Conference on the investment in Date Palm Sector (Reality and Prospects) 23rd- 25th May 2016 Muscat Oman

Water Saving in Arid Regions: A comparison of surface and subsurface drip irrigation systems for Irrigation of Date Palms

A. Z. Dewidar[1, 2], Y. Al-Fehaid[1], S. Al-Hilal[1], M. ben Saleh[3]

1-Centr for Date Palm and Dates, Ministry of Agriculture, PO Box 43, Al-Hassa-31982, Saudi Arabia

2-Irrigation and Drainage Engineering Department, Agricultural Engineering Research Institute, Egypt

3-International Center for Agricultural Research in the Dry Areas (ICARDA), Muscat, Oman

Introduction

Increasing the water supply in Saudi Arabia is questionable. Policy to achieve water securitty and food security is to increase the water use efficiency and water productivity producing more with less water in all water sectorial uses particularly the agriculture sector in which receiving nearly 85% of the available water resources. Technically, several approaches are now implemented for better water saving in the irrigated agriculture among them the introduction of the new irrigation techniques such as surface and subsurface drip irrigation systems.

Date palm represents roughly 74% of the total cultivated area under fruits in the entire Kingdom (Kassem, 2007). Date palm trees are usually irrigated by the flood irrigation system that uses an abundant amount of water. However, amount of the water applied to the farms by farmers are usually based on their experience (Al-Amoud, 2010). Applications of traditional irrigation methods such as flood irrigation are not only putting further stress on the already dwindling water resources but they also happen to be wasteful (Faures et al., 2001; Darfaoui and Al-Assiri, 2010). Adoption of modern irrigation techniques is needed to be emphasized to increase water use efficiency. Drip irrigation and subsurface drip irrigation systems are the most effective ways to convey directly water and nutrients to plants and not only save water but also increase yield of crops.

Objectives

The aim of this research work is to:

1- investigate the efficiency and practicality of subsurface drip system for irrigating date palm trees.

2- compare subsurface with surface drip irrigation system, especially in areas where water is a limited source.

Methodology

Study area

Location and site characteristics at different soil layers are shown in figures 1 and 2.

Climate Condition

Climatic conditions were monitored by an in-situ meteorological station (Davis vantage pro2). the reference evapotranspiration (ETo, mm day-1) was calculated according to the Penman-Montieth equation (Eq.1)

Figure 1. Localization of the field experiment

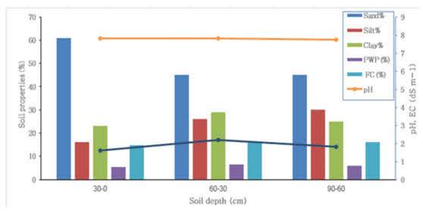


Figure 2. Physical and chemical properties of the filed at different layers

$$ETo = \frac{0.408\,\Delta(R_n - G) + \gamma[(900U_2)/(T+273)](e_s - e_a)}{\Delta + \gamma(1 + 0.34U_2)} \quad \text{Eq.1}$$

where Rn and G are daily net radiation and soil heat flux in MJ m-2, respectively, is the slope of saturation vapor pressure curve (kPa/ °C), U2 is the average daily wind speed at 2 m above soil surface (m s-1), is the moisture constant (kPa/ °C), T is the average daily air temperature at 2 meter height (°C) and (es - ea) is the saturated vapor pressure deficit (kPa).

Irrigation scheduling

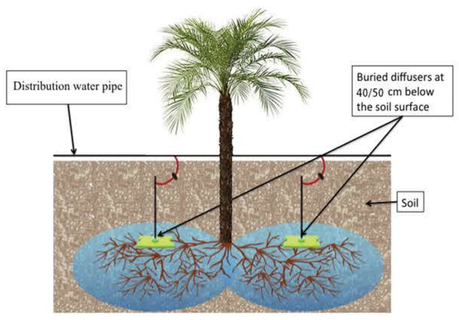
The date palm trees were daily irrigated with a water volume (Vw) based on the actual climatic data acquired from a nearby-automated weather station according to Eqs. 2 and 3. v

$$V_w = \frac{ET_o \times K_c \times A_p \times K_r}{E_i \times (1 - LR)} \quad \text{.....for(DI)} \qquad V_w = \frac{70}{100} \times \left[\frac{ET_o \times K_c \times A_p \times K_r}{E_i \times (1 - LR)}\right] \quad \text{.....for(SDI)}$$

where ETo is the reference evapotranspiration, Kc is the constant crop coefficient, Ap is the soil surface area, Ei is the irrigation system efficiency, LR is the leaching requirements, Kr is a reduction factor, DI is the drip irrigation and SDI is the subsurface drip irrigation.

Irrigation system description

The date palm trees were separately irrigated with surface drip irrigation and subsurface drip irrigation (Fig.٣) during the study period. The irrigation system consisted of head unit, main and sub-main delivery polyethylene pipes of ٧٥ and ٦٣ mm in diameter, respectively. The main line was connected to sub-main which leads water to subareas through laterals.



Weather conditions in the experimental site

Figure 4 summarizes the main climatic data of the study area during the research period.

Amount of the applied wat

erFigures 5 and 6 show how the quantity of water applied in mm per month fluctuated in surface and subsurface drip systems between January to December (2015) during the various stage of the crop.

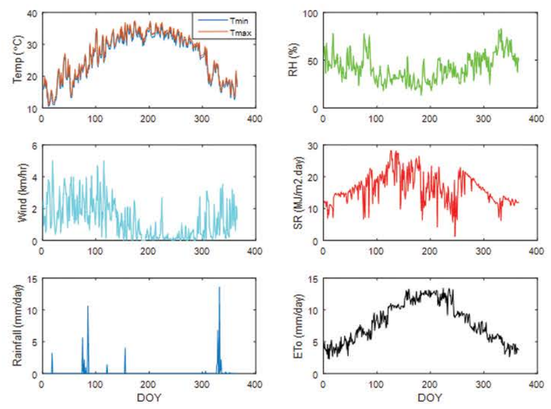


Figure 4. Average daily values of climatic conditions in the experimental site

Subsurface versus drip irrigation method

Figure 7 shows that the amount of water applied to subsurface drip irrigation was 30 % less than the quantity of water applied to drip irrigation.

Water use efficiency (WUE)

Data shown in figure 8 cleared that WUE was significantly increased by 27% more in case of subsurface drip irrigation (1.32 kg m-3) compared to drip irrigation(0.96 kg m-3).

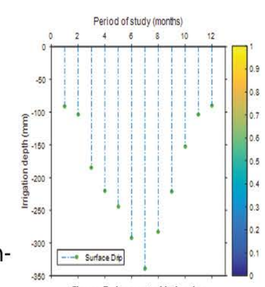


Figure 5. Amount of irrigation water applied to subsurface drip plots

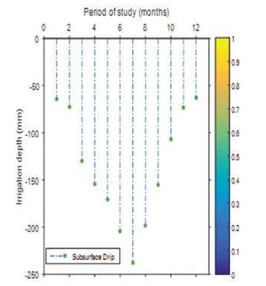


Figure 6. Amount of irrigation water applied to surface drip plots

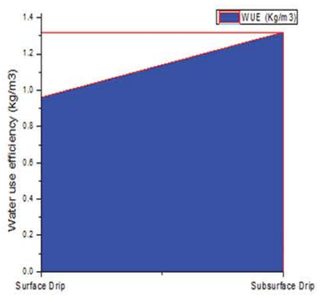


Figure A. Water use efficiency under surface and subsurface drip systems

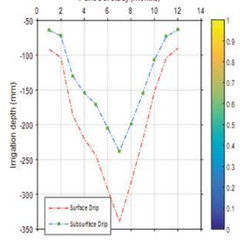


Figure7. Amount of irrigation water applied under DI and SDI systems

Date palm yield and physical analysist

Method of irrigation had not noticeable effect on agronomic traits (yield, fruit weight, fruit length and fruit diameter) of date palm trees in response to water applied (Table.١).

Economic analysis

The total return and net profit of date palm were slightly affected by drip irrigation (DI) and subsurface drip (SDI) treatments (Table.٢).

Conclusiont

The results of the field experiment showed that the subsurface drip irrigation uses water more efficient compared to the surface drip system in oasis areas, where a considerable amount of water lost through evaporation was potentially saved. Furthermore, subsurface drip irrigation system was found to sustain good date palms agronomic parameters in comparison with the drip irrigation scheduling method when it is designed, maintained and used properly.

Acknowledgment

The International Center for Agricultural Research in the Dry Area (ICARDA) is cordially thanked for its financial support of this research

References

.Kassem, M.A., 2007. Water requirements and crop coefficient of date palm trees Sukariah CV. Misr J. Ag. Eng, 24(2), pp.339-359

Al-Amoud, A.I., 2010, March. Subsurface drip irrigation for date palm trees to conserve water. In IV International Date Palm Conference .(882 (pp. 103-114

Faures, J.M., Eliasson, A., Hoogeveen, J. and Vallee, D., 2001. AQUASTAT-FAO's information system on water and agriculture. GRID-Magazine of the IPTRID Network (FAO/United Kingdom.)

Darfaoui, E.M. and Assiri, A.A., 2010. Response to climate change in the Kingdom of Saudi Arabia. Director General of the Department .of Natural Resources, MOA. KSA, pp.1-17

Date Palm Project in the GCC Countries