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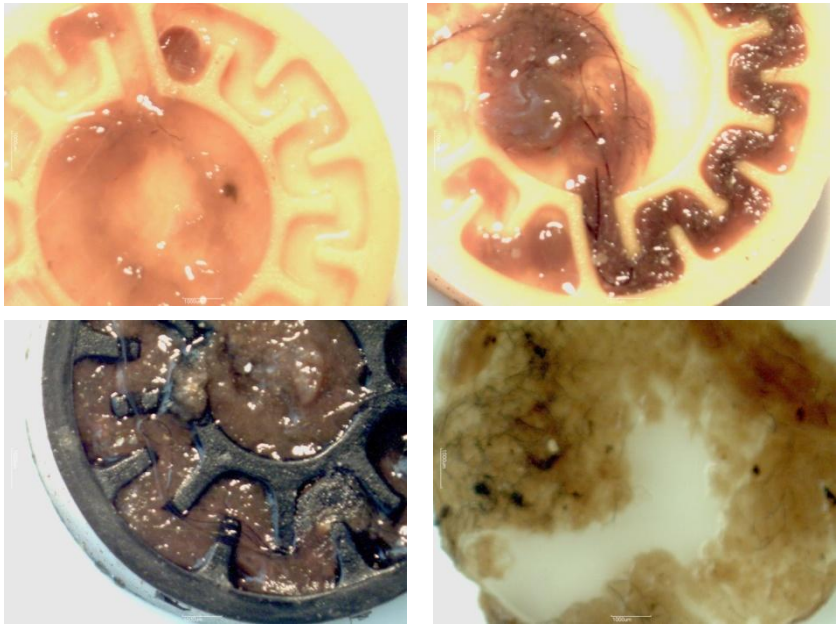
BIOFILM GROWTH AT HIGH COD AND PARTICLE CONCENTRATION LEVELS: APPLICATION TO THE CASE OF MICRO-IRRIGATION EMITTERS USED FOR WASTEWATER REUSE



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Presentation outlines

1. Context and objectives

2. Material and methods

3. Emitters performance using mineral particles

4. Interaction between biofilm and mineral particles

5. Conclusions and perspectives

Context : Wastewater reuse for irrigation

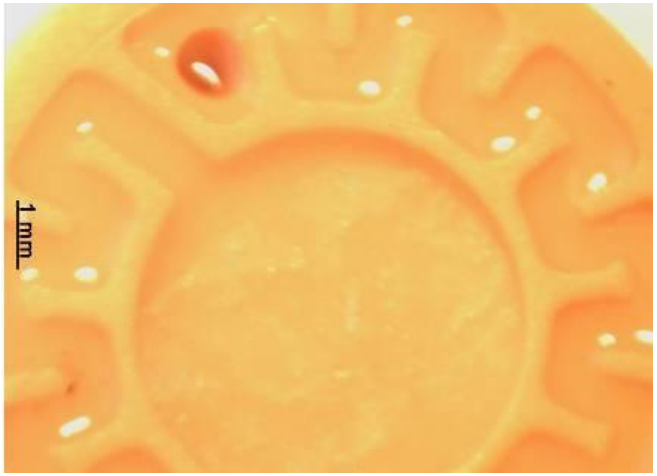
- Population increase : + 2 billion people worldwide by 2050 (PNUD, 2006)
- Decrease in water resources
- 70% of water is used for irrigation (FAO, 2012)

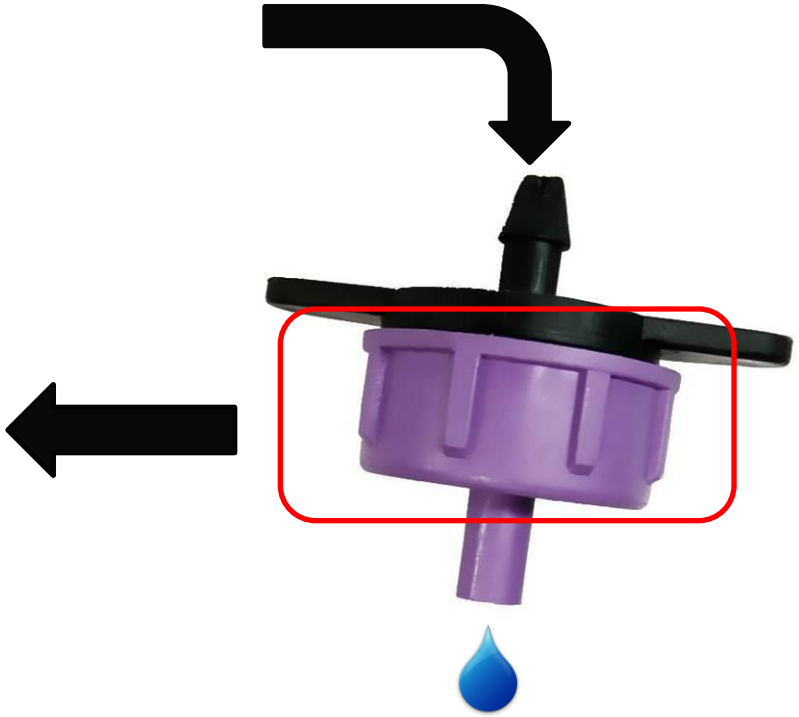
Sustainable solutions to feed the world

Wastewater reuse using micro-irrigation

- Highest irrigation efficiency
- Micro-irrigation is the safest technology for wastewater reuse in agriculture
- Highest sensitivity to clogging

Context: Emitters clogging





Narrow cross section ➔ Clogging

Context: Emitters clogging

Micro-irrigation clogging sources

Physical deposits
(Bounoua, 2010)

Chemical deposits
(Levy et *al*., 2011)

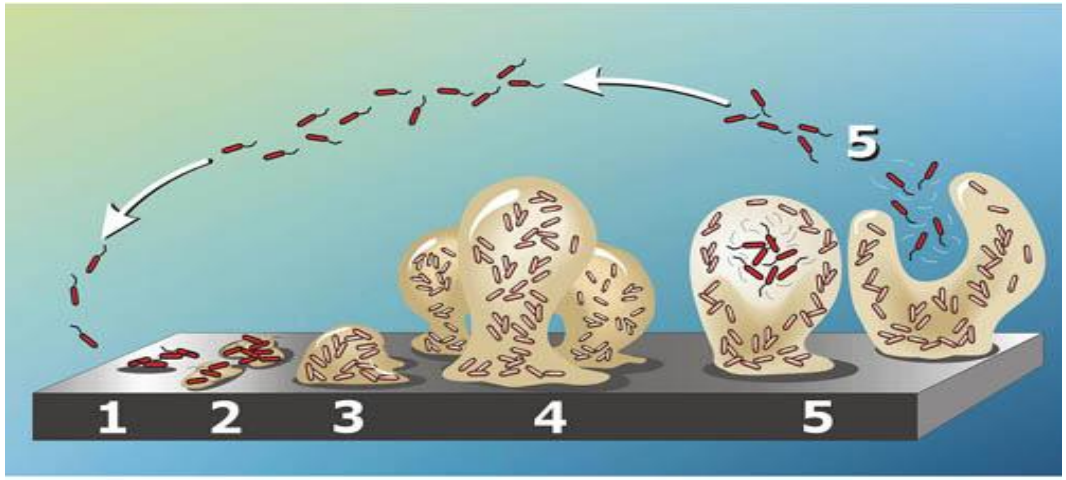
Biological growth
(Adin et Sacks, 1991)

➔ Micro-irrigation clogging sources are combined (Adin et Sacks, 1991)

➔ Clogging causes a decrease in micro-irrigation system performance (Gamri et *al*., 2014)

Context: Emitters clogging

Biofilm = micro-organisms attached to a support by a protective matrix (Characklis, 1973)

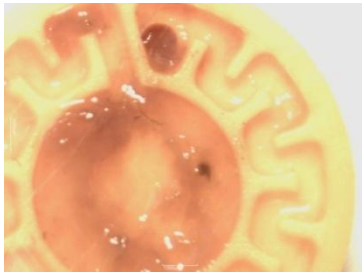


Stages of biofilm development (Cunningham et *al*., 2008)

(1)+(2) { Micro-organisms attachment

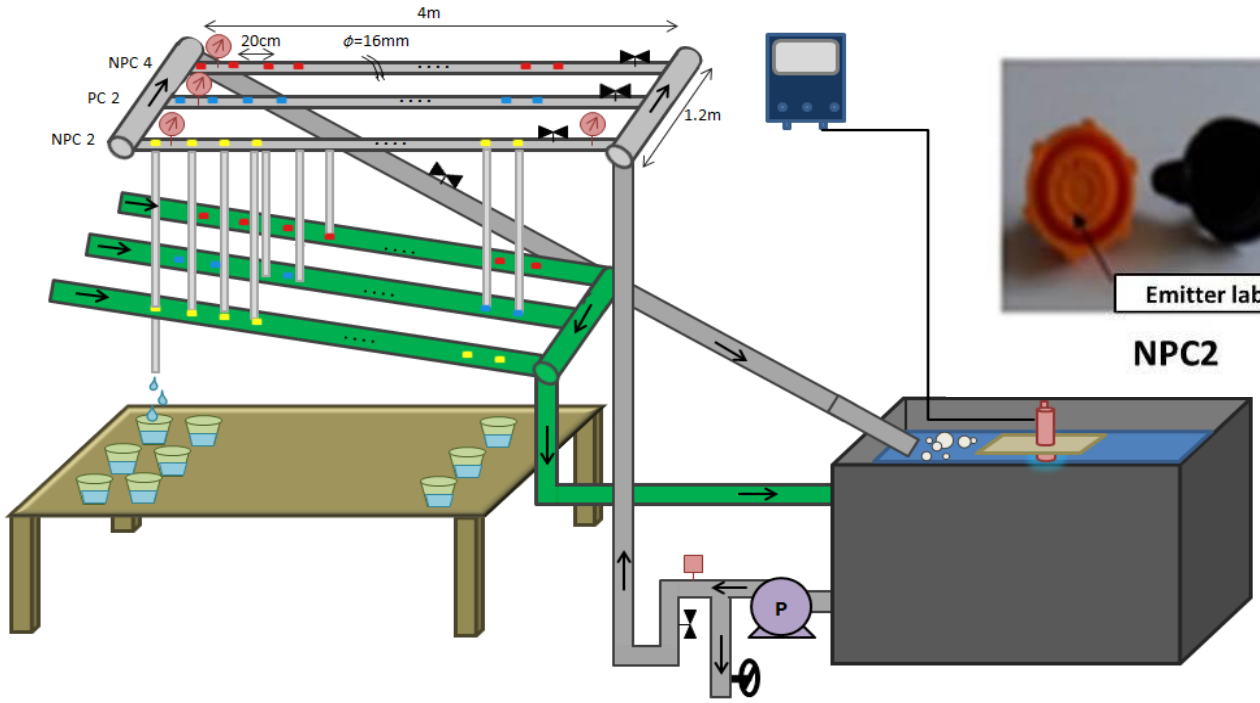
(3)+(4) { Biofilm growth

(5) { Biofilm detachment

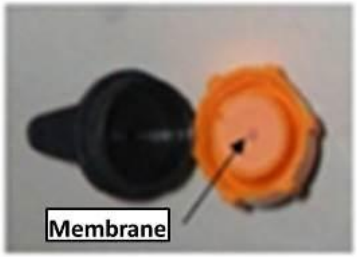


Material and methods :

Experimental set-up and measurements



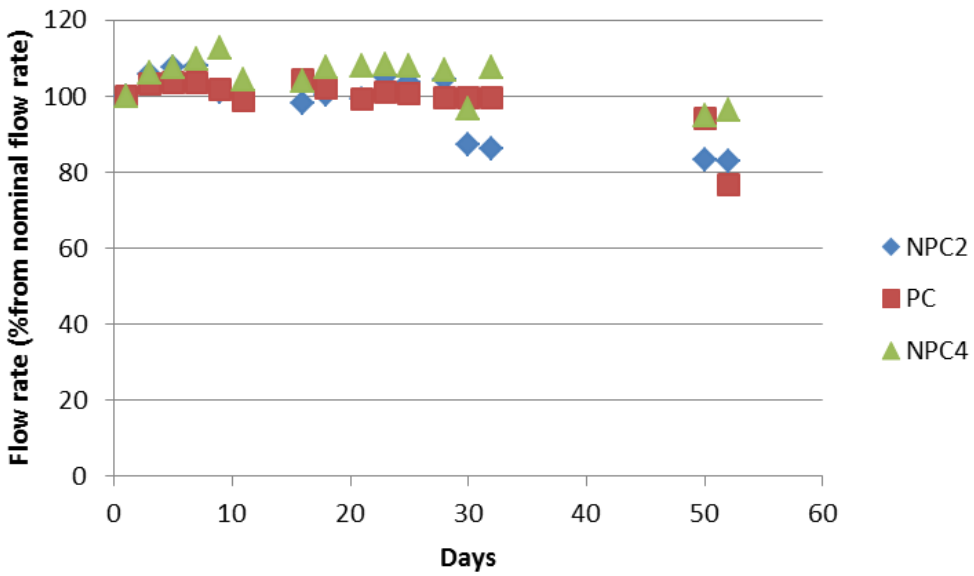
NPC2



PC

- Three types of drippers are used : NPC 4 $L.h^{-1}$, NPC 2 $L.h^{-1}$ and PC 2 $L.h^{-1}$.
- The system operates 8 hours/day.
- Two experiments are carried out using a synthetic effluent : with and without mineral particles.
- Flow rate measurements and deposit analysis (dried mass and microscope observations)

Emitters performance using mineral particles



Flow rate variation with mineral particles

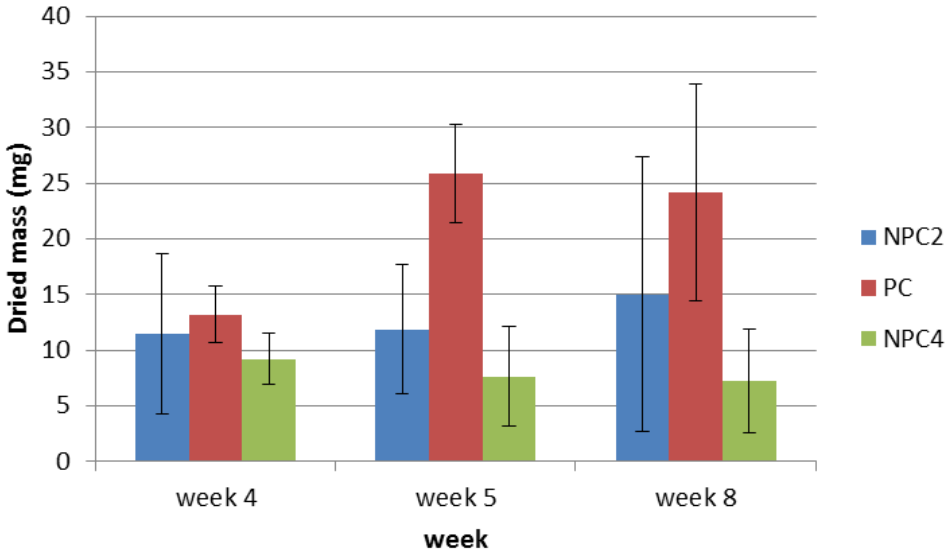
- Flow rate variations tend to exceed the nominal flow rate during the first 30 days of the experiment : around 5% for NPC2 and PC and 10% for NPC4.

- Flow rate decreases from the 30th day. At the end of the experiment flow rate has decreased by 17% for NPC2 emitters, 23% for PC and 4% for NPC4.

➡ PC and NPC2 emitters tend to clog faster than NPC4.

Water4Crops (KBBE.2012.3.5-03)

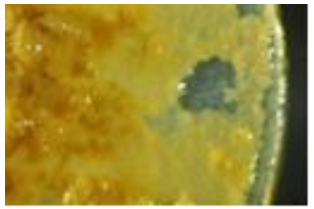
Emitters performance using mineral particles



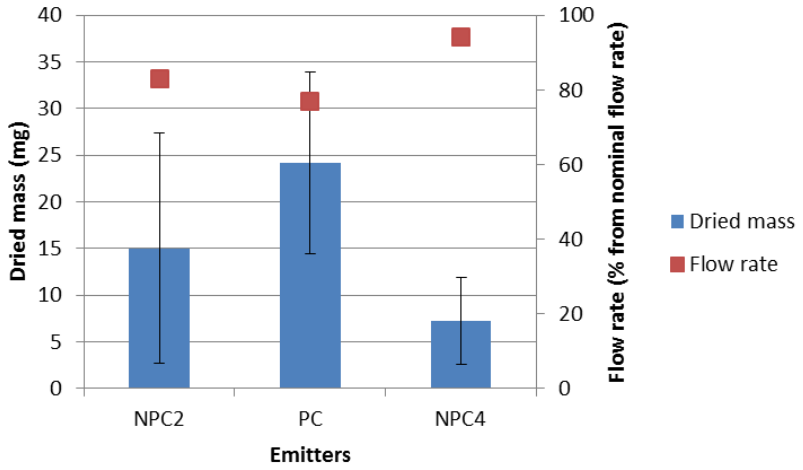
Dried mass measurements

- From the 5th week, the deposit increases especially for PC emitters.
- Deposit trapped in the drippers is lower for NPC4 than for NPC2.

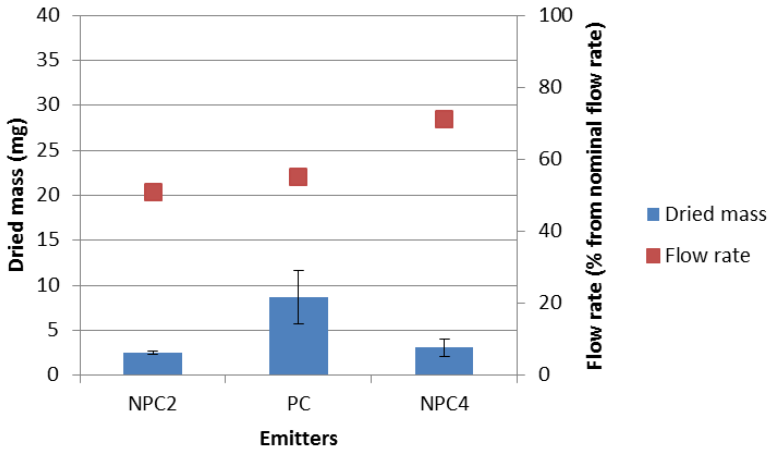
➡ Mineral deposit and biofilm growth are related to nominal flow variations



Interaction between biofilm and mineral particles



Flow rate and dried mass measured using mineral particles after 8 weeks of experiment



Flow rate and dried mass measured without mineral particles after 8 weeks of experiment

- Dried masses measured in the experiment with mineral particles are significantly higher than those measured without particles.
- Flow rate is less affected when mineral particles are used.

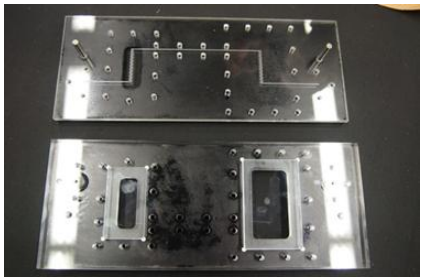
Conclusions

- NPC4 emitters are less sensitive to clogging than NPC2 and PC emitters.

- Mineral particles have a little effect on emitter clogging compared to biofilm growth. Possible effect of abrasion?

Perspectives

- To develop the use of milli-channels with simplified geometry to investigate the mechanics of interactions between fluid, particles and walls.



- To focus on the interaction between biofilm and mineral particles in situ using treated wastewater.

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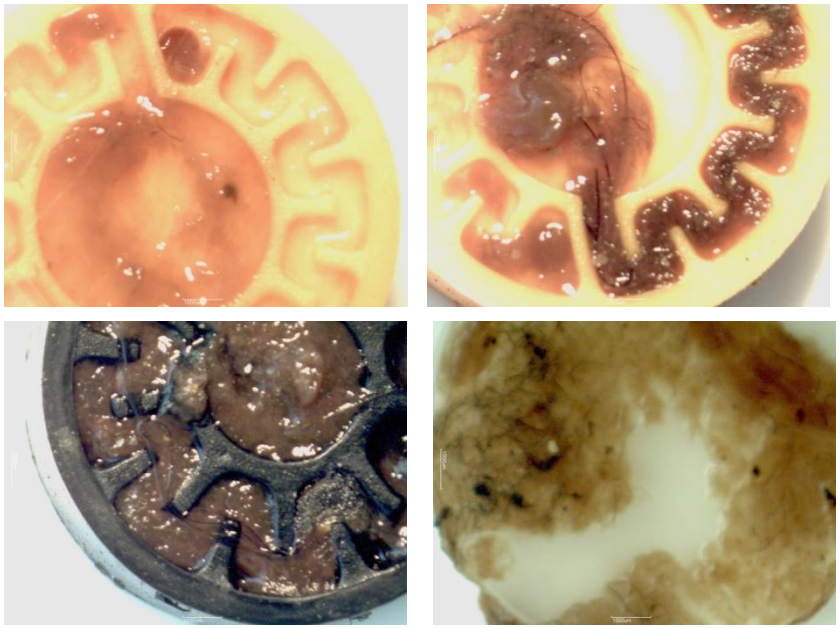
THANK YOU FOR YOUR ATTENTION



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