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ASSESSMENT OF DEFICIT IRRIGATION AND SOIL MULCHING TECHNIQUES ON WATER PRODUCTIVITY FOR FRUIT CROPS GROWN IN NEW RECLAIMED AREAS

By

MOSTAFA ABDELAZEZ HELMY SOKKAR
B. SC. (Soil and Water), Fac. Agric. Al-Menofia Univ., Egypt 2015

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ABSTRACT

Mostafa Abdelazez Helmy Sokkar: Assessment of deficit irrigation and soil mulching techniques on water productivity for fruit crops grown in new reclaimed areas. Unpublished M.Sc., Department of Soils, Faculty of Agriculture, Ain Shams University, 2022.

A field experiment was conducted in new reclaimed areas during 2019–2020 growing season at Um-Saber Farm, plot 23, belongs to PICO “Modern agriculture company”, El-Boheira Governorate. This study aims to improve avocado trees water productivity cultivated under deficit irrigation as well as mulching. The sustained deficit irrigation (SDI) treatments were 90, 80, 70, and 60% of the reference evapotranspiration (ET_o).

Results revealed that the water requirements during different avocado trees physiological growth stages were 613, 1509, 1755, 1391, and 632 m^3/fed for flowering to end of fruit set, fruit set to approximately 50% of the expected market fruit size, during the fruit growth stage, during the fruit ripening stage, and during the flower bud formation stage, respectively. These values represent approximately 10.4%, 25.6%, 29.7%, 23.6%, and 10.7% of the total yearly water requirement.

The soil salinity ($EC_{1:2.5}$) values slightly increased from 0.24 dS/m at 100 SDI-%ET_o to 0.3, 0.4, and 0.54 dS/m at 90, 80, and 70 SDI-%ET_o, respectively. Soil salinity increased to 1.04 dS/m when SDI reached to 60 SDI-%ET_o. However, these increases in soil salinity occurred by increasing SDI levels up to 60 SDI-%ET_o level, which had visible adverse effects on growth or production of avocado trees.

A slight increase in the concentration of K, Ca, Mg, Na, and Cl in soil due to the increase in SDI levels without any harmful effects on avocado growth or fruit production. There were significant increases in the accumulation of water-soluble K, Ca, Mg, Na, and Cl in soil for the treatment of 60 SDI-%ET_o. These increases lead to impacts on growth and production of avocado trees based on known sensitivity to salts in growth medium.

There was only a slight increase in the content of K, Na, and Cl in avocado leaves, particularly at the 60 SDI-%ET_o treatment. These results might due to the concentration effect from water stress associated with this level of SDI and the previously observed accumulation of these elements particularly between tree trunks.

The highest crop water productivity value of 1.24 kg/ m^3 water was attained at 70 ET_o-%ET_o followed by 1.18 kg/ m^3 water at 80 DSI-%ET_o while the least CWP (1.06 kg/ m^3 water) was realized at 100 %ET_o. Hence the crop water requirement of 5110 m^3/fed/year with high irrigation frequency is recommended for mulched sandy soil cultivated with avocado trees.

Keywords: Avocado, Drip irrigation, Soil mulching, Sustained deficit irrigation and Water productivity.

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INTRODUCTION

The limited resources of water is a worldwide problem facing many countries all over the world. For example, Egypt has passed the threshold of the water resource value of 1000 m^3/capita/year in nineties. This will be evident with population predictions for 2025 which will bring Egypt down to 500 m^3/capita/year. Moreover the available data indicate that rapid deterioration is occurring also in surface and ground water quality. The major challenge facing Egypt now is the strong need for better development and management of the available limited resources of water, land and energy to meet the needs of population growth (**MWRI, 2014**).

The issue of insufficient water resources is of increasing importance as the limited supply of quality water is the most important factor limiting crop production. Egypt, as all the Arab countries, is located in arid and semi-arid regions that are known for their lack of annual precipitation, very high rates of evaporation, and consequently very insufficient renewable water resources **(Aqeil *et al*., 2012)**.

The moisture content in the soil should not be increased to a level that will harm the root growth due to the lack of oxygen which will quickly lead to suffocation and the tree will start to deteriorate. Excess water in the soil may expose the roots to soil diseases such as the avocado root rot fungus (Phytophthora cinnamomi). However, even if the fungus is not present, the excess water in the soil edue to xcessive watering can also bring more salt into shallow soil depths as explained by **Grant (2015)**.

Lahav and Kalmar (1977), showed that the regime of avocado irrigation in spring and autumn is not the determining factor for increasing avocado yields. On the contrary, the same yield and the same fruit quality can be achieved with less water and more efficient use.

Carr (2013) reported that both drip and under-tree micro-sprinklers were successfully used to irrigate avocado trees. Moreover, mulching of young trees is a recommended water conservation measure and has other benefits.

Deficient irrigation (DI) strategies have become common in areas where water supplies are limited under volatile climatic conditions (**Fereres and Soriano, 2007**). It also provide significant opportunities to save water without compromising production. Many researchers report 43% to 65% water savings under the Regulated Deficient Irrigation (RDI) strategy with slightly lower yields, but higher product quality. (**Mirás-Avalos *et al*., 2016**).

Regulated Deficient Irrigation is an irrigation practice in which a crop is irrigated with less than full crop water requirement (CWR) in order to reduce water use and increase water use efficiency (WUE). This practice was used in many irrigated areas. There are different ways to implement RDI such as RDI at different stages of crop development (RDIC) where full irrigation is applied in critical growth stages with less application in non-critical growth stages (**Nangare *et al*., 2013** and **Roccuzzo *et al*., 2014**).

Deficit or regulated deficit irrigation scheduling is one way of maximizing water use efficiency for higher yields per unit of irrigation water used in agriculture (**Nagaz *et al*., 2012** and **Geerts and Races, 2009**). In deficit irrigation application, the crop is exposed to a certain level of water stress either during a particular growth period or throughout the whole growing season, without significant reductions in yields (**Allen, 2000**). The expectation is that the yield reduction by inducing controlled water stress will be insignificant compared with the benefits gained through diverting the saved water to irrigate additional cropped area (**Kirda *et al*., 1999** and **Gijón *et al*., 2007**).

The main purpose of this work is to investigate the effect of different sustained deficit irrigation treatments on water productivity of avocado fruits to find the optimum water requirements for drip irrigation of mulched sandy soil cultivated with avocado trees (*Hass Cultivae with lula rootstoch*) in south of Tahreer sand soil, Egypt.

REVIEW OF LITERATURE

The total population of Egypt increased by about 450% from 1950 to 2015. This rapid increase in population growth may continue to increase to about 150 million by 2050. These high rates of population growth are expected to increase the problems related to the available water resources in terms of both quantity and quality (**Ashour *et al*., 2009**).

Per capita fresh water availability in Egypt has been dropped from 1893 cubic meters in year 1959 to 925 cubic meters in 2000 and tends to decline further to the values of 536 by year 2025. The main reason behind this rapid fall is the fixed water resources and the rising pressure from population growth (**Abd-El-Hai, 2002**).

With the current economic and population growth as well as potential environmental challenges, Egypt is rapidly facing a serious water scarcity problem. The rate of water availability per capita is already among the lowest in the world. In 2000, the per capita water withdrawal was about 1,000 m^3. This is assumed to reach to about 500 m^3 by 2025. In addition, the per capita renewable water supply decreased from 853.5 m^3 (2002) to 785.4 m^3 (2007) and reached 722.2 m^3 (2012). This is expected to reach 534 m^3 by 2030 (**FAO, 2014**).

Water shortage is an issue of increasing importance in many parts of the world. This is particularly the case in the dry areas of Arab countries which are known for their lack of annual precipitation, very high rates of evaporation, and therefore very insufficient renewable water resources **(Aqeil *et al*., 2012)**.

The major challenge which facing Egypt now is the strong need for better development and management of the available limited resources of water, land and energy to meet the needs of population growth.

2.1 Avocado growth and crop production

Rudolph Hass, a postman, patented the Hass avocado tree on August 27, 1935 (U.S. Plant Patent No. 139). His patent expired in 1952. Therefore, Hass accounts for 95% of avocado production in California. **Grant, (2015)** reported that avocados may considered as one of the longest harvesting seasons with the highest protein content relative to any other fruit.

Avocado "Hass" is the most commonly grown trees over the world with a fine shelf life and year-round availability in California. Some of their characteristics include a small to medium sized seed, easy peeling at ripe, skin darkens as it ripens, and great taste. These oval-shaped, medium to large sized fruit with average weight ranged 150-350 g/fruit. The most common tree spacing for avocado "Hass" is 5 × 6 m with an average of 140 trees/fed. The avocado "Hass" season typically runs from January to October with the best eating quality during the latter months (**Grant, 2015**).

Avocado trees highly succeed in well-aerated loose soil. Hence, if the soil does not drain well, the trees can be planted on raised mounds to increase drainage and control root rot. Appropriate drainage and regular irrigation is necessary to leach excess salts. Although avocados can tolerate both acidic and alkaline soils, the best pH range is between 5.5 and 6.5 (**Grant, 2015**).

Unfortunately, in some areas, Hass yields can be severely alternating. Where, the average crop yield obtained from 5 feddans over a five year period is 3973 kg/fed, but the yearly averages were 9532, 1842, 6474, 823 and 1196 kg/fed during this period (**Lazicki *et al*., 2016**).

The Florida Avocado Administrative Committee lists 25 major and 29 minor varieties used as rootstock for avocado trees "Hass". 13.4%