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Self-regulation of discharge in non-compensating subsurface drip irrigation emitters

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While studying emitter discharge variability of subsurface drip irrigation (SDI) in the laboratory, the authors found out a possible self-regulation effect of non-compensating emitter discharge. This is due to the interaction between effects of emitter discharge and soil pressure.

As known, under certain circumstances, a positive pressure h_s develops at the discharge point of a buried emitter. The hydraulic gradient between the emitter interior and the soil would then decrease compared to the situation where the emitter is on the surface. Thus, the discharge reduces, following:

$q=k\cdot(h_0 - h_s)^x$,

where q is the emitter flow rate, h_0 is the working pressure head, and k and x are the emitter coefficient and exponent, respectively.

The soil pressure would act as a regulator. The emitters with a greater flow rate in surface irrigation would generate a higher pressure in the soil. Therefore, the subsurface irrigation discharge would be reduced to a greater extent than in emitters with a lower flow rate. Consequently, the flow emitter variability would be smaller in buried emitters than in surface ones.

The above interaction would not be observed in compensating emitters, even for the same or greater soil pressure variability. Their elastomers keep the flow rate constant within a compensation range, provided that the hydraulic gradient between the emitter interior and the soil pressure is higher than the lower limit of this range.

To confirm this hypothesis, simulations were performed for both uniform and heterogeneous soils reproducing the laboratory conditions (working pressure head and emitter discharge). When the soil has a high heterogeneity, the self-regulation effect was very small as compared to the variability caused by the soil. Nevertheless, the authors consider that this effect is worth to be studied.

The objective of the paper is to perform new simulations in order to determine under which circumstances self-regulation would be significant and find thresholds for its application to improve the performance of SDI.