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Effect of flushing frequency on emitter clogging in microirrigation with effluents

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ABSTRACT

Flushing is an important maintenance task that removes accumulated particles in microirrigation laterals that can help to reduce clogging problems. The effect of three dripline flushing frequency treatments (no flushing, one flushing at the end of each irrigation period, and a monthly flushing during the irrigation period) was studied in surface and subsurface drip irrigation systems that operated using a wastewater treatment plant effluent for three irrigation periods of 540 h each. The irrigation systems had two different emitters, one pressure compensating and the other not, both molded and welded onto the interior dripline wall, placed in laterals 87 m long. Dripline flow of the pressure compensating emitter increased 8% over time, while in the nonpressure compensating emitter, dripline flow increased 25% in the surface driplines and decreased 3% in the subsurface driplines by the emitter clogging. Emitter clogging was affected primarily by the interactions between emitter location, emitter type, and flushing frequency treatment. The number of completely clogged emitters was affected by the interaction between irrigation system and emitter type. There was an average of 3.7% less totally clogged emitters in flushed surface driplines with the pressure compensating emitter as compared to flushed subsurface laterals with the nonpressure compensating emitter.

1. Introduction

The use of effluents in agriculture is a viable alternative in areas where water is scarce or when there is intense competition for its use. The best way to apply effluents from the public health and environmental points of view is by means of microirrigation (Bucks et al., 1979). Surface drip irrigation (DI) and subsurface drip irrigation (SDI) are two types of microirrigation systems. Surface drip irrigation uses emitters and lateral lines laid on the soil surface or attached above-ground on a trellis or tree while subsurface drip irrigation emitters are buried below the soil surface. The main advantages of these drip irrigation systems are that they increase water use efficiency, minimize salinity hazard to plants, improve chemical application, decrease energy requirements and improve cultural practices (Ayars et al., 2007). Additionally, SDI systems diminish human exposure to effluents and also vandalism potential, but have a higher initial investment cost and need careful and consistent operation, maintenance and management (Lamm and Camp, 2007).

Dripline temperatures in SDI systems are lower, which may help to reduce biological and chemical clogging hazards (Lamm and Trooien, 2005). The salt concentration is reduced at the emitter in SDI because there is no evaporation face for salts to accumulate and this helps to diminish chemical clogging (Hills et al., 1989). However, Capra and Scicolone (2007) found no significant differences in clogging between DI and SDI systems.

SDI systems must have good and consistent filtration, water treatment, flushing and maintenance plans to ensure long economic life (Lamm and Camp, 2007). Filtration systems do not normally remove clay and silt particles, algae and bacteria because they are too small for typical economical filtration. These particles may travel through the filters as individual particles, but then flocculate or become attached to organic residues and eventually become large enough to clog emitters (Nakayama et al., 2007). Therefore, dripline flushing is periodically needed to remove these particles and organisms that are accumulated within the laterals (Adin and Sacks, 1991; Ravina et al., 1992).

The irrigation system should be designed so that it can be flushed properly. To be effective, flushing must be done often enough and at an appropriate velocity to dislodge and transport the accumulated sediments (Nakayama et al., 2007). A minimum flushing velocity of 0.3 m/s is recommended for microirrigation systems (ASAE, 2003). Lamm and Camp (2007) pointed out that the

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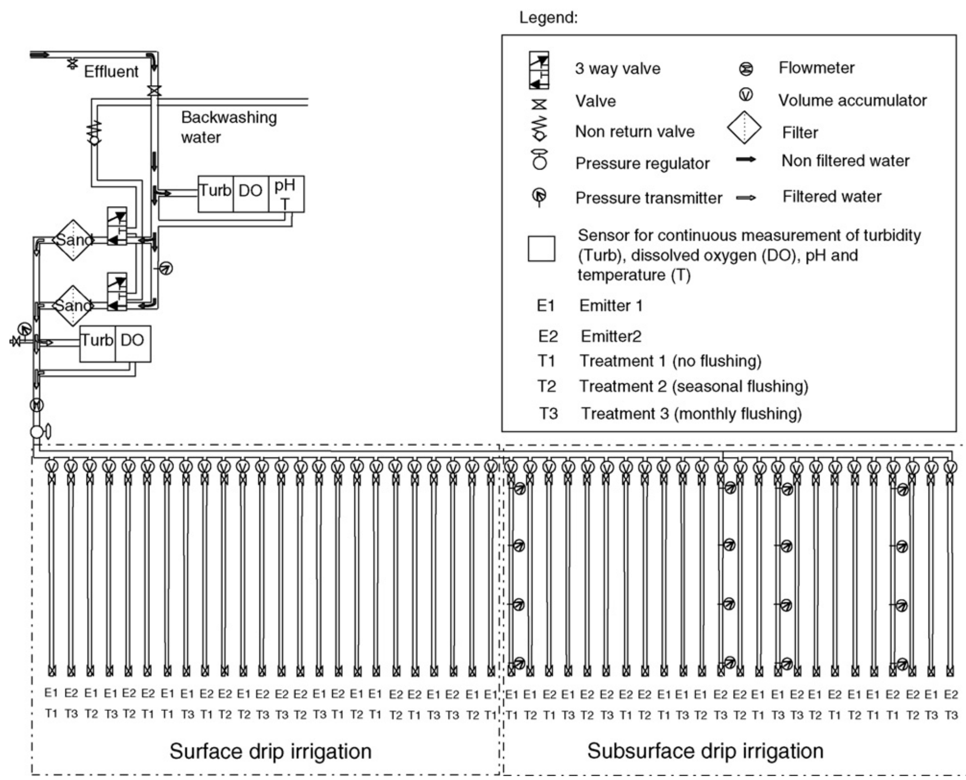

Fig. 1. Hydraulic diagram of the microirrigation system and location of monitoring and control equipment.

ASAE criterion seems appropriate for SDI in the absence of a stronger scientific reason for higher velocities. However, a flushing velocity of 0.5–0.6 m/s may be needed when larger particle sizes need to be removed, like when coarser filters are used (Hills and Brenes, 2001; Nakayama et al., 2007).

There is not a general agreement on what is the best flushing frequency. Several researchers have studied different flushing frequencies: daily with stored treated effluents (Ravina et al., 1997), twice per week (Tajrishy et al., 1994) and once per week (Tajrishy et al., 1994; Hills et al., 2000) with a secondary clarified effluent, every two weeks with stored effluents (Ravina et al., 1997) and with a secondary effluent (Hills and Brenes, 2001) or fortnightly and monthly with stored groundwater (Hills et al., 2000). However, in many areas, only one flushing is carried out at the beginning and/or at the ending of irrigation season.

The objective of this study was to analyze the effect on emitter clogging of three flushing frequencies in surface (DI) and subsurface (SDI) drip irrigation systems when using a biological effluent.

2. Material and methods

2.1. Experimental set-up

The experimental microirrigation system (Fig. 1) had two sand filters (Regaber,[1] Parets del Vallès, Spain) in parallel, both filled with 175 kg of sand as a single filtration layer. After the filtration system, 48 laterals 87 m long were installed on a 0.35 ha field (approximately 38 m wide and 94 m long) with an average slope of 0.85%. Twenty-four laterals were placed on the field surface (surface drip irrigation) while the other 24 were installed approximately at a depth of 25 cm (subsurface drip irrigation).

Subsurface laterals were placed in a trench prepared with an AFT65 tractor mounted trencher (AFT Trenchers Ltd., Sudbury, England). Then the trenches were carefully backfilled with the previously removed soil.

There were two dripline types, each having a different emitter type (Netafim, Tel Aviv, Israel), that were replicated four times in the experiment. The two types of emitters used (Ram 17012 (emitter 1) and Tiran 16010 (emitter 2)) had injection molded dripper construction and were welded onto the interior dripline wall. The primary emitter and lateral characteristics are shown in Table 1.

Three flushing frequency treatments were carried out: no flushing (treatment 1), only one flushing at the end of each irrigation period (treatment 2) and a monthly flushing during the irrigation period (treatment 3). For both irrigation systems (surface

Table 1
Main emitter and dripline characteristics, according to manufacturer's specifications.

Characteristic	Emitter 1	Emitter 2
Nominal flow rate (L/h)	2.3	2.0
Nominal pressure (kPa)	50–400	100
Maximum operating pressure (kPa)	400	350
External diameter (mm)	17.0	16.1
Distance between emitters (m)	1.00	1.00
Flow exponent (x)	0.05	0.46
Pressure compensation	Yes	No
Manufacturer variation coefficient (%)	<3	<3
Water passage width (mm)	1.15	0.76
Water passage depth (mm)	0.95	1.08
Water sectional area (mm^2)	1.09	0.82
Water passage length (mm)	22.0	75.0
Water passage filtering area (mm^2)	8.0	70.0

[1] Mention of trade names is for informational purposes only and does not constitute endorsement of the product by the authors.