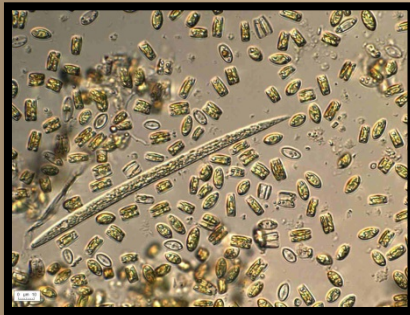


Predation, competition and chemical stressors in freshwater biofilm: synergism or antagonism?

Case study of a nematode (*Aphelenchoides bicaudatus*) and two diatoms species: *Planothidium lanceolatum* and *Gomphonema gracile*

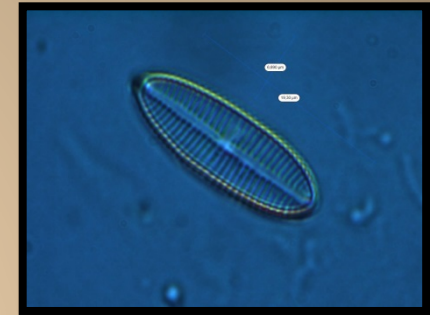
Julie Neury-Ormanni, Jacky Vedrenne, Soizic Morin



Aphelenchoides bicaudatus



Planothidium lanceolatum



Gomphonema gracile



Introduction

- Toxic pollution → direct and indirect effects on biological interactions
- Micro-meiofauna – primary producers: often neglected
→ Complementarity of studied organisms improves quality assessment
- IBD = Diatoms (Coste et al. 2009) – AMBI = Meiofauna (Borja et al. 2003)
→ joint dynamics under multistress conditions
- Meiofauna key component of benthic ecosystems

Aims

Explaining growth kinetics individually and jointly of two diatoms species (*Planothidium lanceolatum*, *Gomphonema gracile*) under various pressures:

- Potential grazer (NEM)
- Competition between microalgae (COMP)
- Pesticide (PEST)
- Combination of these factors

Material and methods

Biological material



Gomphonema gracile

(Gg)

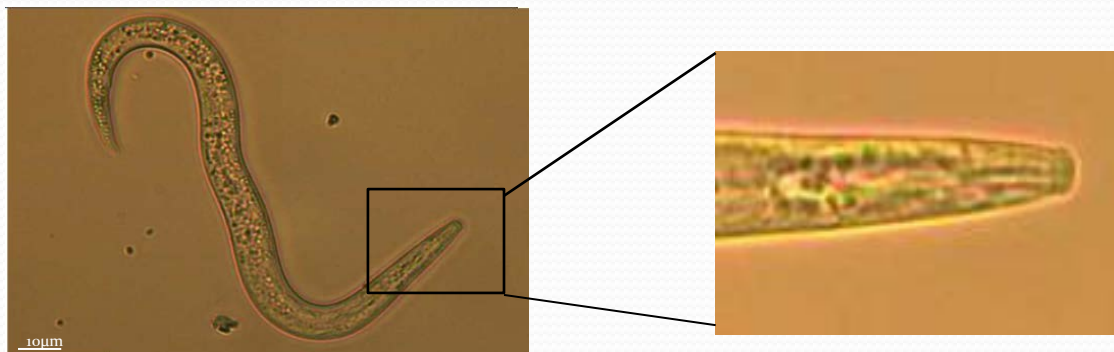
Gomphonemataceae; 15-20µm,
Rebec, Upstream Leyre, South-West
France



Planothidium lanceolatum

(Pl)

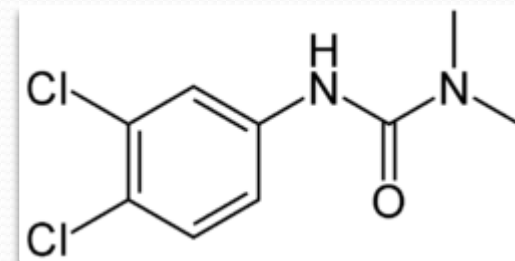
Achnantidiaceae; 3-5µm
Le Lourdan, Lentigny, East
France
(2012)



Aphelenchoides bicaudatus (NEM)

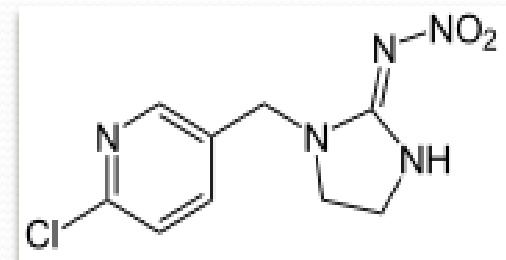
Aphelenchoididae; Isolated from sample from upstream Leyre (2014). 150-300µm
« Suction feeder » = Stylet (10-12µm) (Siddiqui 1969) Microorganisms (Wood 1973)

Chemical material



Diuron (DIU)

Substituted urea
Priority substance
Solubility: 42mg/L



Imidacloprid (IMI)

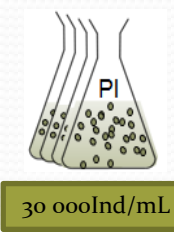
Neonicotinoid
« Watch list »
Solubility: 610mg/L

Growth dynamic of diatoms individually (CTRL)

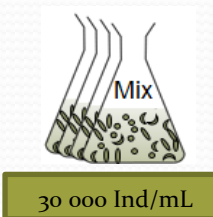
Identification of the separate effect of each factor (COMP, NEM, IMI et DIU)

Identification of combined effects between competition and other factors (NEM-COMP, IMI-COMP, DIU-COMP)

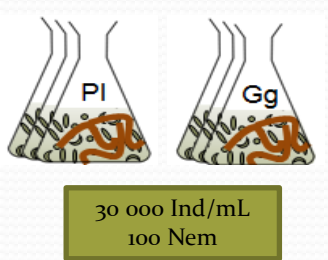
Predation, competition and chemical stressors (DIUNEM-COMP, IMINEM-COMP)



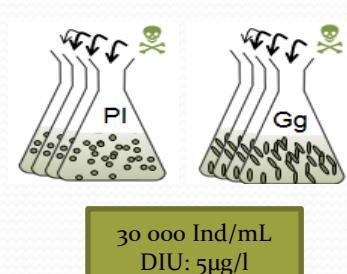
Competition



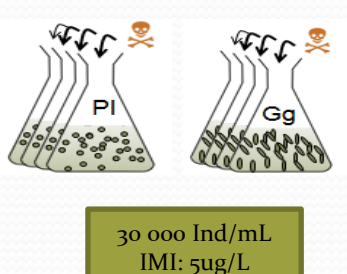
Predation



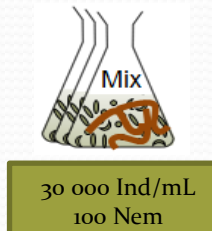
Diuron



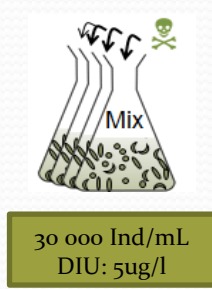
Imidacloprid



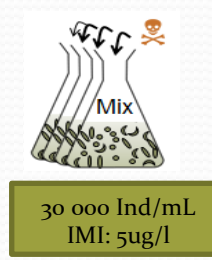
Predation Competition



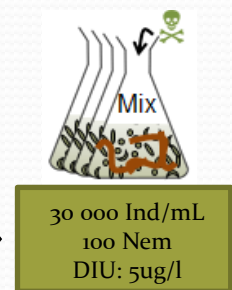
Diuron Competition



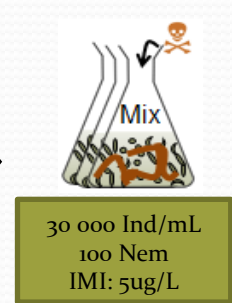
Imidacloprid Competition



Predation Diuron Competition



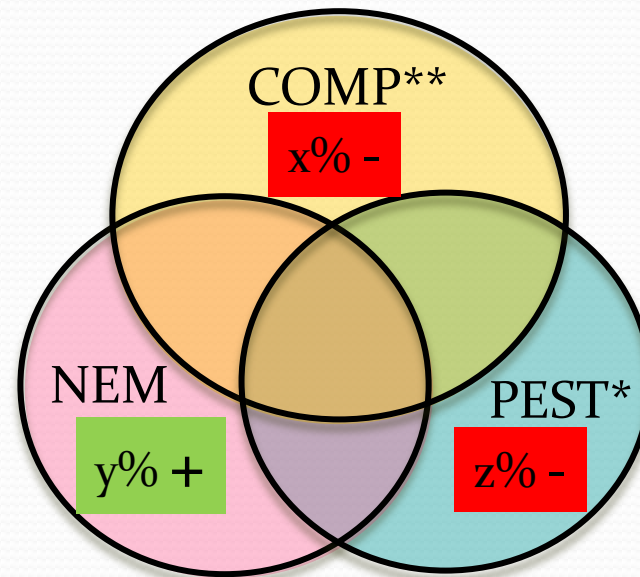
Predation Imidacloprid Competition



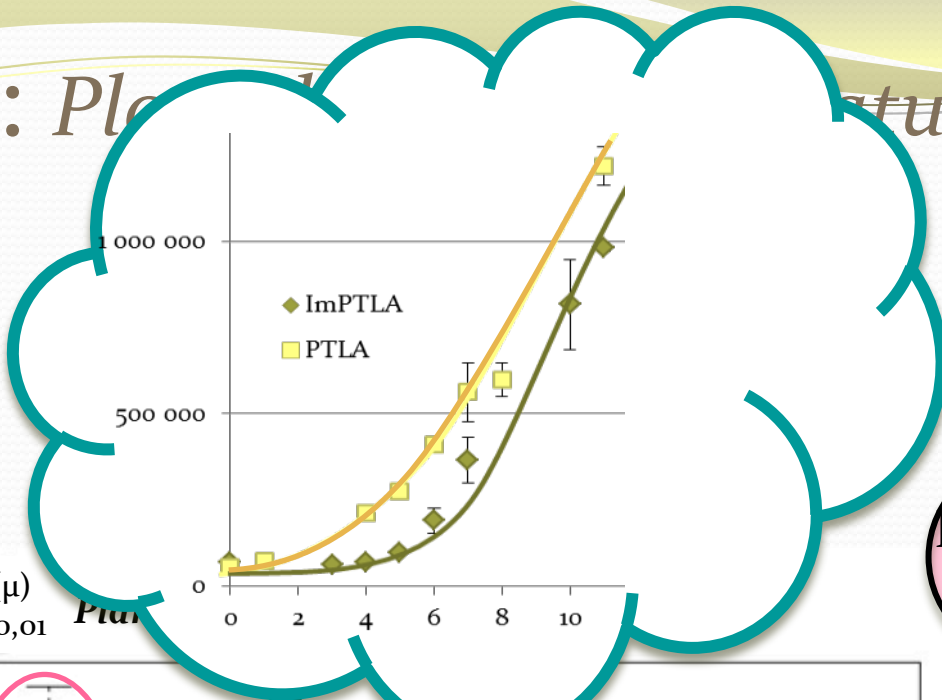
Erlenmeyer = 150mL/40cm²
Incubation 16:8 à 16,6°C ± 2°C

Data analysis

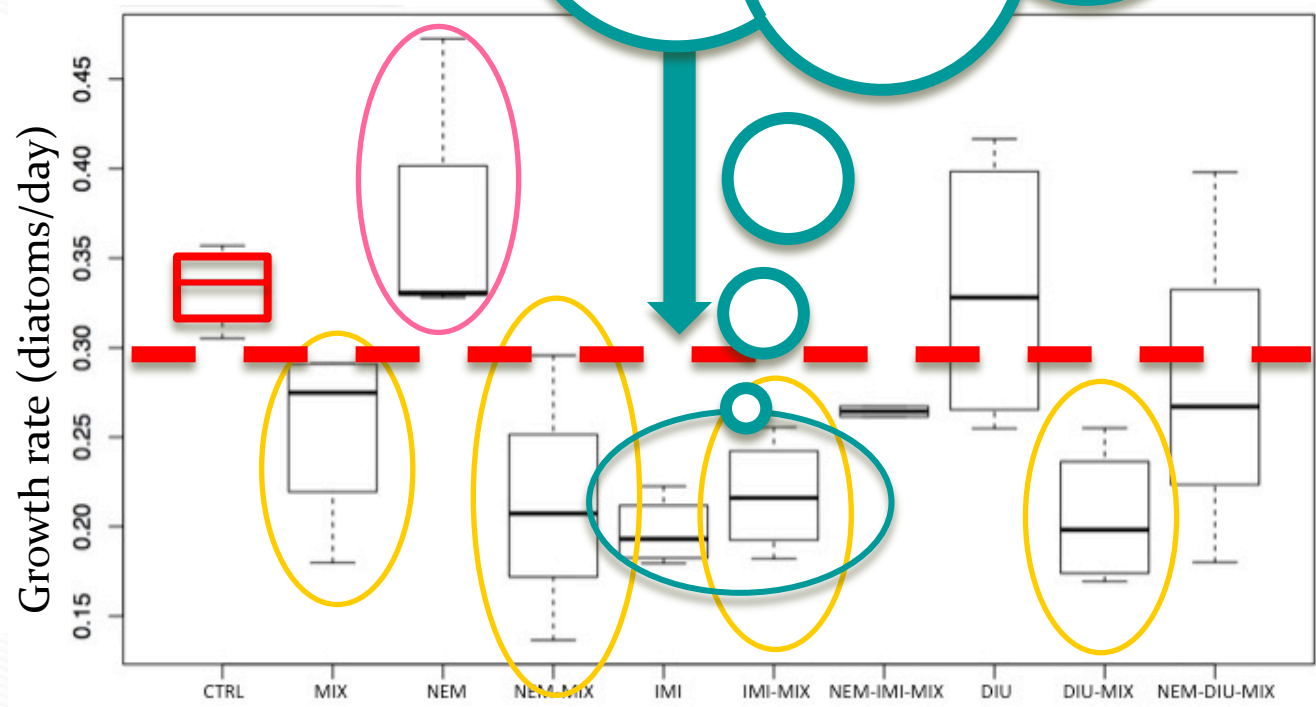
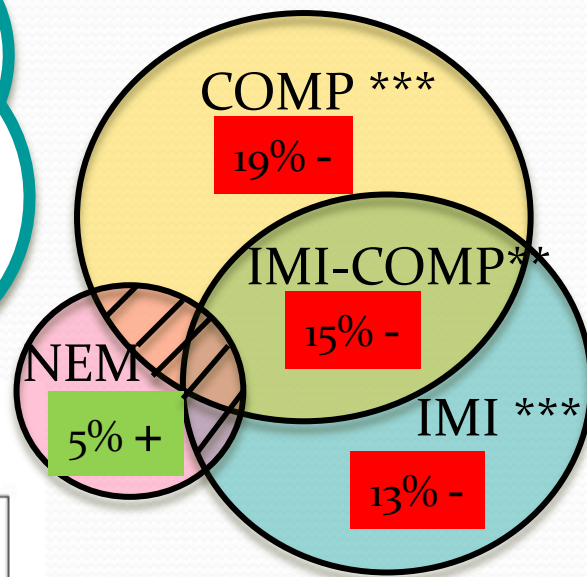
- Growth rate were designed by linear model
→ Impact of controlled explanatory variables (Nematodes, Competition, Diuron and Imidacloprid)
- Venn diagram of the variance explained by each factor on **mean growth rate (μ)**, according to a linear model driven by Akaike criteria (AIC)



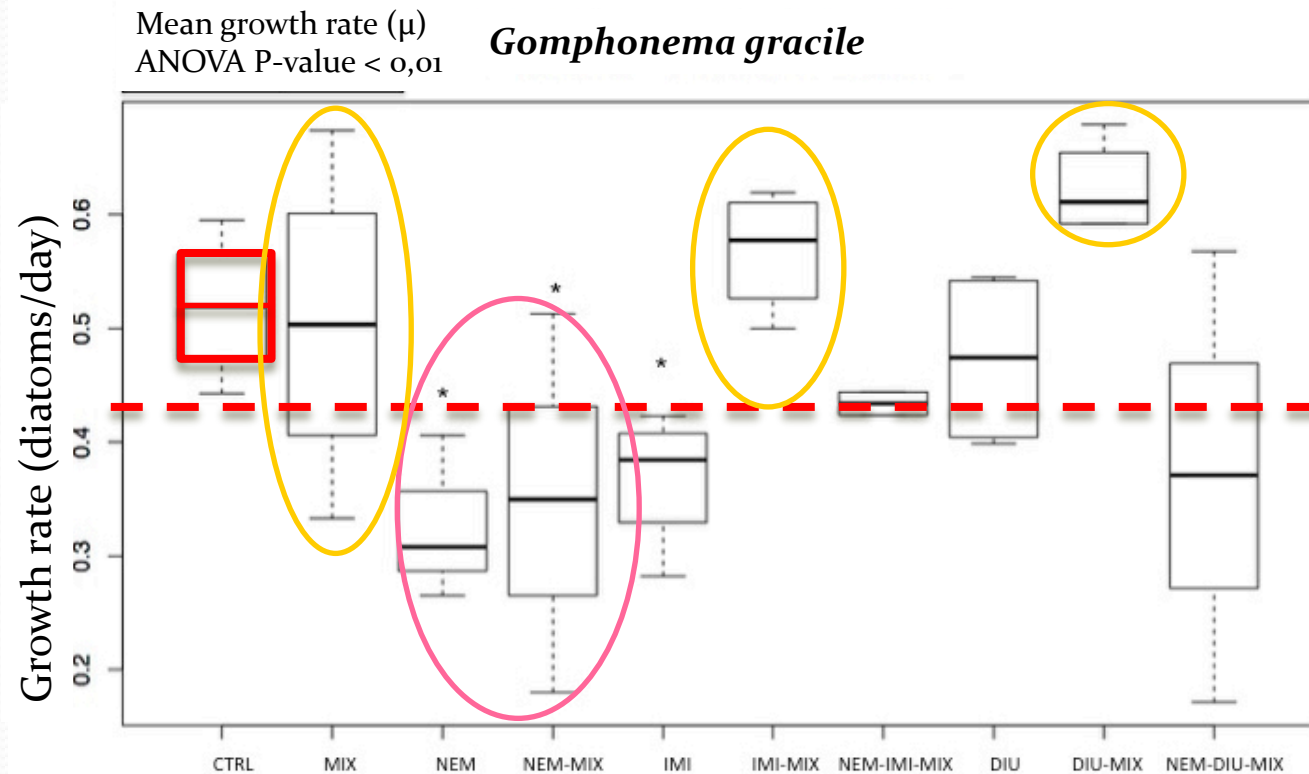
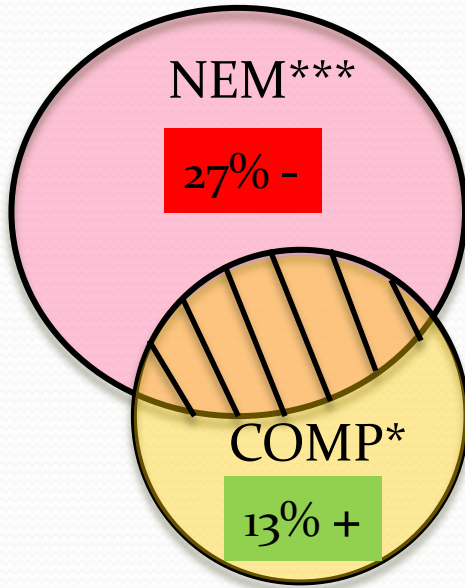
Results: *Plankton* *Plankton*



Mean growth rate (μ)
ANOVA P-value < 0,01

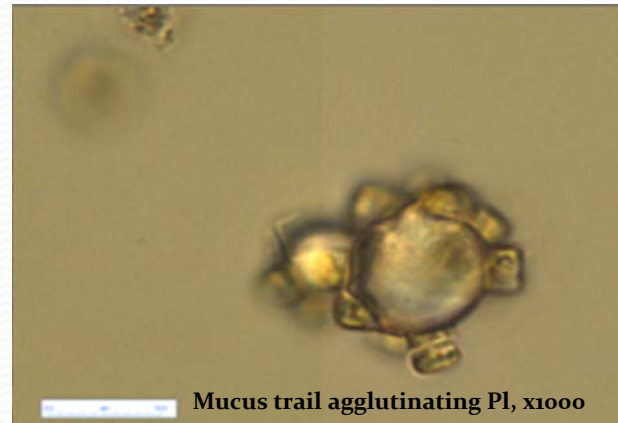
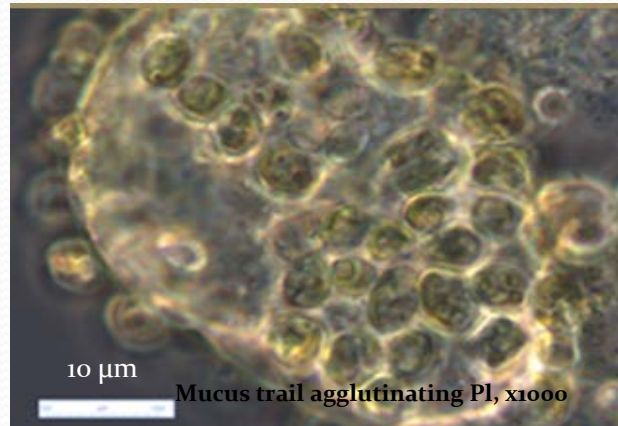
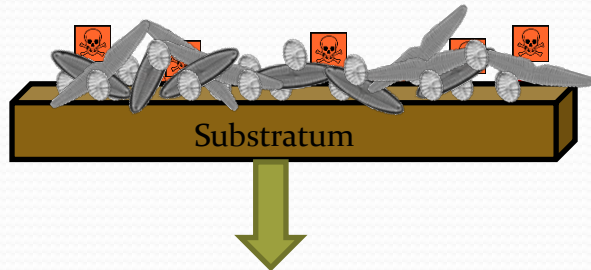


Results: *Gomphonema gracile*



Discussion:

Abiotic factors



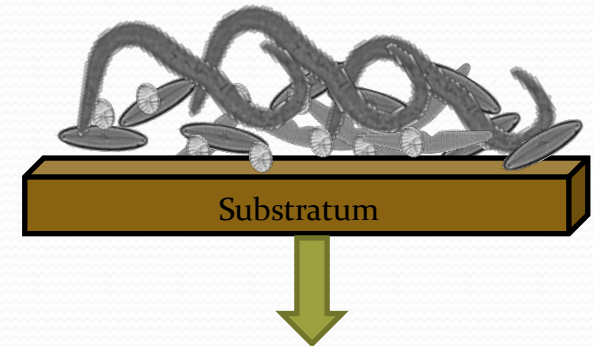
Diuron:

- Not structuring effect on growth.
- Synergy/antagonism with competition depending on the species

Imidacloprid:

- Latency period for two species
- Impact on microbial loop (Rier et Stevenson 2002)
- Antagonism with competition

Biotic factors



Competition:

- For nutrient and space
- Variable among species

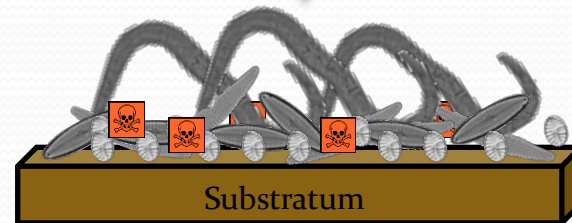
Predation:

- Available resources/Top-Down (Lubchenco 1978, Rakowski 2016)
- « Pantry » (Riemann 2002, Majdi, 2015)
- Selection of bigger diatoms
- Synergy with competition

Discussion:

Abiotic factors

Biotic factors



Diuron + Nematodes + Competition

- Active grazing on big species
- Growth Pl ++
- Predation antagonist competition/diuron

Imidacloprid + Nematodes + Competition

- Potential sensitivity of nematode
→ No impact of NEM on diatom growth

COMBINED abiotic and biotic factors
have **SIGNIFICANT** and **UNEXPECTED** effects...



Conclusions

- Competition is a structuring factor for PI
- Herbivory extremely structuring (Rejuvenation of biofilms (Guasch et al. in press)), dvpt opportunistic taxa (PI).
- Non negligible effect of combined biotic (Predation, Competition) and abiotic factors (Chemical stress).
- Need dedicated studies to better understand these interactions → Better interpretation of biological indices

Thank you for your attention



Aphelenchoides bicaudatus et *Gomphonema gracile*. X200 DIC

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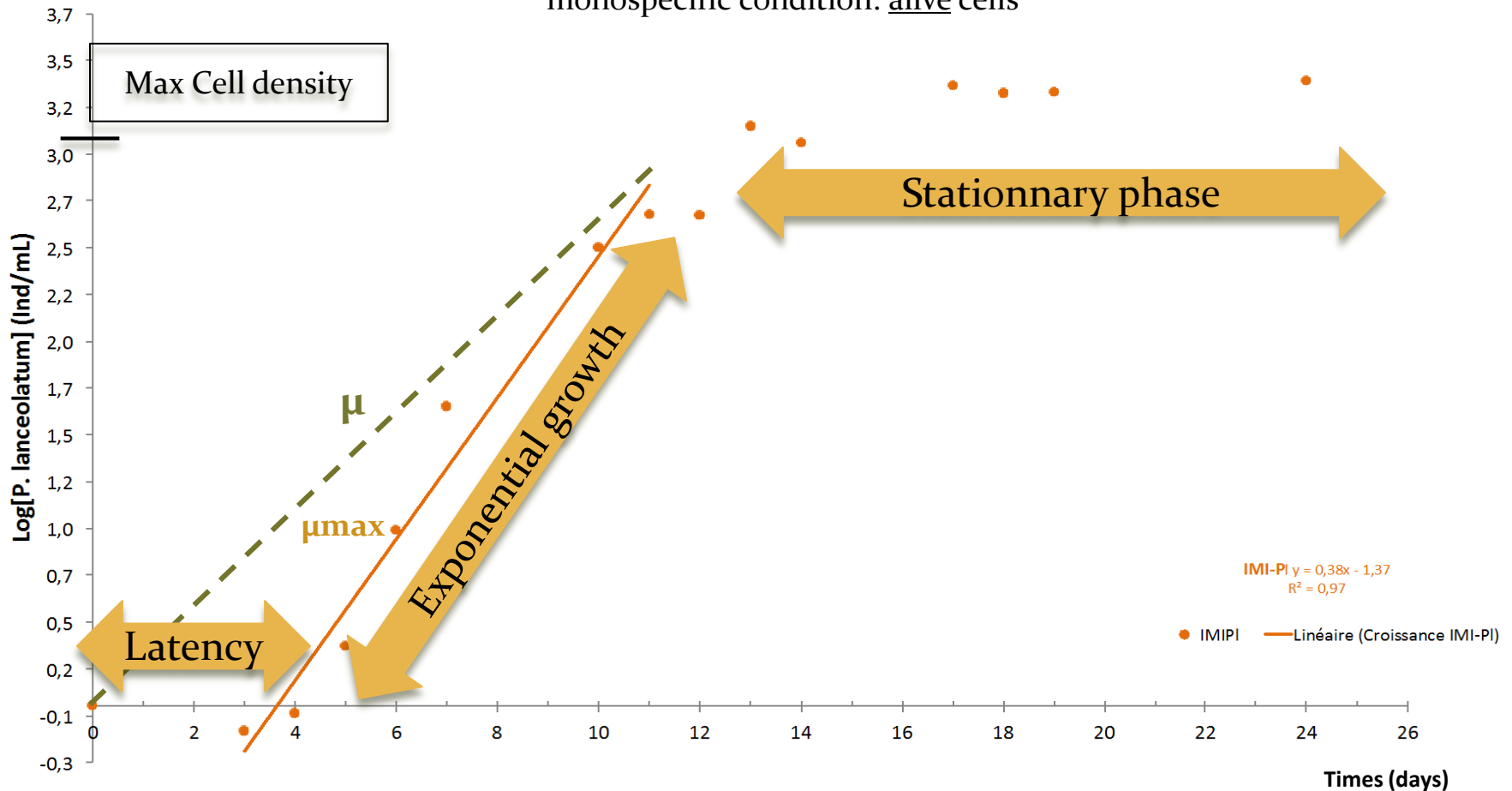
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Data analysis

Growth dynamic of *Planothidium lanceolatum* under imidaclopride treatment in monospecific condition: alive cells

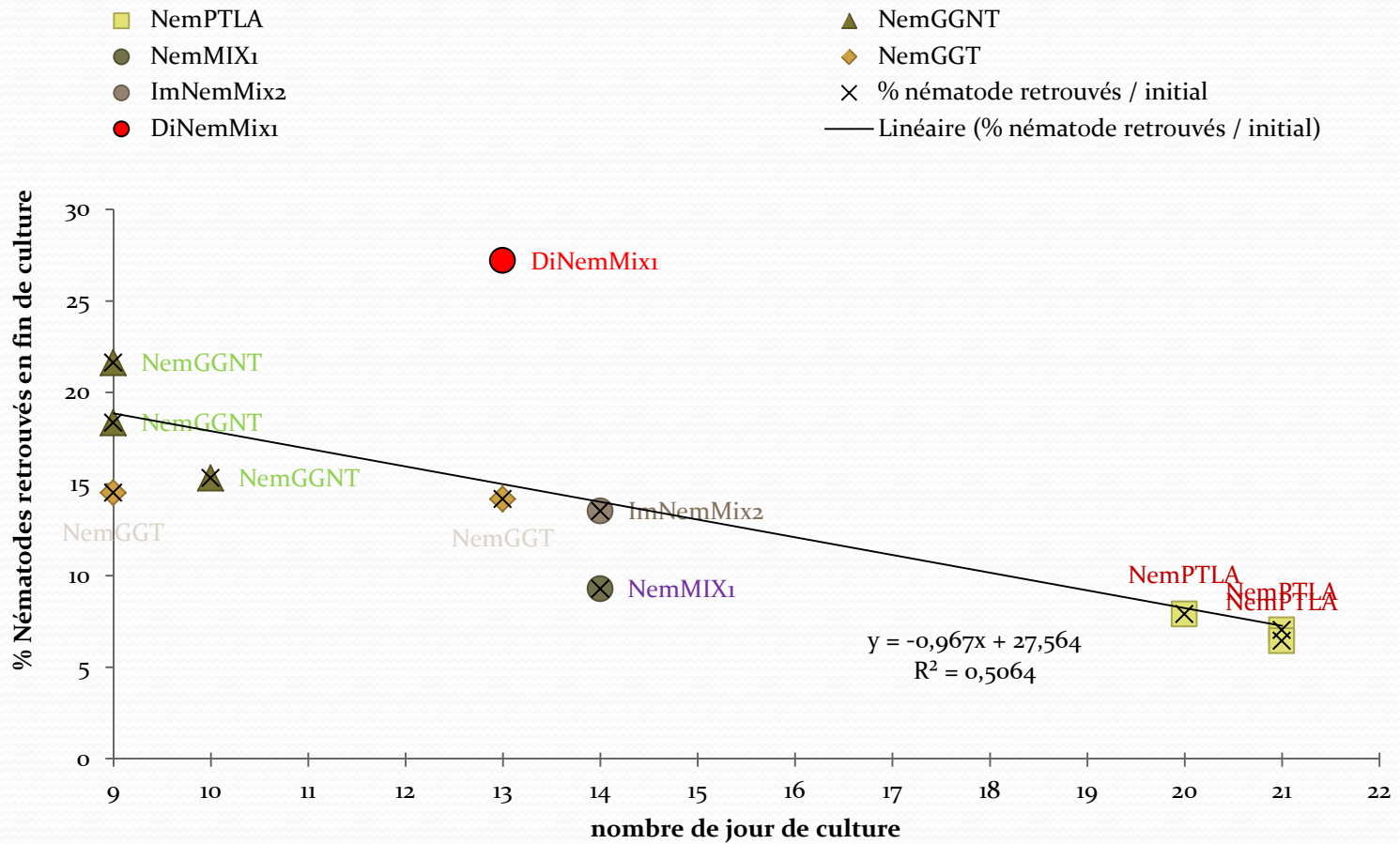


$$\frac{d[cell]}{[cell]} = \mu \times dt$$

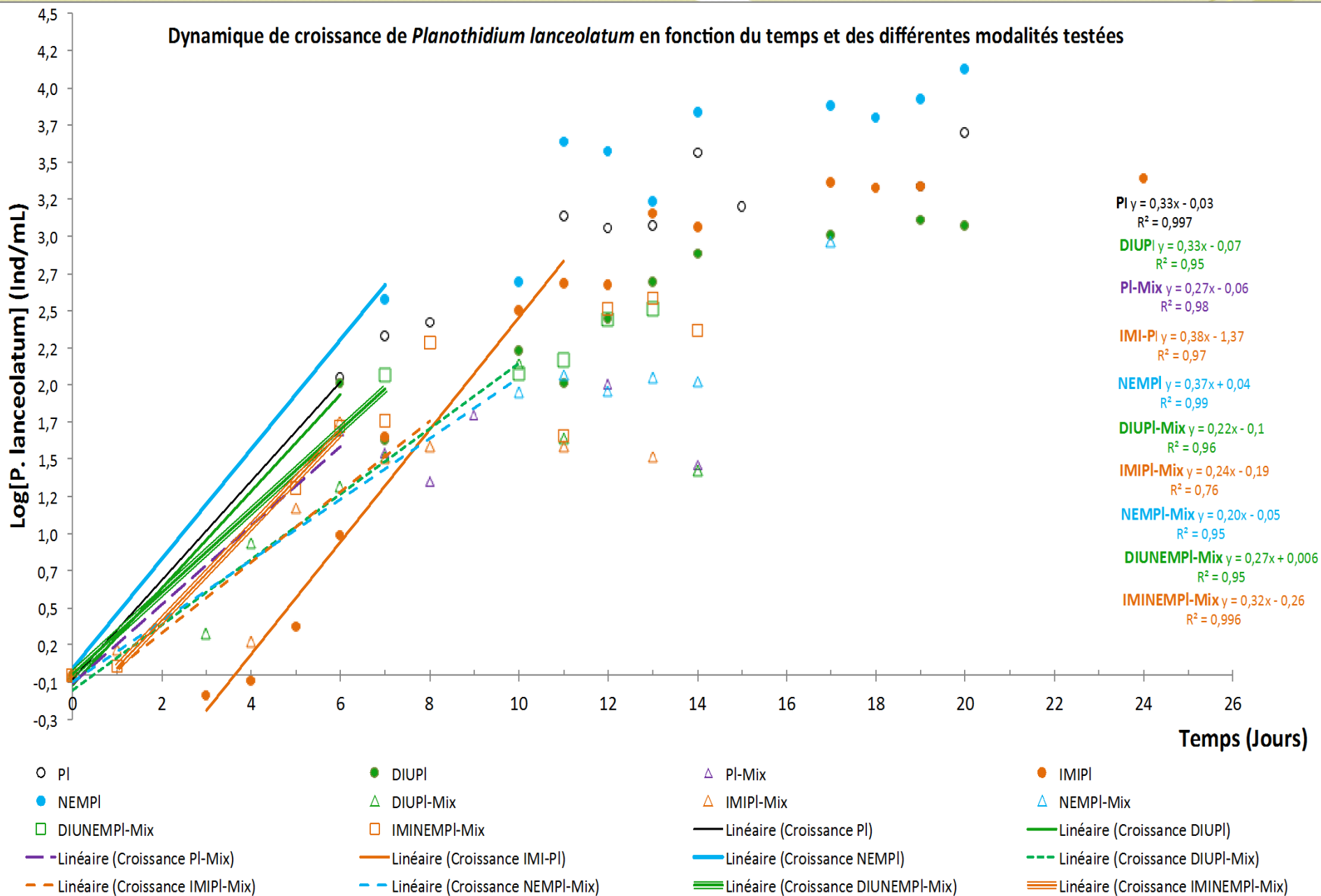
$$\mu = \frac{\ln[cell]_{stationnary} - \ln[cell]_{t_0}}{\text{date of stationnary phase}}$$

$$\mu_{max} = \frac{\ln[cell]_{stationnary} - \ln[cell]_{t_{exp}}}{\text{date of stationnary phase}}$$

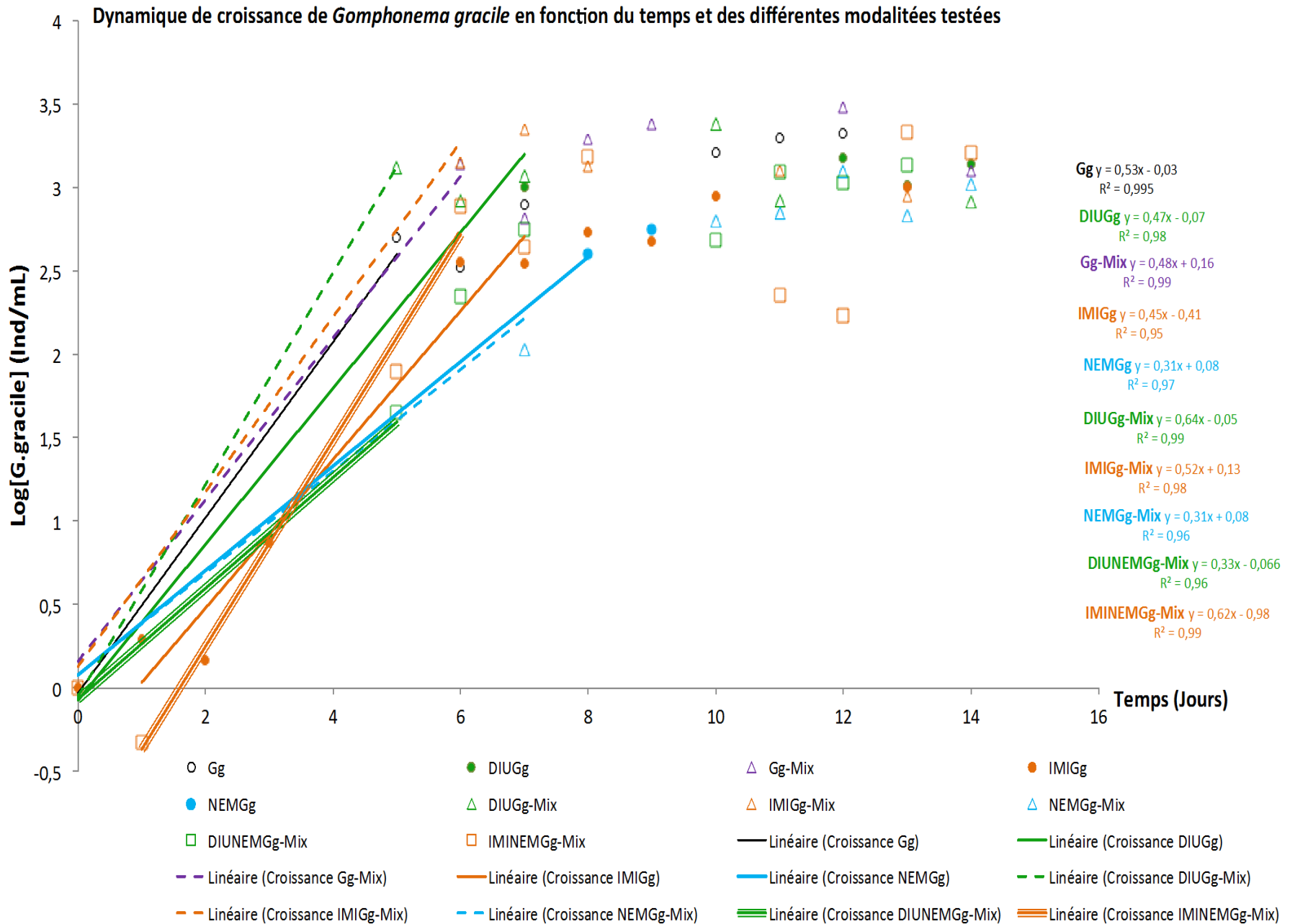
Nématodes after experiments

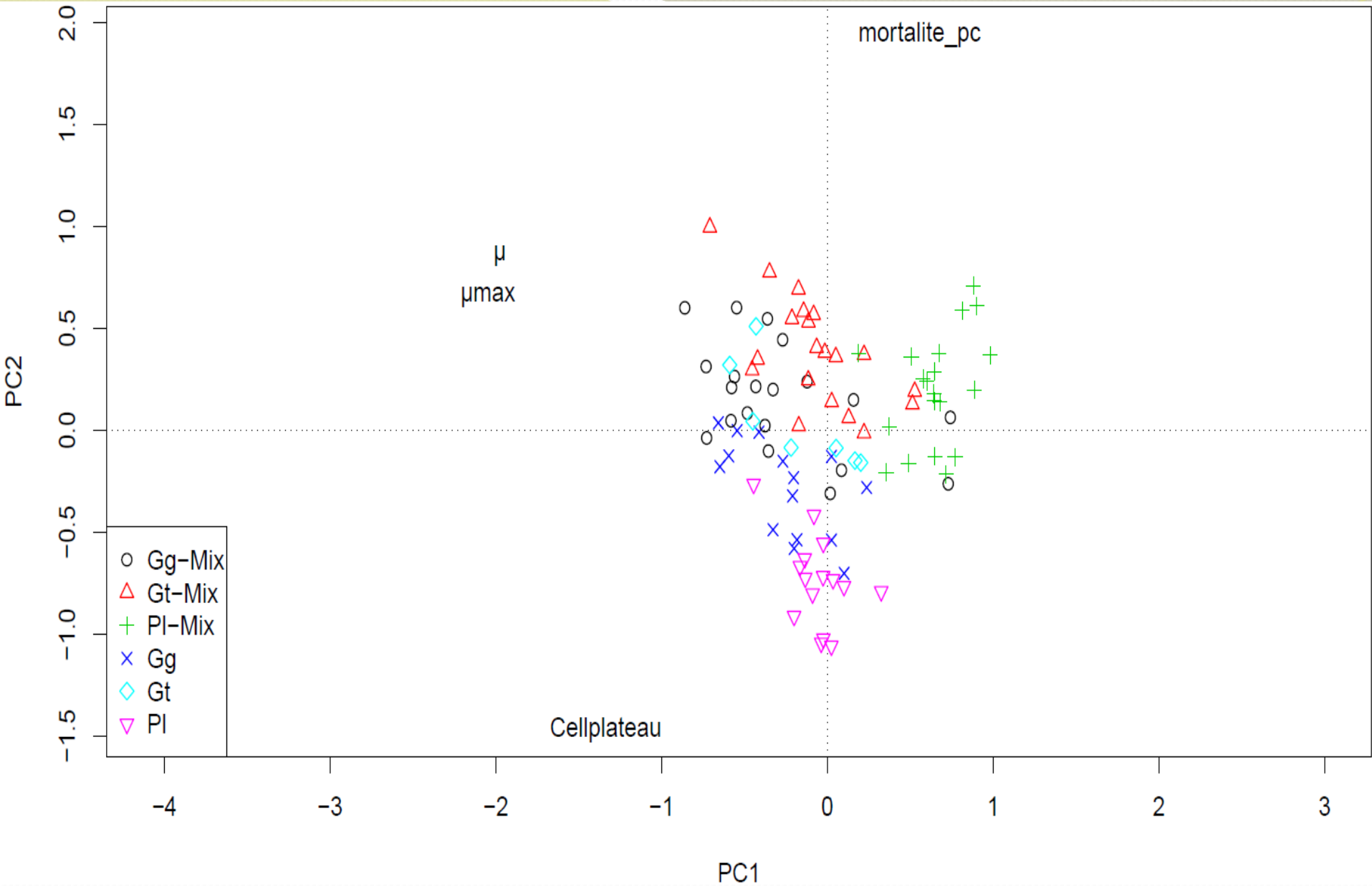


Dynamique de croissance de *Planothidium lanceolatum* en fonction du temps et des différentes modalités testées

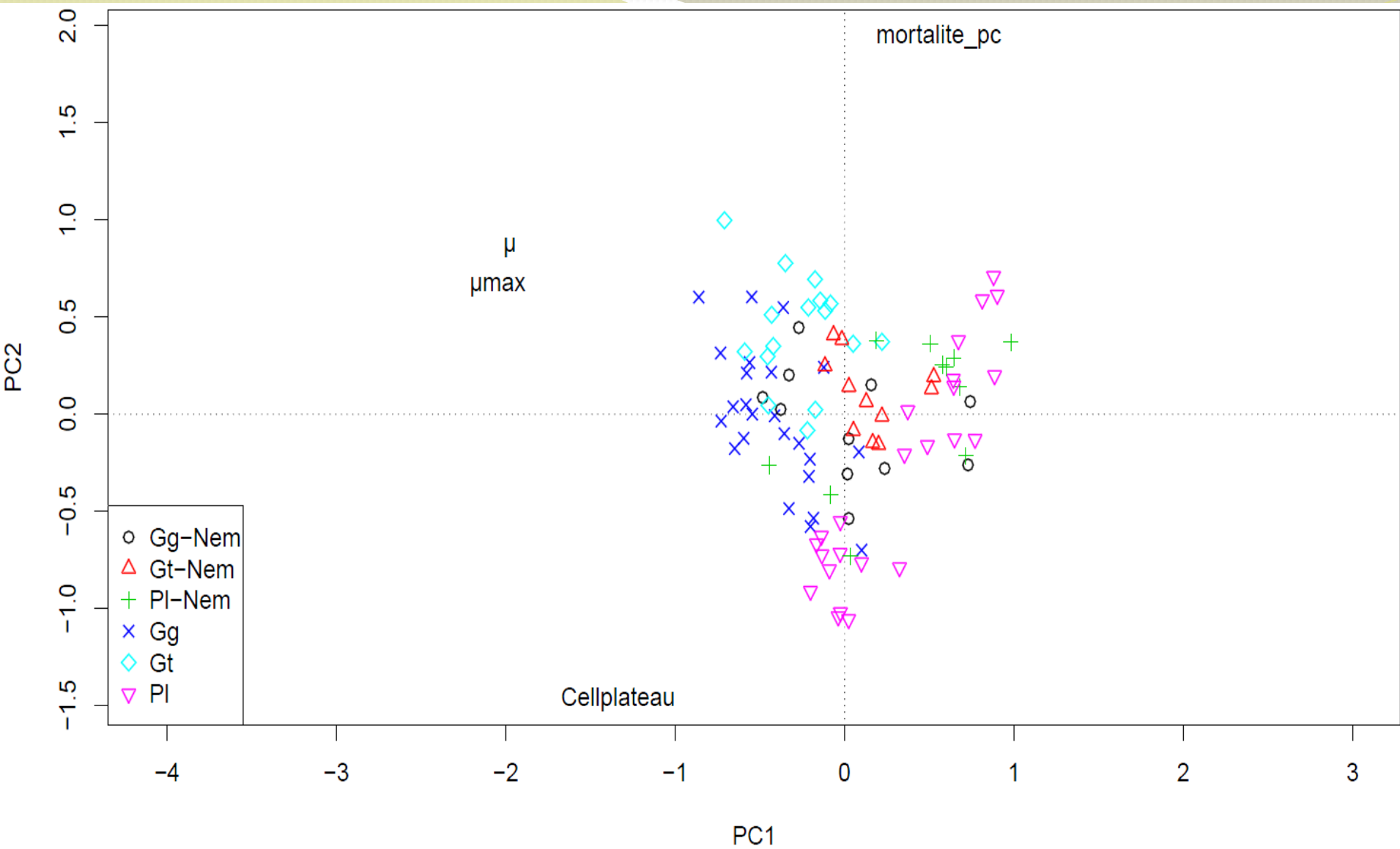


Dynamique de croissance de *Gomphonema gracile* en fonction du temps et des différentes modalités testées

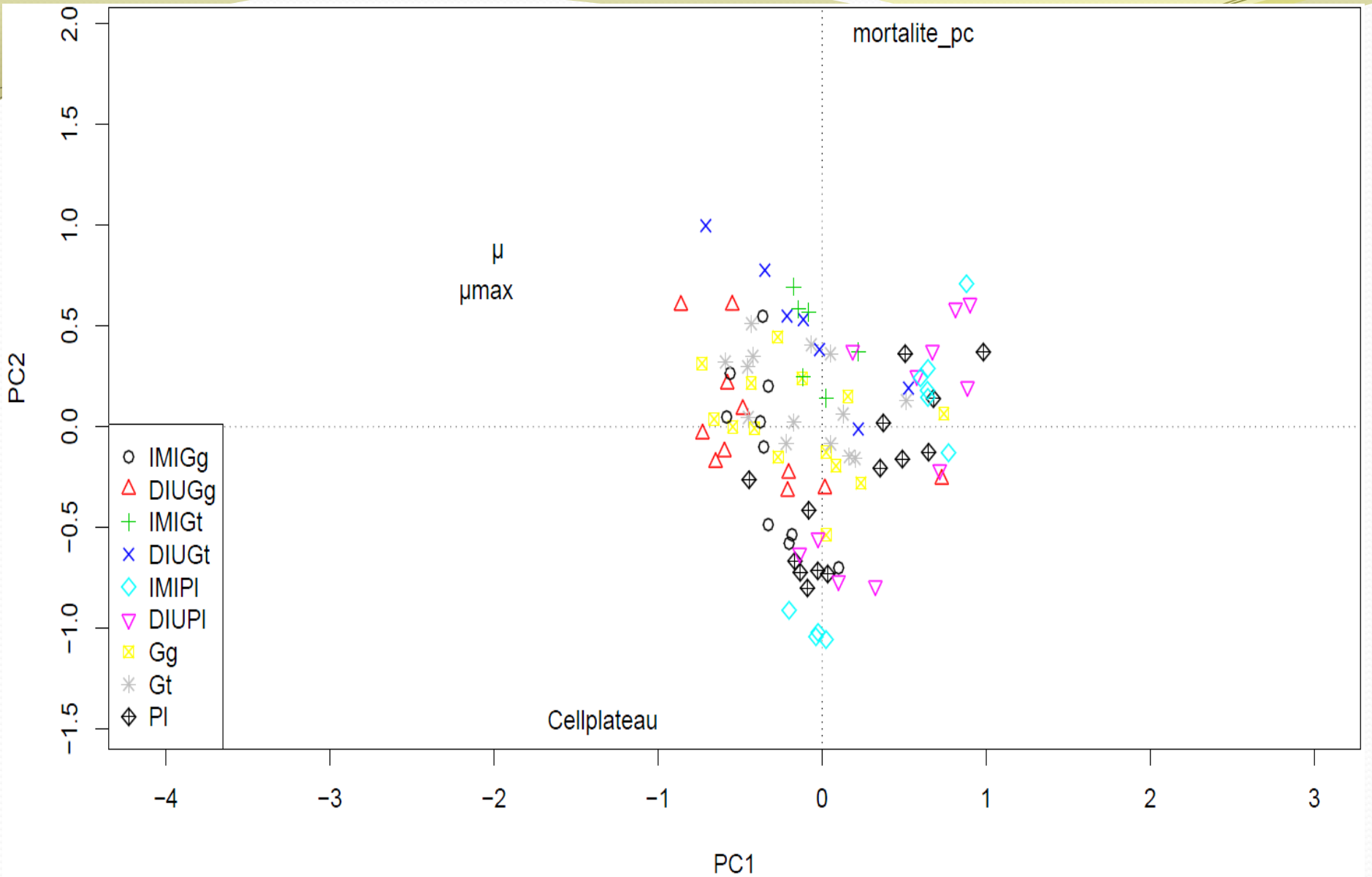




ACP présentant la répartition des points de chaque répliquat en fonction du facteur **Compétition**



ACP présentant la répartition des points de chaque réplicat en fonction du facteur **Nématode**

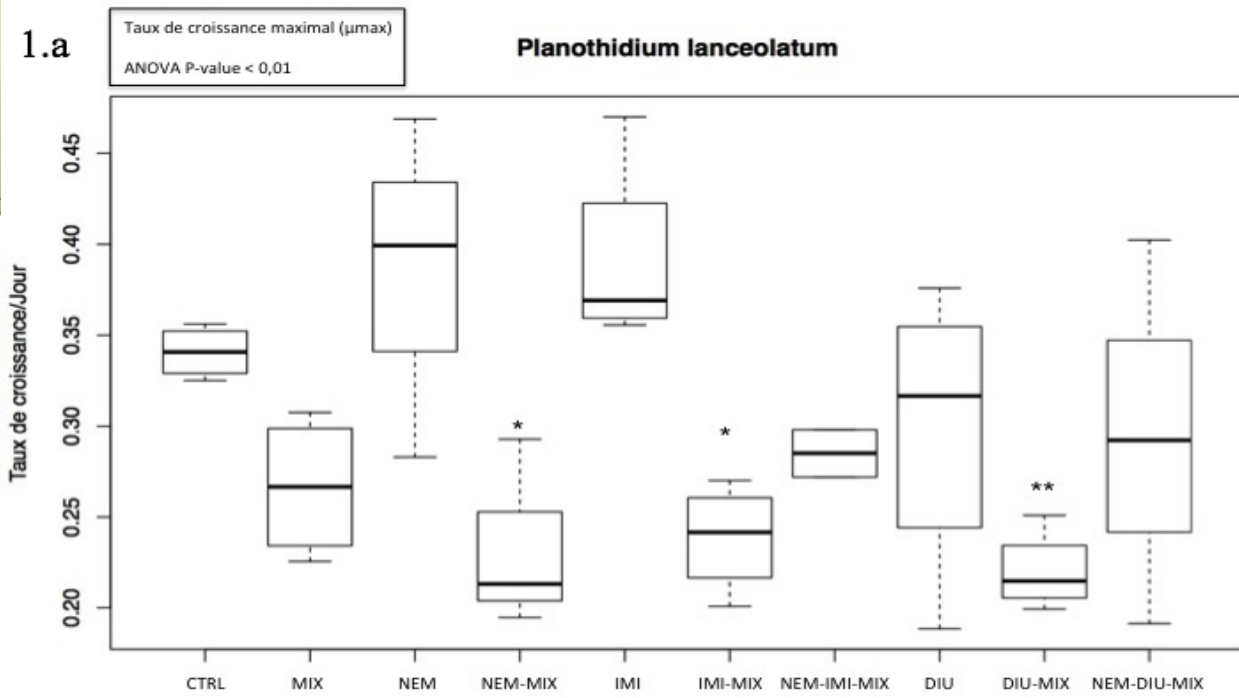


ACP présentant la répartition des points de chaque réplicat en fonction du facteur **Stress chimique**

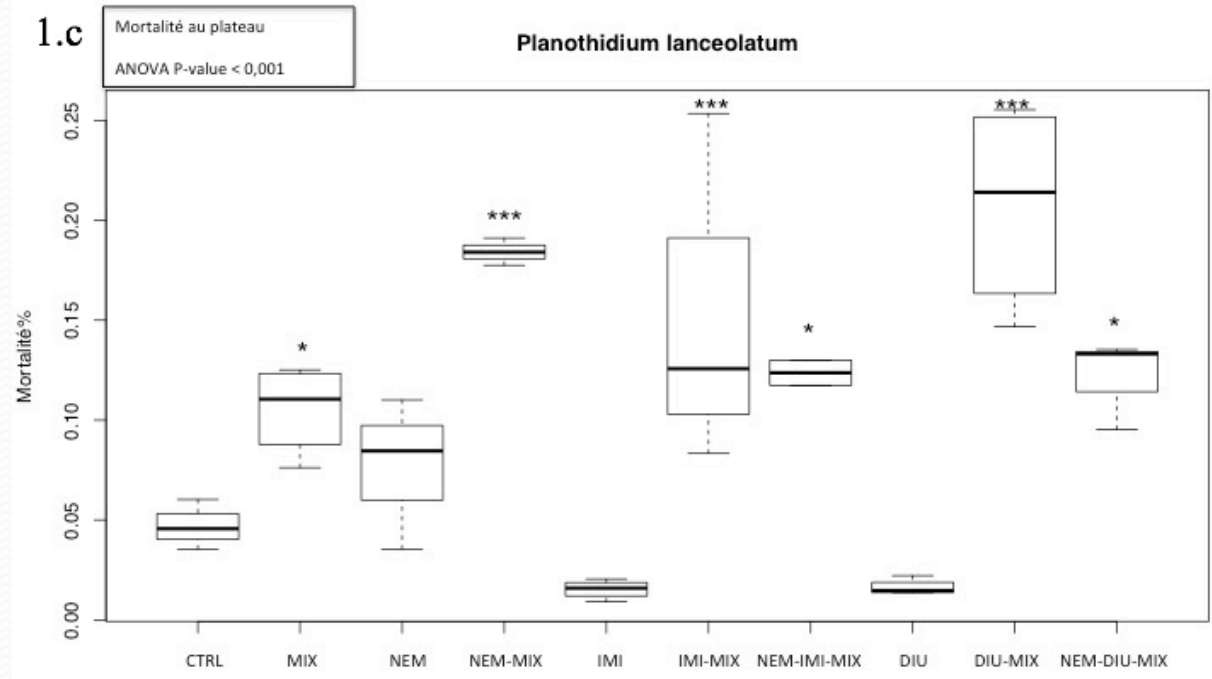
Variable	Facteurs	Variance expliquée	Coefficient estimé	P-value
<i>Planothidium lanceolatum</i>				
μ_{max}	(Intercept)		0,34 ±0,01	***
	Mix Nematodes	41,56 3,63	-0,10±0,02 0,03±0,02	***
μ	(Intercept)		0,34±0,02	***
	Mix	19,279	-0,11±0,02	***
	Imidaclopride Nematodes	13,482 4,607	-0,14±0,03 0,03±0,02	***
	Mix :Imidaclopride	15,249	0,14±0,04	**
Cellplateau	(Intercept)		14±0,1	***
	Mix	87,925	-2,28±0,11	***
	Diuron	2,548	-0,93±0,12	***
	Imidaclopride	0,864	0,28±0,16	,
	Nematodes	0,623	-0,4±0,12	**
	Mix :Imidaclopride Diuron :Nematodes	4,536 9,956	-0,21±0,2 0,69±0,21	*** **
Mortalité-pc	(Intercept)		0,04±0,01	**
	Mix	62,107	0,11±0,02	***
<i>Gomphonema gracile non tératogène</i>				
μ_{max}	(Intercept)		0,47±2 ^{e-16}	***
	Nematodes Mix	17,437 8,675	-0,13±0,004 0,08±0,06	** .
μ	(Intercept)		0,46±0,03	***
	Nematodes Mix	27,317 12,716	-0,17±0,04 0,1±0,04	*** *
Cellplateau	(Intercept)		13,05±0,09	***
	Mix	62,538	-0,2±0,11	.
	Nematodes	12,749	-0,05±0,13	.
	Imidaclopride	3,979	0,06±0,12	.
	Diuron	1,872	0,31±0,12	*
	Mix ;Diuron	3,424	-0,7±0,15	***
	Mix :Imidaclopride Mix ;Nematodes	2,35 3,226	-0,53±0,16 -0,46±0,15	** **
Mortalité-pc	(Intercept)		0,09±0,01	***
	Imidaclopride	18,958	-0,07±0,02	***
	Mix	19,608	0,07±0,02	***
	Diuron	12,259	-0,01±0,02	.
	Mix :Diuron	6,167	-0,06±0,03	*

Variable	Facteurs	Variance expliquée	Coefficient estimé	P-value
<i>Gomphonema gracile tératogène</i>				
μ_{max}	(Intercept)		0,50±0,02	***
	Nematodes	37.807	-0,13±0,03	***
μ	(Intercept)		0,51±0,02	***
	Nematodes	53.757	-0,16±0,03	***
Cellplateau	(Intercept)		13±0,11	***
	Mix	51.113	-0,25±0,15	.
	Nematodes	10.806	-0,21±0,16	.
	Imidaclopride	4.149	-0,71±0,15	***
	Diuron	5.513	-0,74±0,15	***
	Nematodes :Diuron	5.388	0,99±0,23	***
	Mix ;Nematodes Nematodes :Imidaclopride	3.0368 6.233	-0,74±0,23 0,73±0,25	** **
Mortalité-pc	(Intercept)		0,15±0,01	***
	Nematodes	24.871	-0,04±0,01	**
	Mix Diuron	13.428 6.132	0,02±0,02 0,02±0,02	.

1.a



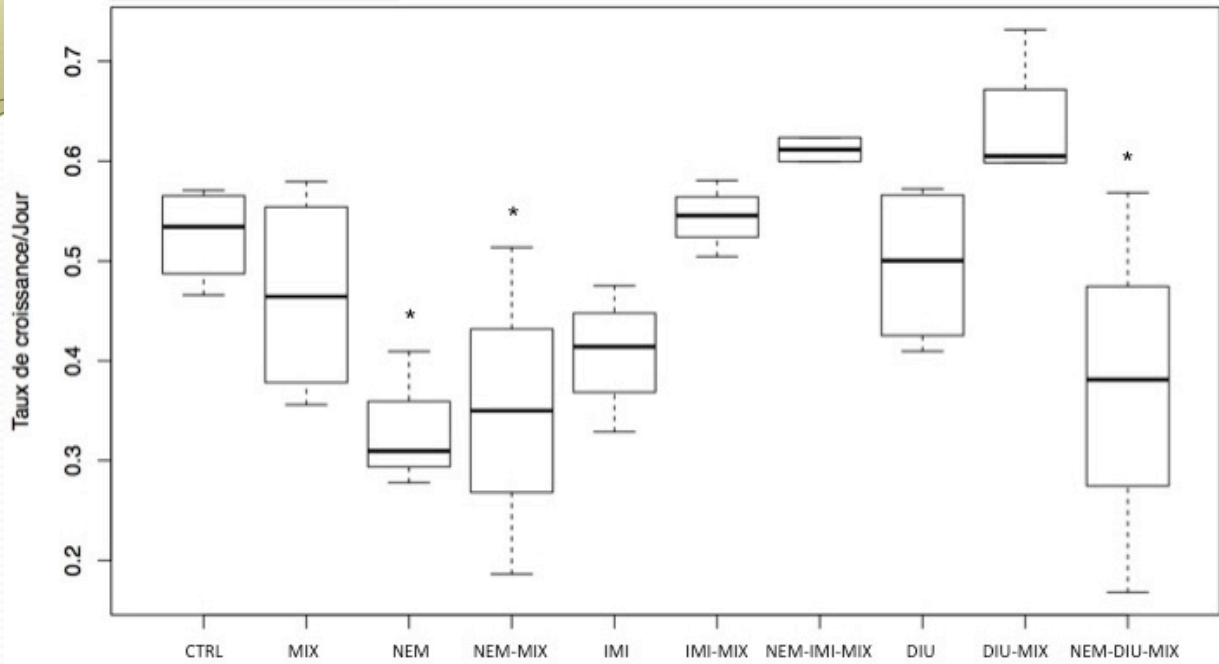
1.c



2.a

Taux de croissance maximal (μ_{max})
ANOVA P-value < 0,01

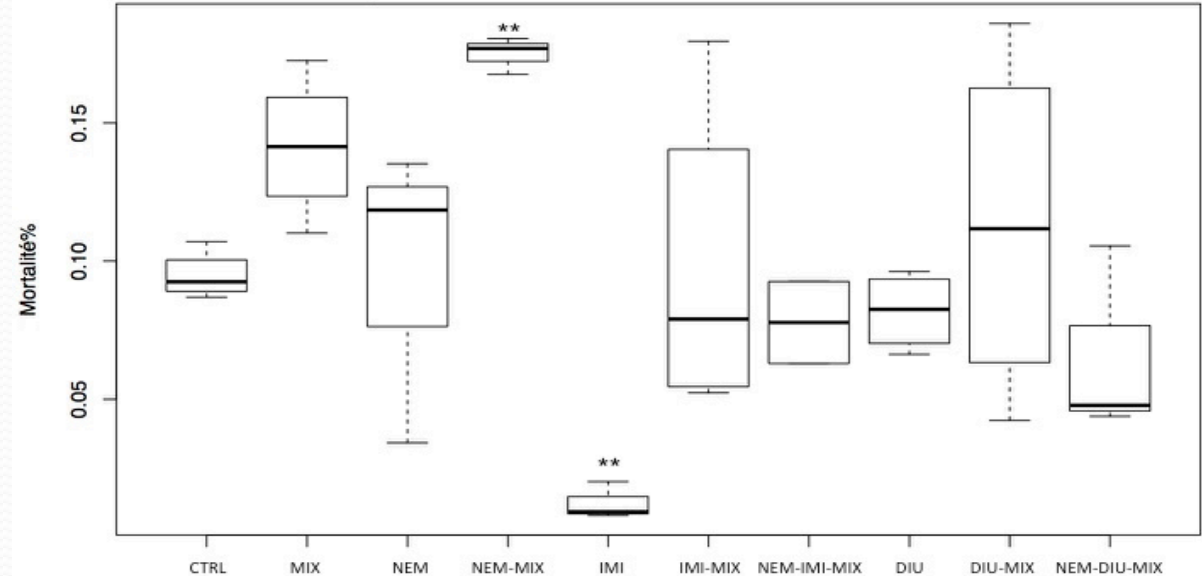
Gomphonema gracile non t ratog ne



2.c

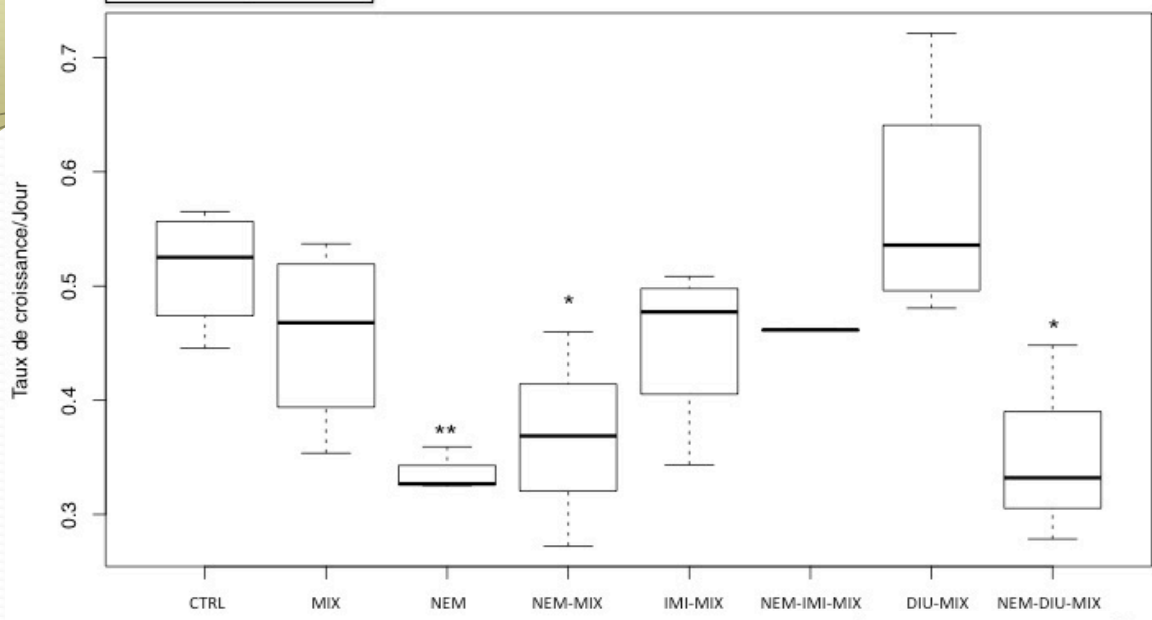
Mortalit  au plateau:
ANOVA P-value < 0,001

Gomphonema gracile non t ratog ne



3.a

Taux de croissance maximal (μ_{max})
ANOVA P-value < 0,01

Gomphonema gracile T ratog ne**3.c**

Mortalit  au plateau
ANOVA P-value < 0,01

Gomphonema gracile T ratog ne