Research Article

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Irrigation options to save water while enhancing export-size fruit and storability of 'Smooth Red' cactus pear

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Abstract

BACKGROUND: A two-year study assessed deficit irrigation options for their effects on water-saving, yield, fruit quality, and postharvest performance of 'Smooth Red' cactus pear. We evaluated: (i) full irrigation (FI), (ii) partial rootzone drying (PRD), (iii) deficit irrigation (DI), and (iv) non-irrigated (NI) treatment as control.

RESULTS: The FI plants had the largest fruit size and the highest yield. PRD and DI plants used irrigation water with the highest efficiency and had the highest water productivity. The NI plants showed the highest water use efficiency in both growing seasons. Compared with FI, the yield was reduced in PRD by 5.5% in 2005 and by 7.8% in 2006. The corresponding reductions for DI were 6.0% and 7.4%, respectively. The NI plants had the lowest percentage of marketable yield. The PRD and DI treatments did not negatively affect fruit quality attributes either at harvest or after storage compared with FI and NI fruits. Fruit water loss tended to be lower in FI, PRD, and DI fruits.

CONCLUSIONS: This study was aimed at obtaining the maximum yield per unit of water applied instead of maximizing the yield per unit of area. We therefore recommend PRD or DI as feasible irrigation options for sustainable production of cactus pear.

Keywords: *Opuntia ficus-indica* (L.) Mill.; water use efficiency; water productivity; yield; postharvest

INTRODUCTION

Cactus pear is grown as fodder, vegetable, and fruit in arid and semiarid regions, not only in Mexico, but also in the Mediterranean basin, Asia, South Africa, Oceania, and America.[1] Despite using crassulacean acid metabolism, under irrigation it has become as productive as C_3 or C_4 crops.[2] Early research in Israel reported fruit yields of 20 and 25 Mg ha^{-1} for 'Orfer' cactus pear under fertigation.[3,4] In Mexico, this native plant is cultivated extensively (*ca* 77 593 ha) for different purposes. More than 47 633 ha are allocated to fruit production. Of this area, 98.2% is grown under rainfed conditions and the remainder is irrigated. On average, the rainfed yield (Mg ha^{-1}) is 10.1 and the irrigated yield is 18.6.[5] Despite water shortage, many Mexican growers are shifting from rainfed to irrigated production, motivated by higher yield, better fruit quality, and higher numbers of export-size fruit. The purpose of irrigation is to maximize the yield per unit of water applied rather than maximizing the yield per unit of area.

Water-saving irrigation technologies have not been assessed for their effects on fruit yield and quality of cactus pear. Cactus pear has been exposed only to full irrigation or no-irrigation treatments.[6] Our objective was to study reduced irrigation options for their effects on water savings and productivity, yield, fruit quality, and postharvest performance of 'Smooth Red' cactus pear. Cactus pear is sensitive to changes in soil water because of its shallow root system.[7] We therefore expected measurable differences in fruit yield between full irrigation and reduced irrigation treatments while we wondered about how fruit size, quality, and shelf life would respond to reduced irrigation.

MATERIALS AND METHODS

Experimental site, plant material, and orchard management

The experiment was set up on 01 March 2005 and conducted for two consecutive growing seasons in a commercial orchard called 'Rancho La Tunera' located in Santa Fe, Jerez, Zacatecas (22° 32′ N, 103° 03′ W, elevation 1976 m). The experimental site has an annual mean temperature of 16.5 °C and precipitation of 482 mm, with 62% occurring between July and October. The soil is clay loam with 1.63% organic matter and a pH of 7.1. The field capacity and permanent wilting point were at 0.38 and 0.22 m^3 m^{-3}, respectively. Soil fertility analysis revealed a total concentration (mg kg^{-1}) of 11.4 inorganic N, 0.1 total N, 24 P, 371 K, 6106 Ca, and 182 Mg. A five-year-old 'Smooth Red' cultivar of cactus pear (*Opuntia ficus-indica* (L.) Mill.) was used. This is an early-maturing cultivar with red pulp. Plants were trained to an open vase system and spaced at 5 × 3 m. Except for irrigation, plants received the same cultural practices as for local commercial fruit production including pruning; pest, disease, and weed control; and mowed cover crop strips between rows. Crop load was adjusted by thinning on 20 April 2005 and on 22 March 2006. Plants, except for

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