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CLOSING LOOP WITH BIOLOGICAL NITRIFICATION FOR NUTRIENTS RECOVERY AND SURFACTANTS REMOVAL

Melissa conference

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The experiment

Project description and aim

- Urine and grey water preparation on basis of recipe
- Aerobic treatment of mixture of urine and grey water
- Dilution (and modification) of aerobically treated mixture of urine and grey water to meet plants requirements
- Cultivation experiment

AIM: to check what is the stress factor in lettuce cultivation based on nitrified urine and grey water

The experiment

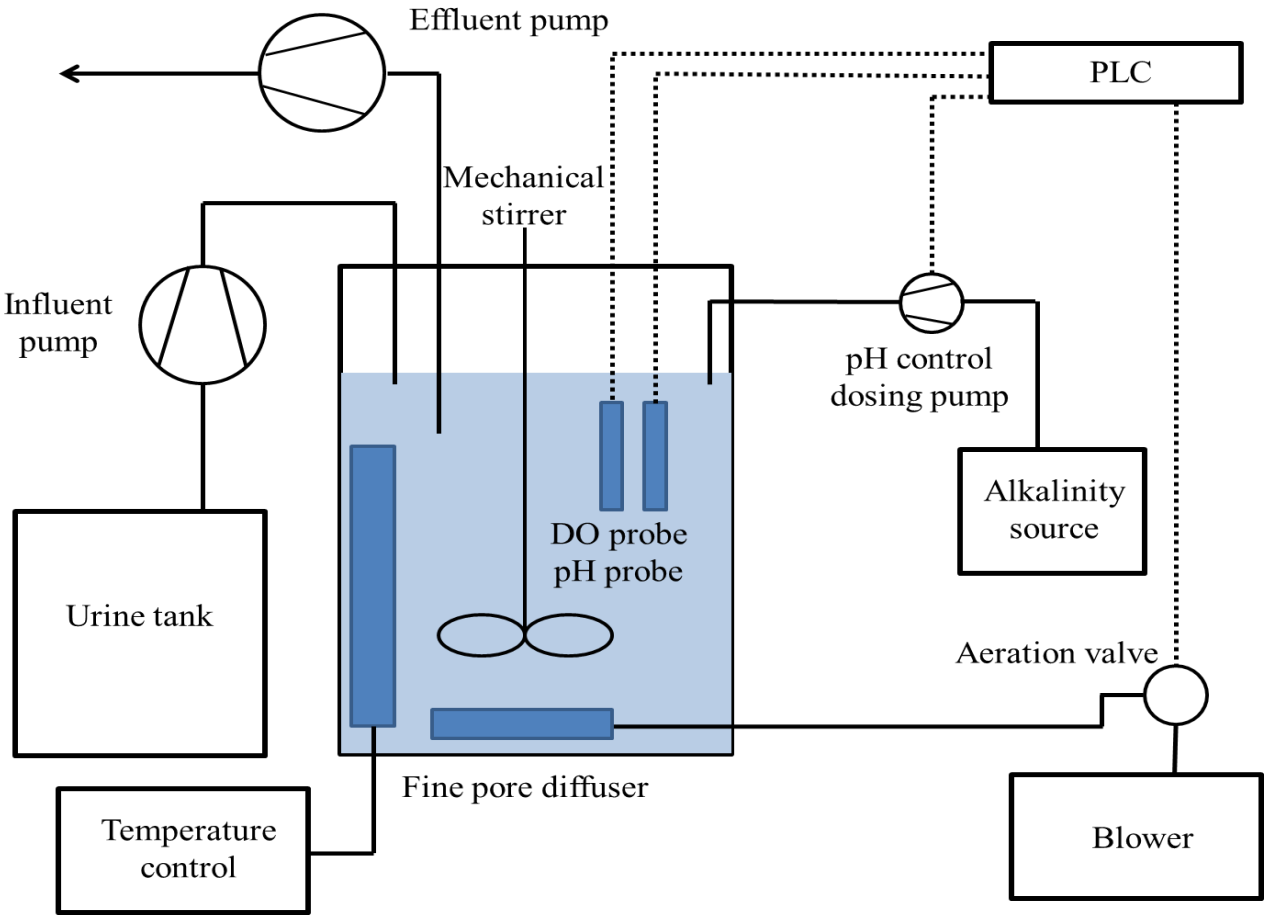
Urine and grey water preparation

- Urine based on Feng and Wu, 2006
- Grey water based on Verostko et al., 2004a
- Final composition obtained assuming 14.38 L/day for grey water, and 2 L/day for urine and flush water (Anderson et al. 2018)

Element		N (mainly N-NH_4)	P	C	Mg	S	Ca	K	Na	Cl	Anionic surfactant SMCT
Concentration	mg/L	644	67	350	16.6	490	125	183.3	260.4	448.8	1760

The experiment

Aerobic treatment - reactor



The experiment

Aerobic treatment - results

Parameter	Unit	Nitrified Urine and Grey water
pH	-	6.5±0.15
EC (electrical conductivity)	$mS \cdot cm^{-1}$	7.98±0.05
N-NO_3	$mg \cdot L^{-1}$	566.0±5
P_{tot}	$mg \cdot L^{-1}$	61.0±0.5
K_{tot}	$mg \cdot L^{-1}$	220.0±2.5
Ca_2+	$mg \cdot L^{-1}$	93.8±1.5
Mg_2+	$mg \cdot L^{-1}$	21.4±0.2
Na+	$mg \cdot L^{-1}$	1490.0±0.5
Cl-	$mg \cdot L^{-1}$	616.0±1.5
S-SO_4^{2-}	$mg \cdot L^{-1}$	497.0±5
Fe	$mg \cdot L^{-1}$	0.2±0.05
Mn	$mg \cdot L^{-1}$	0.2±0.05
Cu	$mg \cdot L^{-1}$	0.2±0.05
Zn	$mg \cdot L^{-1}$	0.2±0.05
B	$mg \cdot L^{-1}$	0.21±0.05
Mo	$mg \cdot L^{-1}$	trace
SMCT	$mg \cdot L^{-1}$	85±5

Comment

- Very high surfactant removal
- Nearly complete nitrification
- High conductivity due to Na^+ excess
- Moderate pH

The experiment

Nutrient solution composition

Parameter	Unit	Module 1 NUG	Module 2 NUGE	Module 3 HS	Module 4 RCF
pH	-	7.21±0.15	6.2±0.15	5.61±0.15	5.71±0.15
EC (electrical conductivity)	$mS \cdot cm^{-1}$	2.96±0.05	3.22±0.05	2.02±0.05	2.15±0.05
$N\text{-}NO_3$	$mg \cdot L^{-1}$	210.0±5	223.0±5	214.0±5	219.5±5
P_{tot}	$mg \cdot L^{-1}$	23.0±0.5	43.0±0.5	30.7±0.5	50.2±0.5
K_{tot}	$mg \cdot L^{-1}$	82.0±2.5	265.0±2.5	238.0±2.5	299.7±2.5
Ca_2+	$mg \cdot L^{-1}$	35.0±1.5	80.0±1.5	204.4±1.5	219.8±1.5
Mg_2+	$mg \cdot L^{-1}$	8.0±0.2	48.0±0.2	24.0±0.2	16.9±0.2
Na+	$mg \cdot L^{-1}$	554.0±0.5	497.0±0.5	0.002±0.5	0.0±0.5
Cl-	$mg \cdot L^{-1}$	229.0±1.5	205.0±1.5	0.0±1.5	0.0±1.5
$S\text{-}SO_4^{2}$-	$mg \cdot L^{-1}$	185.0±5	221.0±5	32.1±5	22.8±5

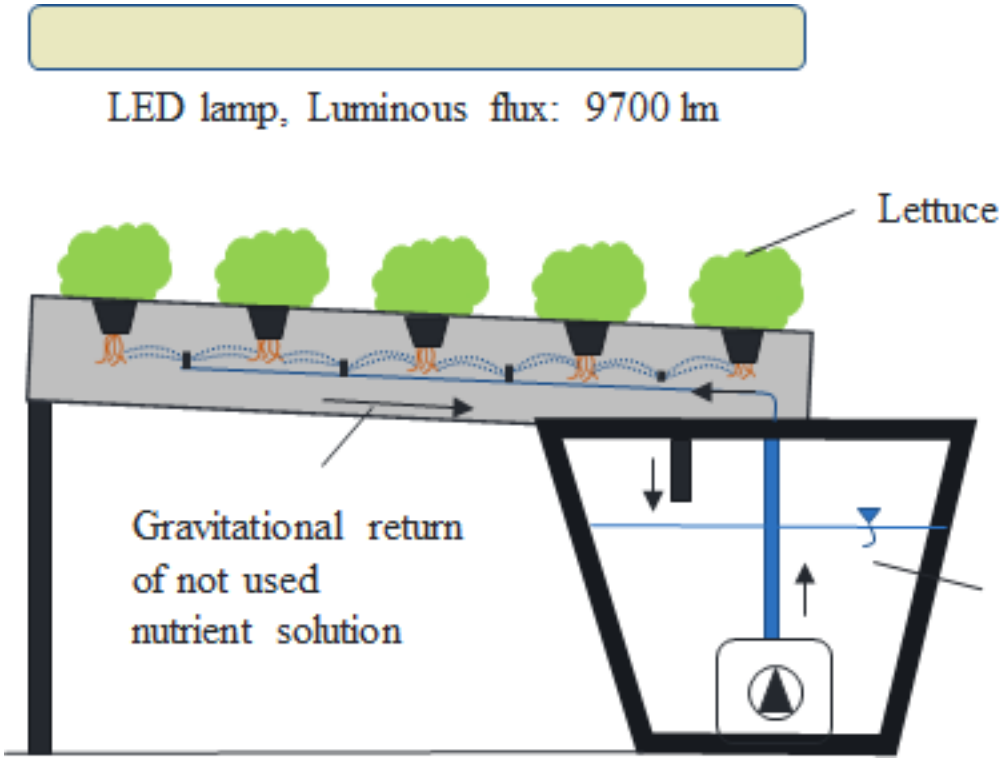
The experiment

Nutrient solutions composition

Parameter	Unit	Module 1 NUG	Module 2 NUGE	Module 3 HS	Module 4 RCF
Fe	mg·L^{-1}	0.07±0.05	1.80±0.02	4.19±0.02	2.30±0.02
Mn	mg·L^{-1}	0.07±0.05	0.77±0.05	0.50±0.05	1.40±0.05
Cu	mg·L^{-1}	0.07±0.05	0.22±0.05	0.0006±0.05	0.100±0.05
Zn	mg·L^{-1}	0.07±0.05	0.08±0.05	0.0006±0.05	0.300±0.05
B	mg·L^{-1}	0.08±0.05	0.42±0.05	0.055±0.05	0.400±0.05
Mo	mg·L^{-1}	trace	0.06±0.05	0.005±0.05	0.400±0.05
Anionic surfactant SMCT	mg·L^{-1}	31± 5	26.3± 5	0	0

The experiment

Cultivation



Comment

4 experiments
10 plants per experiment
16 hours of light/d

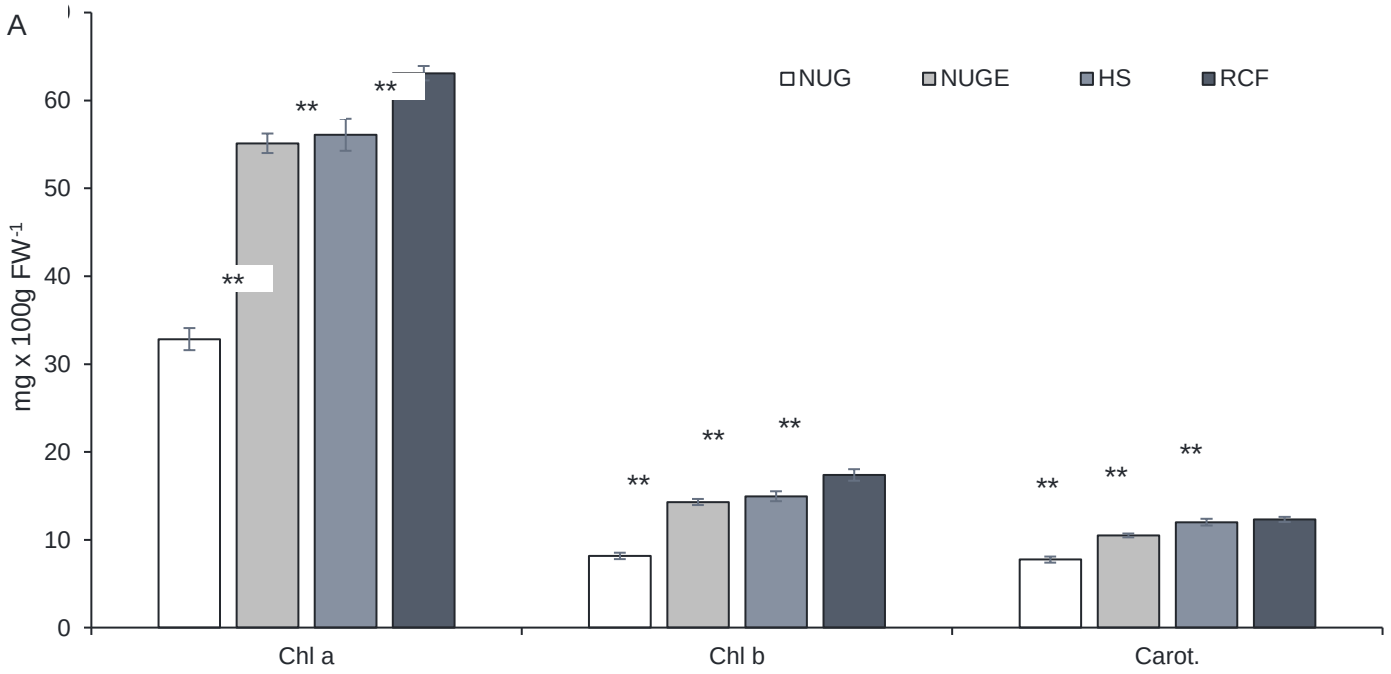
The experiment

Cultivation results - yield

Module number	Leaf		Stem		Roots		Harvest index	Edible to Inedible ratio
	FM	DM	FM	DM	FM	DM		
	g·plant^{-1}	%	g·plant^{-1}	%	g·plant^{-1}	%	%	-
Module 1 NUG (N=10)	25.69±6.47	4.68±0.12	4.18±1.05	8.72±0.21	9.68±2.57	2.85±0.03	75±4	3.22±1.05
Module 2 NUGE (N=10)	34.65±11.72	5.43±1.20	5.64±1.91	8.93±0.04	11.45±3.17	2.81±0.06	77±3	3.51±0.67
Module 3 HS (N=9)	36.08±5.01	4.96±0.02	5.87±0.82	8.95±0.04	11.49±1.28	2.82±0.03	78±2	3.66±0.35
Module 4 RCF (N=9)	33.7±8.22	4.83±0.04	5.49±1.34	8.86±0.06	9.06±2.35	2.59±0.03	81±1	4.35±0.38

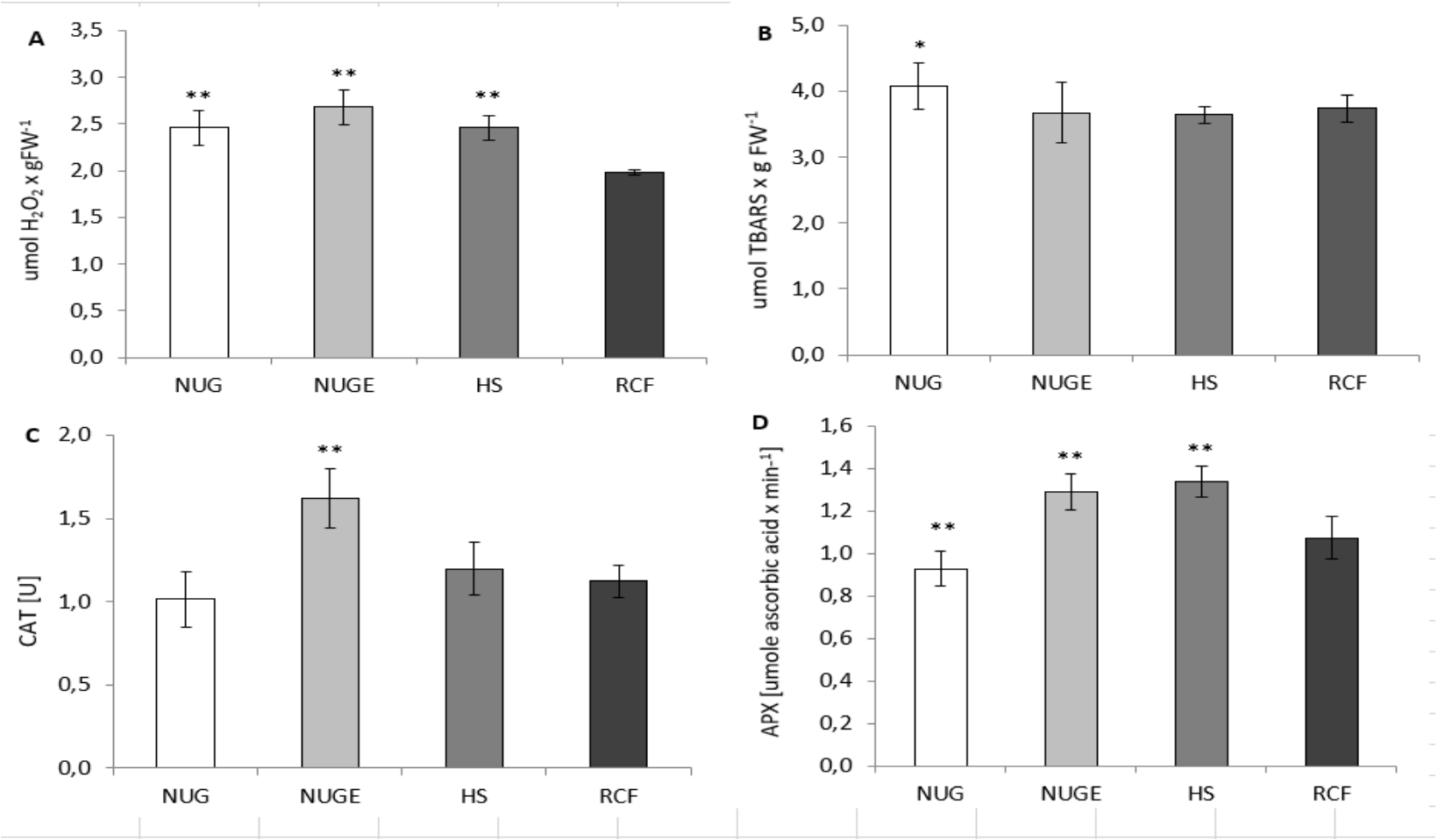
The experiment

Results – chlorophil and carotenoids content



The experiment

Results – stress parameters



The overall results

Nutrient defficiency rather than stress due to surfactant presence is the main factor of lower crops in nitrified urine and greywater cultivation

Literature

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