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EXTENDED ABSTRACT

The Influence of Supplemental Irrigation on Soil Water, Fig Yields and Fig Growers' Income under Drought Conditions in Rainfed Fig Orchards

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Introduction

Iran is the fourth world producer of figs with an average of 75,833 tons from 1993 to 2013 (FAO, 2016). Estahban area provides about 90% of dried fig in Iran (Jafari, Abdolahipour-Haghighi and Zare, 2012). The rainfed fig orchards in this area have been extremely affected by severe drought in recent years, leading to 10% to 80% reduction in fig trees and fruit in 2010, respectively (Jafari, Abdolahipour-Haghighi and Zare, 2012). For this reason, the tendency to apply supplemental irrigation in Estahban fig orchards has increased in previous years. However, the lack of information about the amount, timing, and application position of supplemental irrigation to achieve efficient use of water in this area makes it difficult to deal with this issue in the study area. The main objective of this study was, thus, to investigate the effect of different amounts and times of supplemental irrigation at different distances from tree trunk on soil water variation, quantity of fruits, and fig growers' income under drought conditions.

Methodology

The experiment was conducted in a fig orchard in Estahban, Fars Province, Iran (29°07′ N, 54°04′ E, elevation 1749 m) from 2013 to 2015. The annual average rainfall is reported about 354 mm (Bagheri and Sepaskhah, 2014) in the region. The experiment was done on 72 uniform, 45-year-old, edible fig cultivars of Sabz fig trees. The experiment was, indeed, performed in a split plot design with four replications. The supplemental irrigation treatments included irrigation application positions: close to tree trunks; under tree canopy (1-1.1 m from tree trunk) and outside of tree canopy. In turn, the amount of irrigation water included no supplemental irrigation (Control), 1000 and 2000 liters irrigation water per tree, and irrigation times: in early spring and mid-summer. Soil water content (SWC) was, then, measured monthly at 30 cm intervals up to 150 cm soil depth. The

access tubes were installed at three different distances from the tree trunks in the closest place to the applied irrigation water. The fruits of each tree were collected from the mid-summer to the beginning of autumn. To evaluate the pomological characteristics, the collected figs were divided in three different commercial grades (AA, A, and B) using the local commercial method of grading. In this method, a sorting machine including vibrating sieves separated the fruits based on their diameter. Higher quality fruits included figs with larger diameters. The sieves with the given different mesh sizes separated fruits based on a defined diameter standard: >22 mm (grade AA), 17-22 (grade A) and <17 mm (grade B). The fruit weight for different classes of size for each tree was found. The measured data for the yield and quantity of fig production were statistically analyzed by using the SAS program. Duncan's multiple range test at 5% level of probability was used for comparison of the means.

Results and Discussion

The minimum soil water content was observed after the fruit harvesting period during autumn. The highest one was occurred at the beginning of spring during the vegetative phase of growing season. Higher SWC in the irrigated trees continued till the following irrigation event, however, the increase in SWC after early spring irrigation was higher compared to the mid-summer irrigation treatment probably due to the higher temperature and higher evaporation during summer. Higher soil water content was obtained in soil depth lower than 0.9 m. The lower SWC for the superficial layers was probably due to higher root density and consequently higher root water absorption in shallow layers. Higher yield was considerably observed in NT treatment for the first (42 and 18% higher than UT and OT treatment) and second year. Indeed, the OT showed the highest yield without significant difference with NT. The results of irrigation amount treatments also showed a significant high yield for the irrigated trees. However, there was no significant difference between 1000 and 2000 liters irrigation water treatments in the second year and also between the irrigation timing treatments. Higher fruits with bigger size (>22 mm) were observed for OT treatment in the first year and this trend continued in the second year. Furthermore, irrigation with 2000 liters per tree resulted in considerably higher yield compared to the rainfed treatment. Conversely, no significant difference existed in the production of 1000 and 2000 liters in the second year. Irrigation in the early spring and middle of summer resulted in higher fruit quality and quantity, respectively.

The economic and income analysis considered the fig price of different grades (AA, A and B) during 2013 and 2014. Irrigation in OT treatment increased the annual average revenue per tree to 31% (18 and 44% in first and second year, respectively) compared to the other position treatments. The results showed that the application of supplemental irrigation could increase farmers' income. Compared to the rainfed treatment, using 1000 and 2000 liters irrigation water increased farmers' income (rial/tree) by 11 and 57%, and 39 and 47%, in the first and second year, respectively. However, no significant difference was observed between 1000 and 2000 liters irrigation water on the fruit price (rial/kg) in two years and on the farmers' income (rial/tree) in the second year. This indicates the efficiency of 1000 liters of supplemental irrigation per tree. Compared to the early spring, the mid-summer irrigation increased significantly the fruit price in the second year, while the mid-summer irrigation could improve the fig growers' income in the first year. The results showed that the irrigation with 1000 liters, out of tree canopy in the middle of summer would lead to the highest economical revenue. However, all limitations parameters should be carefully taken into account in the financial analysis of the supplemental irrigation application.

Conclusion

There was lower soil water content (SWC) loss after the early spring irrigation treatment than the summer one. The control treatment showed the lowest fig production among the water irrigation treatments. Compared to the irrigation application under canopy, irrigation close to tree trunks and outside of the canopy produced higher fig yield. In effect, irrigation out of the canopy resulted in

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31% higher annual revenue (rial/tree). Although the irrigation with 2000 liters per tree in early spring showed higher SWC for rainfed fig orchards, the results indicated the adequacy of 1000 liters per tree. Irrigation in the mid-summer increased the fruit price (rial/kg) and revenue (rial/tree). Using 1000 liters of supplemental irrigation water, out of the canopy in the mid-summer would be recommended to achieve higher income for fig growers, and use the regional water resources sustainably under drought conditions.

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