and semi-arid regions allover the world. It is the process of detachment, transportation, and deposition of soil material by wind action, Chepil (1957). It affects the properties, productivity and constraints of the soil and ecosystems. Soil erosion by wind is a selective process in which soil particles and aggregates are selectivity sorted and removed from soil surface. This process occurs at the soil surface where eroded materials are normally high in organic matter and nutrients content, Gore (1979).

In this concern, Aroug (1995) reported that soil erosion markedly influenced soil chemical properties, particularly salinity soluble cations and anions, CEC and exchangeable cations as well as micronutrients content, through transformation. Skaggs *et al*. (1983) found that infiltration rates tended to increase with coarser deep soil profile. However, in as much as soil profile of most natural soils are seldom uniform, the effect of stratification on infiltration rate is often spectacular. In this accord, Hagan (1973) stated that infiltration rate was severely reduced when wetting front reached sand or clay layers. Hillel (1971) showed that when the soil surface was compacted and the profile was covered by a surface crust of lower conductivity, the infiltration rate was lower than that of the uncrusted soil, similar results were obtained by Hillel (1964) and Hillel and Gardner (1969).

Agrawal *et al.* (1974) found a highly significant positive relationship between sand content and final infiltration rate. El-Samanoudy (1976) clarified that as sand content increased infiltration rate due to the relative increase in large soil pores. Richards (1954) mentioned that the amount of clay in the soil was the major factor in determining soil permeability.

Therefore, the current investigation is performed to study the physical and chemical properties under eroded areas by wind and to study infiltration rates as a very important factor to evaluate water infiltration rate under eroded areas.

The objective of this work is to elucidate the characterization of infiltration rates and other soil physical and chemical properties and the study also included the determination of irrigation frequencies for various plants that might be considered to be potentially grown in this area.

MATERIALS AND METHODS

The current study was conducted on sandy soils at El-Sheikh Zewied Agricultural Experimental Stations of the Desert Research Center, North Sinai Governorate. The areas along the wind direction is divided into three zones, the first zone is considered the eroded area where three infiltration tests were carried out and three soil profiles (1, 2 and 3) were taken at the starting point for the first test, then son apart for the along the direction of wind second and third tests. The second transport zone is far about 500 m from the first zone and the distance between each test and each soil profile (4, 5 and 6) is also 50 m. The third depositional zone is far about 1500 m from the second zone (transport) in which three infiltration tests and three soil profiles (7, 8 and 9) were taken, the distance between each test is 50 m along the wind direction.

The study also included the determination of irrigation frequencies for various plants that might be considered to be potentially-grown in this area. These determinations were based on the infiltration tests and available soil moisture by using meteorological data were collected from Egyptian Meteorological Authority, Cairo, Egypt, to compute ETo rates using Penman – Monteith equation according to FAO Penman – Monteith method as recommended by the FAO Expert Consultation held in May 1990 in Rome, Italy, by using CROPWAT , software version 5.7 (Smith,1992).

- Penman – Monteith Equation : (Smith,1993 and Allen *et al.*,1998)

$$ETo = \frac{0.408\,\Delta\,(R_n - G) + \gamma\,\frac{900}{T+273}\,u_2\,(e_s - e_a)}{\Delta + \gamma\,(1 + 0.34\,u_2)}$$

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 (Kp_a $^oC^{-1}$).

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)

Infiltration rate was determined under constant head of water (7 cm) using double ring infiltrometer, as described by Klute (1986). The cumulative depth of infiltrated water D in cm as a function of time t, according to the Philips two terms equation (1957 a, b):

$$D = st^{1/2} + At \text{ and } I = ½\, t^{-1/2} + A$$

Where; I is the infiltration rate at large time, i.e., the steady state infiltration rate, and S and A are constants. The collected samples were analyzed to determine their physical and chemical properties, dry sieving was used at diameters, 2.0-1.0, 1.0-0.5, 0.5-0.2, 0.2-0.1, 0.1-0.063 and >0.063 mm. Bulk densities were determined using undisturbed soil cores. Klute (1986). Soil moisture retention at 0.06 and 15.0 bar were determined according to Klute (1986). Total carbonate was determined using Collin's calcimeter, total soluble salts of the saturated soil extract and pH were determined according to Richards (1954).

RESULTS AND DISCUSSION

Climate:

The meteorological data of the studied area were collected from Egyptian Meteorological Authority, Cairo, Egypt, Table (1) reveal that the mean monthly temperature varies from 19.10 to 24.10^{o}C, the relative humidity reaches between 60.60 and 80.50 %, the mean monthly evaporation ranges from 3.1 to 5.3 mm, the mean monthly surface wind speed varies from 3.7 to 5.3 m/sec and the mean monthly precipitation is about 1.2 to 3.4 mm.

Initial and basic infiltration rate:

The initial intake rates and basic infiltration rates were calculated, according to Philips equation (1957 a and b). Data of the infiltration rates and initial rates for soils are presented in Table (2) and Figs. (1, 2 and 3). The basic intake rates of the studied soil ranges widely between 49.60 and 134.61 cm/hr (very rapid). The initial infiltration rate also differs widely and fluctuates between 54.12 and 152.8 cm/hr. According to Taylor (1964), if the basic intake rate exceeds 12 cm/hr or the value of "n" exceeds 0.7, the soil is considered unsuitable for surface irrigation except under special conditions. However, the sprinkler or dripping systems are applicable for sandy soils.

In spite of the very rapid basic infiltration rates for all the studied soil profiles, but their values vary either within or between the recognized zones. Similar trends are noticed for the initial infiltration rates.

table1

table2

fig1

fig2

fig3

The results in Table (2) showed that initial intake rates decreased in eroded zone being between 9.88 and 11.06%, transport zone (12.97 to 52.42%) and depositional zone (34.86 to 44.09%). Except for in soil profile (No. 9) for deposit zone, the initial infiltration rate increased 16.52% relatively the soil profile (No. 8).

Between eroded and transport zones, the initial infiltration rates decreased 19.89 and 53.39%, while decreased from 0.44 to 53.28% between transported and depositional zones. Also, the results revealed that the initial infiltration rates decreases between eroded zone and depositional zone (34.51 to 58.37%).

Also, the results in Table (2) revealed that the basic infiltration rates decreased considerably upon shifting eroded zone (13.04 to 36.80%), to transport (1.47 to 16.60%), depositional zones (0.59 and 11.49%), while in the profile (No. 9) for depositional zone, the basic infiltration rate increased by 12.32% relative to the soil profile (No. 8). The results was markedly noticed that between eroded and transported zones, the basic infiltration rates decreased between 30.77 to 47.54%. While its decreased from 5.40 and 28.70% between transported and depositional zones. Also, the results showed that the basic infiltration rates between eroded and depositional zones (34.51 and 58.37%).

The relative decreases of both initial and basic infiltration rates may be due to the increase of the percentage <0.063, 0.1 – 0.063 mm and 0.2-0.1 mm sand fractions, Tables (3, 4 and 5), along wind direction. The higher increases were particularly obtained for 0.1-0.063, sand fractions. Also, data in Tables (3, 4 and 5) showed that the fraction of sand (0.5-0.2 mm) decreases with wind direction, while the sand fraction (1.0-0.5 mm) increases from eroded zone to transport zone and decrease in depositional zone. But, the sand fraction (0.2-0.1 mm) is found in the eroded zone only. It is clearly noticed that the bulk density of the surface layer is gradually increased upon moving from the eroded zone (with a mean value 1.56), the transport zone with a mean value 1.60 to the depositional zone (with a mean value 1.65). The above mentioned results may be responsible the variations in the initial infiltration.

The obtained results for chemical properties at Tables (6, 7 and 8) showed that the concentration of soluble salts are higher in soil profiles (No. 7, 8 and 9) in depositional zone than the soil profile (No. 1, 2, 3) in eroded zone. Aroug (1995), also the concentrations of cations and anions are similar to the obtained results of electric conductivity. These results may be due to the increase of fine sand fraction with wind direction.

Determination of irrigation frequencies:

The irrigation for the most predominant field crops and vegetables that are considered to be potentially grown in this region were 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 was obtained from Penman-Monteith Equation by climatic record, Allen *et al*. (1998).

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8

The following equation was applied, according to Doorenbos and Pruitt (1984):

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

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.

Table (9) shows that calculated irrigation frequencies vary according to the texture of soil, crop and growth season. For coarse and medium sand, watermelon, tomato and peaches can be grown satisfactory using sprinkler or drip irrigation systems except for barley and olives. In case of fine sand the irrigation frequencies are larger than 9 days. Surface irrigation under special conditions was applied for all crops, in spite of the high intake rates.

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 frequencies for plants which might be grown in the area under study.

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معدل الرشح وعلاقته بجدولة الرى فى المناطق المعرضة للإنجراف بالرياح بمنطقة الشيخ زويد - شمال سيناء- مصر

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يهدف هذا البحث الى دراسة الخواص الفيزيائية والكيميائية للاراضى المعرضه للانجراف بالرياح وذلك على طول خط أتجاه الرياح بغرض معرفه التدرج فى الخواص الفيزيائية والكيميائية ومدى أثر ذلك على جدولة الرى بالمنطقة عن طريق دراسة معدلات الرشح والثوابت الرطوبية وأنواع المحاصيل المختلفة.

لذلك: أجريت هذه الدراسة فى منطقة الشيخ زويد شمال سيناء على ثلاث مناطق.

1- المنطقة الأولى : وهى المنطقة المنجرفه بفعل الرياح (Eroded area) وتم عمل ٣ قطاعات تربه بها لتقدير الخواص الفيزيائية والكيميائية الى جانب إجراء ثلاث إختبارات لمعدلات الرشح كل إختبار يبعد عن الآخر ٥٠م فى إتجاه الرياح.
2- المنطقة الثانية : وهى تمثل منطقة الأنتقال (Transport area) وهى تبعد عن المنطقة الأولى بحوالى ٥٠٠م وتم عمل ثلاث قطاعات تربه بها وثلاث إختبارات لمعدلات الرشح وكل إختبار يبعد عن الآخر ٥٠م على طول إتجاه الرياح.
3- المنطقة الثالثة : وهى تمثل منطقة الترسيب (Depositional area) وهى تبعد عن المنطقة الثانية بحوالى ١٥٠٠م فى إتجاه الرياح وتم عمل ثلاث قطاعات تربه وكذلك ثلاث إختبارات لمعدلات الرشح كل إختبار يبعد عن الآخر ٥٠م فى إتجاه الرياح.

وقد توصلت النتائج الى مايلى :

أولا : ١- أن معدلات الرشح تقل تدريجيا على طول خط الأنجراف كالآتى:

معدل الرشح فى المنطقة المنجرفة > منطقة الأنتقال > منطقة الترسيب.

٢- الحبيبات الخشنه تقل تدريجيا كلما أتجهنا فى إتجاه الرياح كالآتى:

الحبيبات الخشنه فى المنطقة المنجرفة > منطقة الأنتقال > منطقة الترسيب.

٣- الحبيبات الناعمة تزيد تدريجيا كلما إتجهنا فى إتجاه الرياح كالآتى:

الحبيبات الناعمة فى المنطقة المنجرفه < منطقة الأنتقال < منطقة الترسيب.

٤- أيضا زاد تركيز الأملاح الذائبة فى إتجاه الرياح كالآتى:

تركيز الاملاح فى المنطقة لمنجرفة < منطقة الأنتقال < منطقة الترسيب.

ثانيا: بالنسبة لحساب فترات الرى للمحاصيل المختلفة أظهرت النتائج مايلى:

1- بالنسبة للقوام الخشن والمتوسط لوحظ أن محاصيل البطيخ والطماطم والخوخ يمكن أن تنمو بدرجة جيدة باستخدام الرى بالرش أو التنقيط ماعدا الشعير والزيتون.
2- أما بالنسة للقوم الناعم فإنه يمكن رى جميع المحاصيل رى سطحى وخاصة عند زيادة فترة الرى عن ٩ أيام.