AUCTORES

Journal of Nutrition and Food Processing

Ali Sheini-Dashtegol *

Open Access

Research Article

# Investigating the Durability and Efficiency of the Subsurface Drip Irrigation System in the Sugarcane Fields in the South of Ahvaz

**Ali Sheini-Dashtegol [1]*, Majid Hamoodi [2], Elham Zanganh-Yusefabadi [3], Shabanzarei [4]**

[1]Ph.D. of Irrigation and Drainage, Director of department Irrigation and Drainage Research, Khuzestan Sugarcane Research and Training Institute.

[2]Former irrigation and drainage research expert, Khuzestan Sugarcane Research and Training Institute.

[3]Researcher, Department of Irrigation and Drainage, Khuzestan Sugarcane Research and Training Institute.

[4]Deputy of Agricultural Monitoring and Research, Khuzestan Sugarcane Research and Training Institute.

**Corresponding author:** Ali Sheini-Dashtegol., Ph.D. of Irrigation and Drainage, Director of department Irrigation and Drainage Research, Khuzestan Sugarcane Research and Training Institute.

**Received date:** April 15, 2025; **Accepted date:** April 23, 2025; **Published date:** May 01, 2025

**Citation:** Ali S. Dashtegol, Majid Hamoodi, Yusefabadi EZ, Shabanzarei, (2025), Investigating the Durability and Efficiency of the Subsurface Drip Irrigation System in the Sugarcane Fields in the South of Ahvaz, *J. Nutrition and Food Processing,* 8(7); **DOI:10.31579/2637-8914/314**



**Abstract:**

In order to investigate the efficiency and durability of subsurface drip irrigation system, research was to investigate the efficiency and durability of the subsurface drip irrigation system. For this purpose, in this research, the changes in the clogging of drippers and changes in the productivity of sugarcane in different years in a drip irrigation system were investigated in the research station of Khuzestan Sugarcane Research and Training Institute. The treatments of this research were the first treatment of subsurface drip irrigation (20 cm working depth, 50 cm dripper intervals and 2.3 lit/hr.), the second subsurface drip irrigation treatment (20 cm working depth) cm, dripper distances of 60 cm and dripper flow rate of 3.6 lit/hr.), surface drip irrigation treatment (dropper distances of 60 cm and dripper flow rate of 3.6 lit/hr.) and Furrow irrigation treatment (control). The results showed that the productivity of irrigation water in sugarcane production decreased with the passage of time in all treatments. The highest productivity of irrigation water in a five-year period (new crop to the fourth ratoon) in the first subsurface drip treatment was 6.6 kg/m$^3$ in Raton I, and the lowest amount in the fifth year in the surface drip treatment was 1 kg/m$^3$ in Raton I. Despite the fact that the useful life of the dripper pipes is predicted to be 10 years, but the drippers were used until the third ratoon (fourth year), and in the fifth year, due to high clogging, the system did not have the necessary efficiency and the yield and productivity of the sugarcane plant decreased significantly.

**Key words:** clogging of dripper; water productivity; sugarcane yield; sugarcane yield; subsurface drip irrigation

## 1.Introduction

Sugarcane fields of south west of Iran have heavy soil texture, high temperatures, and hot dry wind at spring and summer. Hydro-flume gated pipes were used for irrigation. Furrow irrigation was used in sugarcane fields. Due to a water crisis in Iran, Increasing the efficiency of irrigation and water productivity can be promising. Electrical Conductivity of irrigation water was considered about 1.1 dS/m, in basic designs of this irrigation method and for each unit increasing salinity more than this amount, sugarcane yield is reduced by 6%. The maximum EC of irrigation water on Karoon River reads to 4.5 dS/m in downstream. Electrical conductivity of water is about 2.5 dS/m (mean of it: 1.5-3 dS/m). Water Electrical Conductivity is an issue of importance to change from surface furrow irrigation to SDI. Since sugarcane has a high water requirement and is sensitive to waterlogging conditions caused by rising water tables, its irrigation requires a precise irrigation and drainage network in terms of design and implementation, and achieving such conditions is always affected by human limitations (in the design and implementation section) and equipment and supplies, therefore, choosing appropriate irrigation methods for sugarcane for optimal water and energy consumption is important [Abbasi and Shini-Dashtgol, 2016]. Like other agricultural products, changing the irrigation method and also changing the irrigation system management will have significant effects on the product. Subsurface drip irrigation is one of the most effective irrigation systems available for sugarcane cultivation [Barbosa et al, 2017]. In recent years, the use of subsurface drip irrigation has increased in the world for perennial trees and is proposed as a suitable solution to deal with water shortages in irrigated lands in dry regions of the world [Consoli et al., 2014]. Subsurface drip irrigation is recognized as a water-saving irrigation technology worldwide and is widely used in arid and semi-arid regions. This method can not only improve crop yield and quality, but also increase water and fertilizer efficiency [Wang et al., 2021].

Bernado et al. [2019], in a study, showed that the water required to produce one kilogram of sugarcane biomass through surface drip irrigation and subsurface drip irrigation is less than conventional (furrow) irrigation. Thiagarajan and Manikandan5 [2021], conducted a study aimed at evaluating the development of an optimal irrigation and fertilizer application program under surface drip irrigation and subsurface drip irrigation systems on sugarcane. The results of this study showed that the subsurface drip irrigation system recorded lower water consumption and higher crop yield (113 kg/ha), and was selected as a superior system to surface drip irrigation. Considering the characteristics of subsurface drip irrigation, it is predicted that this method can be successful by applying some conditions such as good hydraulic network design, water quality filtration, and proper network implementation. Therefore, this study was conducted to investigate the durability and efficiency of the subsurface drip irrigation system in sugarcane fields in southern Ahvaz.

## Materials and Methods

This research was conducted on an area of about 0.5 ha, in the W3-5 farm of Research Station No.1 of the Sugarcane Research Institute, located 35-km south of Ahvaz with geographical coordinates of 48 degrees and 33 minutes' east longitude and 30 degrees and 59 minutes' North latitude and an altitude of 7.6 m above sea level.

**The experiment was conducted with the following treatments:**

1. The first subsurface drip irrigation treatment, SDI1 (with an installation depth of 20-cm, a flow rate of 2.3-lit/hr. and a space of 50-cm ($Q_{2.3}$, $D_{20}$, $L_{50}$)).
2. The second subsurface drip irrigation treatment, SDI2 (with an installation depth of 20-cm, a flow rate of 3.6-lit/hr. and a space of 60-cm ($Q_{3.6}$, $D_{20}$, $L_{60}$)).
3. The surface drip irrigation treatment, DI (flow rate of 3.6 lit/hr. and a space of 60-cm ($Q_{2.3}$, $D_{0}$, $L_{50}$)). And 4. the furrow irrigation treatment as conventional irrigation (control).

Sugarcane was planted in October 2018 and during the four-year growth period (planting and first to fourth regrowth), the volume of irrigation water was measured in each treatment, as well as the evaluation of dripper flow rate and quantitative and qualitative yield measurements were performed, and continued until the fourth regrowth. In order to evaluate the hydraulic system in field conditions and based on the recommendation of Merriam and Keller [1987], four laterals (initial, one-third, two-thirds and final), were selected on the main pipe, according to the ASAE standard, and four parts (initial, one-third, two-thirds and final), were determined on each lateral, and the flow rate of the drippers was measured. Then, the percentage of dripper clogging and the uniformity of water distribution were calculated. At the end of each growing season, four 10-m stations were selected from each experimental treatment and harvested manually. Then, quantitative and qualitative characteristics were measured to measure and calculate the yield of sugarcane and sugar (ton/ha). Then, considering the volume of water consumed during the sugarcane growth period (irrigation and rainfall), water productivity (ratio of yield to volume of water consumed), was calculated. Figure (1), shows the design treatments and the separation from the control.

**Figure 1**: The design treatments and the separation from the control.

## Results and Discussion

According to the five-year average, water productivity per sugarcane produced in the treatment ($Q_{2.3}$, $D_{20}$, $L_{50}$), increased by 13, 33 and 41% compared to the treatments ($Q_{2.3}$, $D_{20}$, $L_{60}$), surface and control, respectively. Also, the five-year average water productivity per sugar produced in the treatment ($Q_{2.3}$, $D_{20}$, $L_{50}$), increased by 14, 36 and 39% compared to the treatments ($Q_{2.3}$, $D_{20}$, $L_{60}$), surface and control, respectively (Figure 1, A and B), which is consistent with the results of Consoli et al. [2014], Wang et al. [2021] and Bernardo et al. [2019].

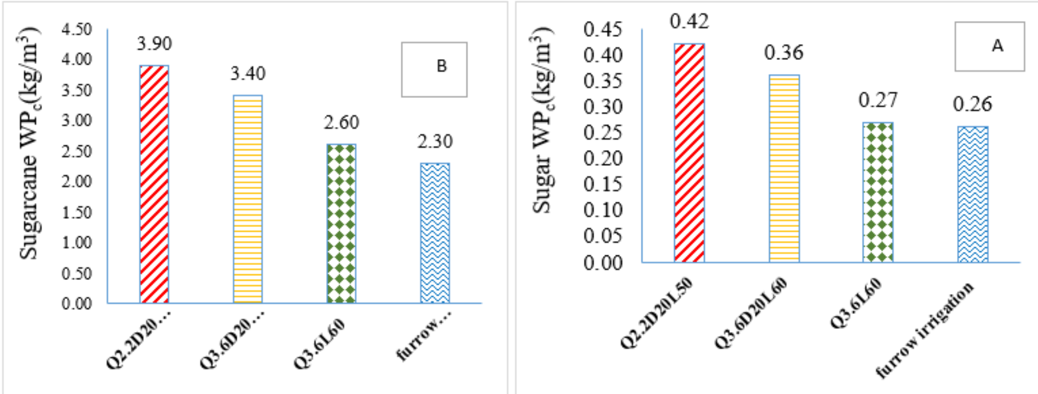


**Figure 1:** Average five-year results of irrigation water productivity for Sugarcane (A) and Sugar (B) production in plant and ratoons cultivation

The results of the dripper flow assessment showed that the uniformity of the system decreased from 95% in the first year of operation of the system (new planting) to 45% in the last year. In the last year of operation of the system, the clogging of the drippers reached 45%. Due to the increase in clogging of the drippers and the decrease in the uniformity of water distribution in the field, the yield and productivity of the sugarcane plant decreased significantly over time. The results of the irrigation water productivity per sugarcane produced in all experimental treatments (plant and four-ratoon) with the exception of the first year (due to pest attack, yield and productivity were low), had a decreasing trend [Figure 2]. The results showed that although acid washing and chlorination were performed intermittently in the system, the pressure regulating drippers used were responsive until the third row (fourth year), and in the fifth year due to high clogging, the system did not have the necessary efficiency.

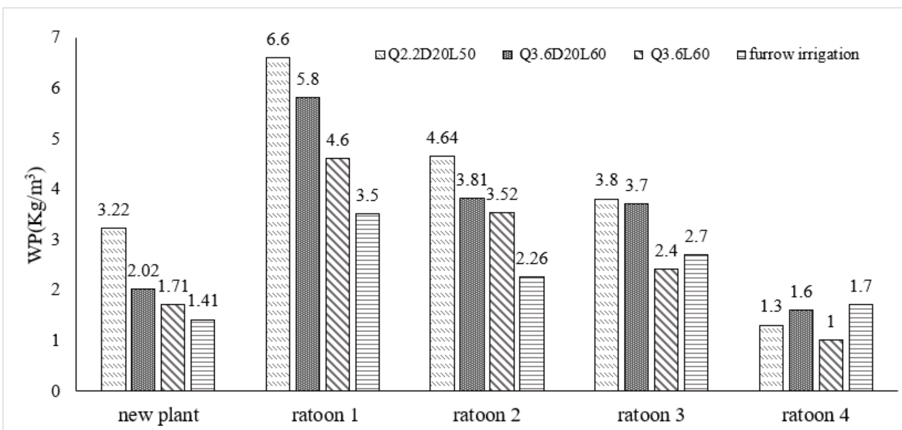


**Figure 2:** Irrigation water productivity per sugarcane produced in experimental treatments (plant and four ratoon)

## Conclusion

The average results in five years of testing showed that the subsurface drip irrigation system, compared to conventional irrigation, resulted in a reduction of about 40% in water consumption, an increase of more than 25% in the average production yield, and, as a result, an increase of more than 50% in water efficiency per sugarcane and sugar produced. The highest productivity of irrigation water in a five-year period (new crop to the fourth ratoon) in the first subsurface drip treatment was 6.6 kg/m3 in Raton I, and the lowest amount in the fifth year in the surface drip treatment was 1 kg/m3 in Raton I. Despite the fact that the useful life of the dripper pipes is predicted to be 10 years, but the drippers were used until the third ratoon (fourth year), and in the fifth year, due to high clogging, the system did not have the necessary efficiency and the yield and productivity of the sugarcane plant decreased significantly. Despite intermittent acid washing and chlorination, the clogging of the drippers reached 45% during five years of operation, and given the high costs of the subsurface drip irrigation system, this system did not have the expected durability and efficiency.

## References


1. Abbasi, F. and Shini-Dashtgol, A. (2016). Evaluation and improvement of furrow irrigation management in sugarcane lands in Khuzestan. *Journal of Soil and Water Science,*
2. Barbosa. E.A.A., Matsura, E.E., Santos, L.N.S.D., Gonçalves, I.Z., Nazário, A.A. et all., (2017). Water footprint of sugarcane irrigated with treated sewage and freshwater under subsurface drip irrigation, in Southeast Brazil. *J. Cleaner Prod.* (153), 448-456.
3. Bernardo, S., Mantovani, E.C., Silva, D.D., Soares, A.A., (2019). Manual de Irrigação. 9. ed. UFV, Viçosa. 545p.
4. Consoli, S., Stagno, F., Roccuzzo, G., Cirelli, G.L. and Intrigliolo, F., 2014. Sustainable management of limited water

resources in a young orange orchard. *Agricultural water management*. 132: 60-68.
5. Merriam, J.L. and J. Keler., (1978). Farm irrigation system evaluation: A guide for management, department of Agriculture Engineering, California, Polytechnic, *State University*,
6. Thiyagarajan, G and Manikandan, M. 2021. Evaluation of Drip Irrigation System and Fertigation of Nitrogen in Sugarcane. *Research Biotica*, 2 (3): 117-120.
7. Wang, H., Wang, N., Quan, H., Zhang, F., Fan, J., et all., (2022). Yield and water productivity of crops, vegetables and fruits under subsurface drip irrigation: A global meta-analysis. *Agricultural Water Management*,



**DOI:10.31579/2637-8914/314**