EXPERIMENT PLAN

TOWARDS A URINE–FERTIRRIGATED EDIBLE LIVING GREEN WALL

Author **ALEXANDRA FLORIN & MICHKA MELO**

Date **11.08.2015**

Introduction 3

1 General Experiment Plan 3

2 General Description of First Experiments 4

2.1 Preliminary experiments 4

2.1.1 Nitrification in aqueous media (NA) 4

2.1.2 Odour tests in Grodan (GO) 4

2.2 Nitrification in Grodan 1 (NG1) 4

2.3 Nitrification in Module (NM1) 5

2.4 Nitrification in Module with Aeration (NMA1) 5

2.5 Nitrification in Grodan 2 (NG2) 5

2.6 Nitrification in Bioreactor (NB1) 5

Detailed Plan of Each Experiments 6

3 Nitrification in Grodan 1 6

3.1 Objective 6

3.2 Setup in short 6

3.3 Materials & Budget 6

3.4 Construction 6

3.5 Parameters 6

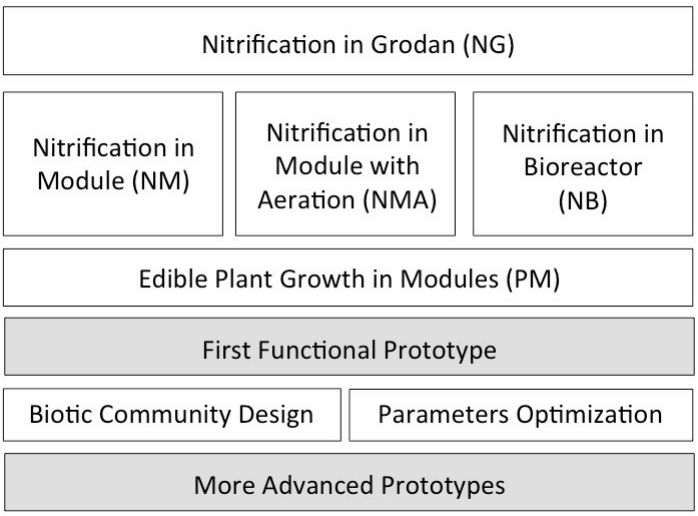
3.5.1 Variables 6

3.5.2 Constants 6

3.5.3 Measures 6

Introduction

1 General Experiment Plan



Function	Related experiment
Beauty, comfort	Odour tests : all Nx (nitrification experiments)
User friendliness / process simplicity	All – aim at simplest + automatic process
Food production	PM, Biotic Community Design
Waste upcycling: nutrients solution from urine	All Nx (nitrification experiments)
Air filtration	NMA, PM if using the biofiltration modules

Our main objective is to quickly obtain a first functional prototype, which could be refined afterwards.
To get to this first stage, we will first focus on two main experiment groups.
First, we will try to set up a stable nitrification process, preferably in the wall modules themselves, to transform ammonium from urine into nitrate, the latter being the most plant-available form of nitrogen.
Secondly, we will try to grow several species of edible plants on this new urine-based nutritive solution.
Next steps after this first prototype include the design of multi-functional & synergetic edible plant ecosystems on the walls, as well as parameters optimization to make the process more efficient.
The figure above sums up the general experiment planning. The table shows the relation between different experiments and the multiple functions of the wall. Before these main blocs, we have started some preliminary experiments. We should keep in mind that this plan may evolve according to the results of the first experiments. For this reason, we haven't detailed too much the later ones.

2 General Description of First Experiments

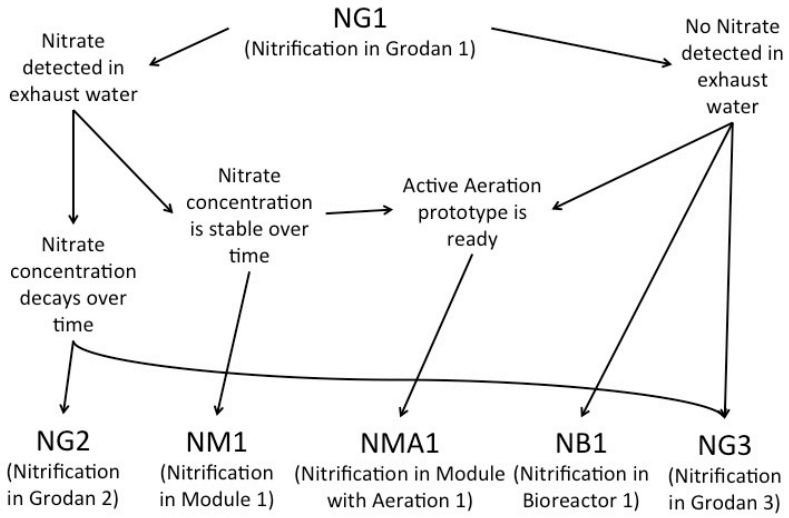
2.1 Preliminary experiments

2.1.1 Nitrification in aqueous media (NA)

The objective of this "preliminary" experiment is to grow a culture of active nitrifying bacteria, adapted to diluted urine. We will us it in priority to inocculate our living wall modules with the suitable microorganisms. It is also an occasion for all project members to get familiar with different processes related to nitrogen conversion.

2.1.2 Odour tests in Grodan (GO)

We expected that working with diluted urine, we wouldn't have odour problems. Experience from nitrification reactors with undiluted reactors (AF) also showed that smell was not a problem in nitrified urine. However while aerating intensely water with some part of urine in NA1, we noticed some smell. For this reason, we will check if the smell is different with less intensive aeration methods, simply by irrigating grodan.



We will then start by experiment NG1, during which we will try to induce nitrification in Grodan, the substrate for plant growth in the wall modules we use. We will move forward to other experiments (NM1, NMA1, NB1, NG2, NG3) depending on the results of NG1. The figure above describes which experiments will succeed to NG1 depending on the obtained results. The next sections explain what are the main objective and measures of each experiment, and in which case we may perform them.

2.2 Nitrification in Grodan 1 (NG1)

The objective of this first experiment is to see if we can induce nitrification in Grodan, the substrate used in our living wall modules.

We will first attempt to induce it by inculating some raw Grodan with nitrifying bacteria, and irrigating it with ammonium-containing diluted urine. We hope to obtain a steady nitrate concentration in water dripping out of the Grodan, showing that nitrification is happening in the substrate, and that nitrifying bacteria are not washed out by irrigation.

2.3 Nitrification in Module (NM1)

If nitrification successfully happened in Grodan during NG1, and if we obtained a stable nitrate concentration over time (days or weeks), we will proceed to this experiment.

The objective of this experiment is to test if nitrification still happens in the full module assembly (with plastic cover) with the same inoculation & irrigation conditions, even though aeration is less optimal.

To assess the strength of nitrification, we will again measure nitrate concentration in water dripping from the module, and analyse its consistency over time.

2.4 Nitrification in Module with Aeration (NMA1)

We will perform this experiment if a stable nitrification was observed during NG1, and if the active aeration prototype is ready.

The objective of this experiment is to test whether the nitrification reaction is stable in the fully-assembled module with active aeration.

We will assess the quality of nitrification occurring in the module by measuring nitrate concentration in the water dripping out of the module, and its consistency over time.

We will also go through this experiment if no nitrate was detected in water dripping from the Grodan during NG1. This may suggest that aeration may be insufficient in raw Grodan for nitrification to occur. This experiment would allow us test if active aeration through Grodan makes the nitrification reaction possible.

2.5 Nitrification in Grodan 2 (NG2)

We will go through this experiment if :

1) no nitrate was detected in water dripping from the Grodan during NG1 ; suggesting that Grodan may not be an appropriate substrate for nitrification.

2) nitrate was detected in water dripping from the Grodan during NG1, but that its concentration was decaying over time.

The objective of this experiment is to induce a nitrification reaction in a module containing dead plant roots, hoping that such a root system may offer a better habitat for nitrifying bacteria than Grodan alone. We use dead plant roots instead of live plants to avoid nitrate being consumed by plants, and therefore not detected in exhaust water.

We will assess the quality of nitrification occurring in Grodan with plant roots by measuring nitrate concentration in the water dripping out of the module, and its consistency over time.

2.6 Nitrification in Bioreactor (NB1)

We will go through this experiment if we did not detect nitrates in water dripping from Grodan during NG1, or if the measured concentration decayed over time. This suggest that we failed to induce a nitrification reaction in Grodan.

The objective of this experiment is to make nitrification happen out of the modules. Urine-sourced ammonium will be transformed into nitrate in a separate container within the irrigation system. We will then irrigate the wall with the obtained nitrate solution.

We will measure the nitrate concentration before irrigation, and in the exhaust water, to make sure that there is no unexpected interaction with the Grodan.

Detailed Plan of Each Experiments

3 Nitrification in Grodan 1

3.1 Objective

The objective of this first experiment is to see if we can induce the transformation of urine-sourced ammonium into plant-edible nitrate (aka nitrification) in Grodan, the substrate used in our living wall modules.

3.2 Setup in short

We will use the linear Grodan racks of our modules as separate samples, each of them being inoculated with nitrifying bacteria, and then watered with a different urine-based irrigation solution. Water dripping from the samples will be collected and chemically analysed with aquariophilic DIY kits.

3.3 Materials & Budget

3.4 Construction

3.5 Parameters

3.5.1 Variables

Irrigation solutions, 5 values :

- Positive control > commercial hydroponics solution
- Negative control > water
- High concentration > 1/10 v/v urine dilution, tbc
- Medium concentration > 1/30 v/v urine dilution, tbc
- Low concentration > 1/50 v/v urine dilution, tbc

3.5.2 Constants

Irrigation :

- Irrigation volume : 100 ml per sample per day (hoping for 10 ml exhaust water for analysis)
- Irrigation frequency : 3 times a day

Inoculation :

- Inoculation method : Bath ? Irrigation ?
- Inoculation time : ?
- Inoculation solution nitrate concentration : ? ([?] is there a link with nitrifyers concentration)

Aeration : passive, through Grodan

Soil : no soil, use rockwool plugs in plant holes

3.5.3 Measures

Concentration of several compounds in water dripping from the samples :

- Nitrate concentration
- Nitrite concentration
- Ammonium concentration