

Water use by perennial crops in the lower Sonora watershed

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ABSTRACT

The North American Monsoon is the principal source of fresh water in northwest Mexico, accounting for almost 70% of annual precipitation and around 80% of surface runoff. In the northern regions above $\sim 28^\circ\text{N}$, there is insufficient surface runoff to satisfy urban, industrial and agricultural users and large coastal aquifers are used to supply water for irrigation. The lower part of the Río Sonora watershed is devoted to irrigated agriculture, where perennial cash crops account for 40% of the area. The major crops are table grapes and pecan with cultivated areas of 100 km^2 and 50 km^2 , respectively. Although efficient drip irrigation systems have been installed for these crops, annual water use remains very high: $\sim 1150\text{ mm}$ for grapes and $\sim 1700\text{ mm}$ for pecan. During the 2005–2006 growing seasons, eddy correlation measurements of evapotranspiration (ET) were performed for two different grape varieties, obtaining 680 mm for Perlette and 776 mm for Superior. During these measurement periods, the applied irrigation depths were 1121 mm and 1088 mm, respectively. For pecans, the ET measurement was 1297 mm and the applied irrigation was 1459 mm. In other words, the applied irrigation is in excess of the water consumed by the plants: about 50% for grapes and 10% for pecan. This conclusion is supported by soil humidity (θ_v) measurements for grapes, where the values of θ_v between depths of 10 cm and 120 cm are larger than field capacity during most of the annual cycle. Therefore, it is proposed that the irrigation depth should be gradually reduced to 800–900 mm, which would save $\sim 30\text{ hm}^3$ of fresh water for other uses each year.

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1. Introduction

Water resources occupy a special place among natural resources. During the past several decades water resources have been overexploited, reducing water quality and limiting its availability (Shiklomanov, 2000). This impact is more evident in arid and semi-arid regions and the majority of developing countries. In most of these countries, agriculture is the main economic activity and accounts for approximately 70% of the total water used (Cosgrove and RijsBerman, 2000).

In the northwest region of Mexico, the main source of water is the summer precipitation (July–September). Rainfall during this

period accounts for 60–70% of the region's annual precipitation (Douglas et al., 1993). In the state of Sonora, surface runoff is stored in several reservoirs, mainly within the Yaqui river system and other small dams across the state. In the northwestern part of Sonora, very little surface water is available and the main water source for annual and perennial crop irrigation is groundwater (CONAGUA, 2006).

This applies to the Costa de Hermosillo aquifer, which has been overexploited for more than 50 years, causing extensive seawater intrusion and aquifer contamination (Rangel-Medina et al., 2004). Currently, the mean annual withdrawal is $\sim 450\text{ hm}^3$, while the net annual “recharge” is $\sim 250\text{ hm}^3$, of which only $\sim 150\text{ hm}^3$ is freshwater, the other $\sim 100\text{ hm}^3$ being saline water (Oroz, 2001).

In this area, pecan and table grapes are the main perennial crops and represent about 30% of the total cropped area. These crops provide an important source of income from exports, as well as a hundreds of thousands of days of labor for farm workers. These

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two crops consume more than 50% of the yearly aquifer recharge requirements. Considering this unsustainable situation, the present work focuses on analysis of irrigation depths, evapotranspiration and soil moisture levels for these crops and addresses their impact on the aquifer.

2. Materials and methods

2.1. Site description

The Costa de Hermosillo is the lower part of Sonora river watershed in northwest Mexico (Fig. 1). This is mainly a flat agricultural area of 169,593 ha, where the annual and perennial crops occupy around 53,000 ha every year, irrigated using water from some 500 deep wells. The climate is arid with an annual rainfall of around 200 mm. The rainy season is from July to September (representing about 70% of the total annual rainfall) and there is virtually no rainfall from March to June. The mean daily

temperatures range from 22 °C to 24 °C, with sporadic frosts in the winter and temperatures that are frequently above 45 °C from the end of spring into summer.

2.2. Experimental sites

The study was conducted in 2005 and 2006 in two 10 ha table grape vineyards (*Vitis vinifera* L., cvs. Perlette and Superior) and a 50 ha pecan orchard (*Carya illinoensis* (Wangenh.) K. Koch, cvs.

The soil texture classes, field capacity (FC) and wilting point (WP) were determined in the Soil Survey Laboratory of the Colegio de Posgraduados (<http://www.colpos.mx>). Soil textures were obtained by the Bouyoucos hydrometer method, while FC and WP were measured using the pressure membrane apparatus at –30 kPa and –1.5 MPa, respectively. The soils of vineyard were classified as sand clay loam “SCL” (64%, 22% and 14% sand, clay and silt, respectively) and those for the pecan orchard as clay loam “CL” (43%, 34% and 23% sand, clay and silt, respectively). These soil

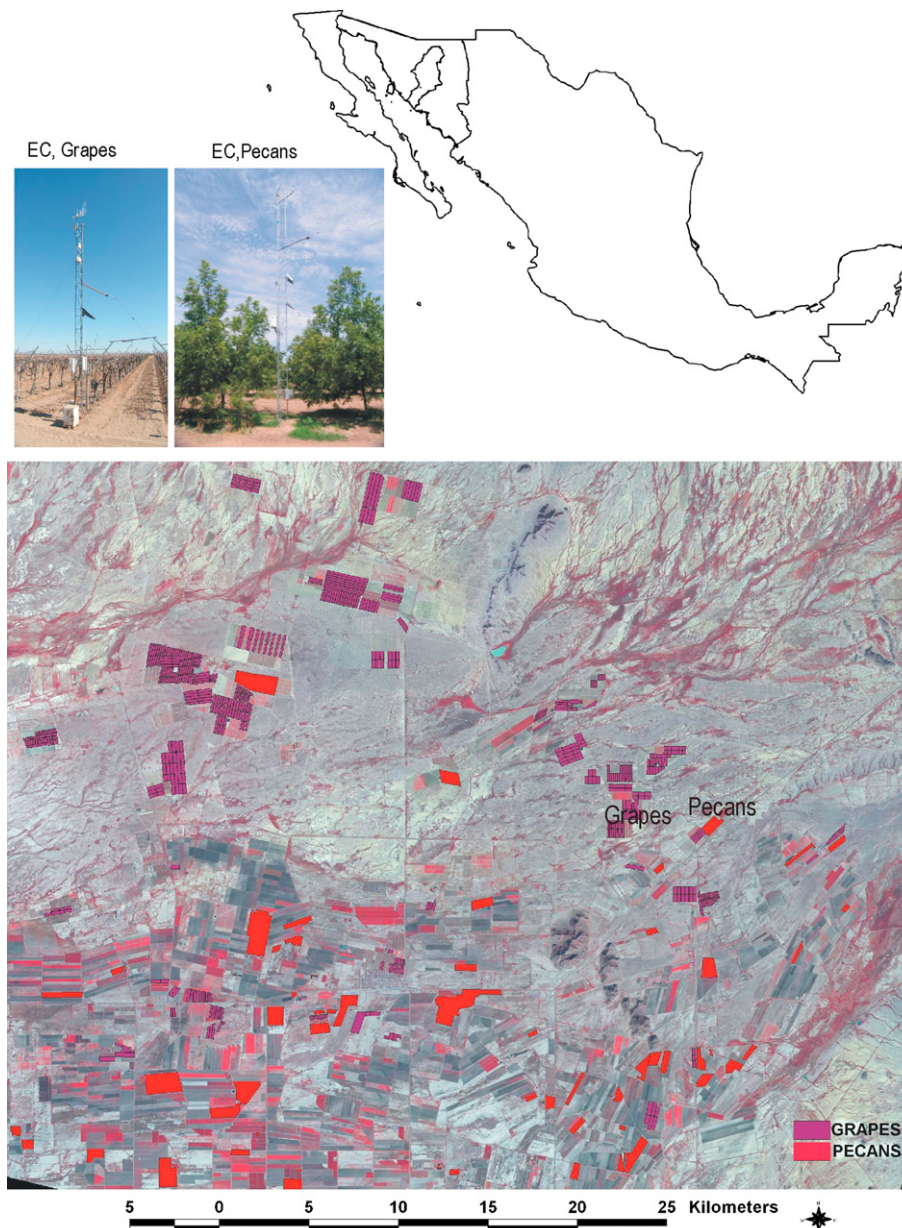


Fig. 1. Experimental sites, eddy correlation system on table grapes, eddy correlation system on pecans and Sonora watershed location on Mexico.

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