Hydraulic versus pesticides effects on periphyton in experimental stream

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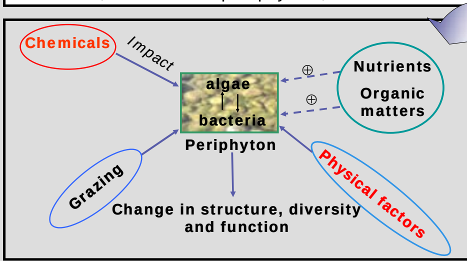
INTRODUCTION

A spatio-temporal study of a stream running though a wine growing watershed showed that two pesticides: the Diuron (herbicide) and the Azoxystrobin (Fungicide) were present at low concentrations. During the low water level period, the average concentrations were respectively 2 µg.L-1 and 0.3 µg.L-1. The aim of the present study was to investigate the potential effect of these low pesticide concentrations on complex aquatic microbial community. Previous studies on ecotoxicity of these pesticides focused on monospecific cultures and under controlled conditions. In the present study, effect of these pesticides on periphyton were considered, within the complex physical, chemical and biological interactions.

Source : www.dive.afssa.fr/agritox/index.php

	Diuron	Asoxystrobin
NOEC ($\mu g.L^{-1}$) Mesocosm phyto and zooplankton	0.52	1.5
CE50 ($mg.L^{-1}$) *Daphnia magna* (48h)	1.4	0.28
CE50 ($\mu g.L^{-1}$) *Scenedesmus subspicatus* (96h)	3.3	
CE50 ($mg.L^{-1}$) *Pseudokirchneriella subcapitata* (96h)		0.36



The periphyton is an assemblage of bacteria, algae and several other organisms. Periphyton development and diversity depend on 4 main environmental factors : Grazing, Nutrients and Organic Matter, Chemical and Physical factors.

This study focused on the effect of two specific factors : **hydrological regime and pesticide application.**

This study aimed at finding the **potential impact of both pesticides on periphyton** in laminar or turbulent streams and try to assess **a possible hierarchy between these two factors**. In order to address this question we used **artificial streams** (designed by VOLATIER (2004).

MATERIEL AND METHODS

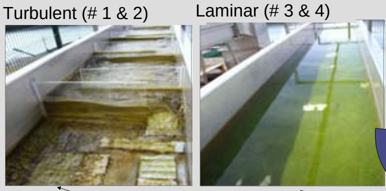
We used 4 artificial streams:
- S1 and S4 were the control, S2 and S3 were the experimental streams.
- S1 and S2 were turbulent streams.

In each turbulent stream, 2 current velocity zones were designed by using plexi-glass defectors. Slow current velocity zones were characterized by values below 20 cm.s-1.

Stream	S1	S2	S3	S4
Polluted	no	yes	yes	no
Hydrology	Turbulent	Turbulent	Laminar	Laminar

artificials channels from L.S.E. (VOLATIER 2004)

Turbulent (# 1 & 2) Laminar (# 3 & 4)



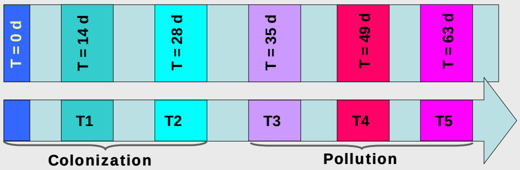
Fixed periphyton on glass plates

Parameters

- Biomass (dry weight)
- Number of phytobenthos and bacteria cells (cytometry)
- Primary production (^{14}C)
- Diatoms diversity (microscopy)

3 samples/streams/date

The experiment lasted for 63 days and streams were sampled 5 times : 2 during the colonization in absence of pesticides, 3 after a mix of pesticides reflecting concentration commonly found in the environment (2.5 µg.L-1) was introduced.



RESULTS AND DISCUSSION

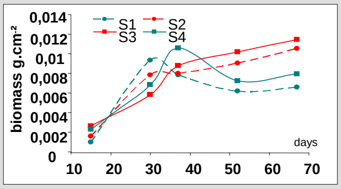


Fig 1: **Biomass dynamic** (g.cm-2). In green : S4 control and laminar stream (Full line), S1 control and turbulent stream (dotted line); In red : S3 polluted and laminar stream (full line), S2 polluted and turbulent stream (dotted line)

The growth of the biofilm in non-polluted streams is consistent with the 3 phases model (Biggs, 2000) short colonization, exponential growth and mortality of biofilm (FIG 1).

Before 40 days, biomasses were similar in all streams. After pesticides introduction, the biofilm growth dynamics was modified and the natural biofilm mortality was delayed.

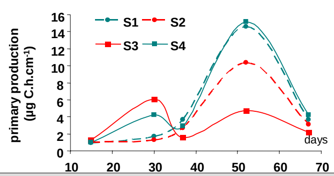


Fig 2 : **Primary production** (µg C.h.cm-1). In green : S4 control and laminar stream (Full line), S1 control and turbulent stream (dotted line); In red : S3 polluted and laminar stream (full line), S2 polluted and turbulent stream (dotted line)

This increase of biomass in polluted streams was associated to a decrease in the primary production.

The primary production was higher in control streams compared to the polluted streams.

This pesticides mixture would affect periphyton growth dynamics. However, pesticides' impact did not depend on the hydrological regimes of the streams as no differences in biomass or primary production between turbulent or laminar streams was detected.

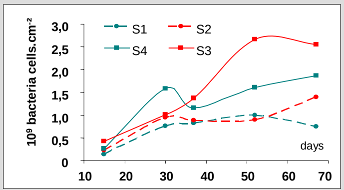


Fig 3 : **Number of bacteria cells** (10^9 cells.cm-2)). In green : S4 control and laminar stream (Full line), S1 control and turbulent stream (dotted line); In red : S3 polluted and laminar stream (full line), S2 polluted and turbulent stream (dotted line)

There were significantly less bacteria cells in turbulent streams than in laminar streams and this pattern was similar in both controlled and polluted streams.

Pesticides would not affect the number of bacteria cells. The number of bacteria cells in the streams would depend more on the hydrological regimes than on the presence of pesticides.

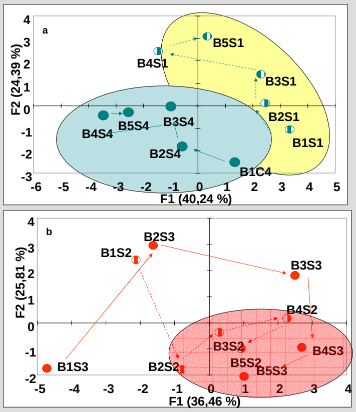


Fig 4 : **PCA of diatoms diversity**.
(a) Control Streams. Full circle : laminar stream (S4), striped circle : turbulent stream (S1)
(b) Polluted Streams. Full circle : laminar stream (S3), striped circle : turbulent stream (S2)

The microscopy counting of diatoms were analyzed using a PCA.

Control stream (S1 & S4): the evolution of diatoms diversity was different between the laminar and the turbulent streams (FIG 4A).

Polluted streams (S2 & S3): the diatoms diversity were different between the two type of streams before pesticide addition. But it tended to get more similar after the pesticides input.

In absence of pesticide, the diatoms diversity depends on the hydrological regime.

At low concentrations of these two pesticides, diatoms diversity got similar and homogenous, independently from the stream hydrological regimes.

CONCLUSIONS AND PERSPECTIVE

Low concentration of these two pesticides resulted in modifications in biomass, primary production and diatoms diversity in our artificial streams.

Main results of this study are that :

1. **A mix of Diuron and Azoxystrobin has an impact on a complex microbial community for concentration lower than NOEC.**

2.The community response does not depend on hydrological regime

3.The hydrological regime influences the number of bacteria cells and the diatoms diversity when there is no disturbance due to pesticide.

However, these patterns might change depending on the season, as temperature and light are major factors shaping periphyton. Results from this study will be compared with those from a similar experiment conducted in summer.