Yield and nutritional quality of lettuce as affected by bio-based fertilizers application : A field study

L. F. KEBALO, S. HOUOT, P. Garnier, L. VIEUBLE

Hertogenbosh, May 12th, 2022

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.860127"

Content

- **Introduction**

✓ Context

✓ Objective/Hypothesis

- **Material and method**

✓ Field experiment

✓ Incubation

- **Results and discussion**

✓ Composts and manure mineralisation

✓ Lettuce yield

✓ Heavy metals uptake

✓ Pathogens transfer

- **Conclusion**

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.860127"

Introduction | Material and method | Results and discussion | Conclusion

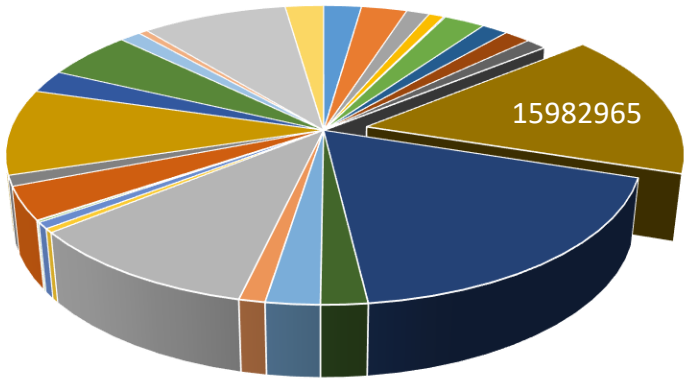
FertiCycle

High quantities of bio-waste generated

Human urine in urban and peri-urban areas with separate collection promoted (Tristan et al., 2022)

Other wastes: greenwastes, manure..

Potential bio-waste generation per EU Country (tons/year)



AUSTRIA, BELGIUM, BULGARIA, CROATIA, CYPRUS, CZECHIA, DENMARK, ESTONIA, FINLAND, **FRANCE**, **GERMANY**, GREECE, HUNGARY, IRELAND, ITALY, LATVIA, LITHUANIA, LUXEMBOURG, MALTA, NETHERLANDS, NORWAY, POLAND, PORTUGAL, ROMANIA, SLOVAKIA, SLOVENIA

Bio-waste

- EU: Directive (EU) 2018/851: separate collection by January 2024.
- France : Separate collection by December 2023

(European Commission, 2019)

Peri-urban agriculture

Arable crops | Market gardening

- ✓ Sustainable agriculture
- ✓ Circular economy: EU policies
- ✓ Recoupling cities with agriculture
- ✓ Reduction of chemical fertilizer use (*high cost , energy and gaz consuming, from non renewables resources,P K*)
- ✓ Necessity for organic farming

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.860127"

Concerns about effectiveness ,heavy metals and pathogens when using these BBF under vegetables

- Overall aim

Assess the agronomic impacts of bio-based fertilizers (BBF) under lettuce production

- Hypothesis

Use of BBF could lead to similar or more interesting yield and nutritional characteristics of lettuce than synthetic fertilizer (SF)

BBF would not lead to significant heavy metals or pathogens concerns on harvested lettuce

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.860127"

FertiCycle

- **Field experiment**

Amendment value *Fertilizing value*

9 treatments * 3 rep

GWC-SF
GWC-HU
GWC-D
FWC-SF
FWC-HU
FWC-D
MAN-SF
SF
Control

Mixed to 15 cm layer

Compost/manure: 3-4 tC/ha

Mineral N +
Assumed N mineralized

Min. N : SF, HU, D

Lettuce (Batavia)

120 kg N/ha

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.860127"

FertiCycle

• Field experiment

Assessed parameters

- ✓ DM yield at day 50 subsequent to BBF application
- ✓ N,P,K, Ca, Mg, nitrate content
- ✓ Heavy metals
- ✓ Pathogens

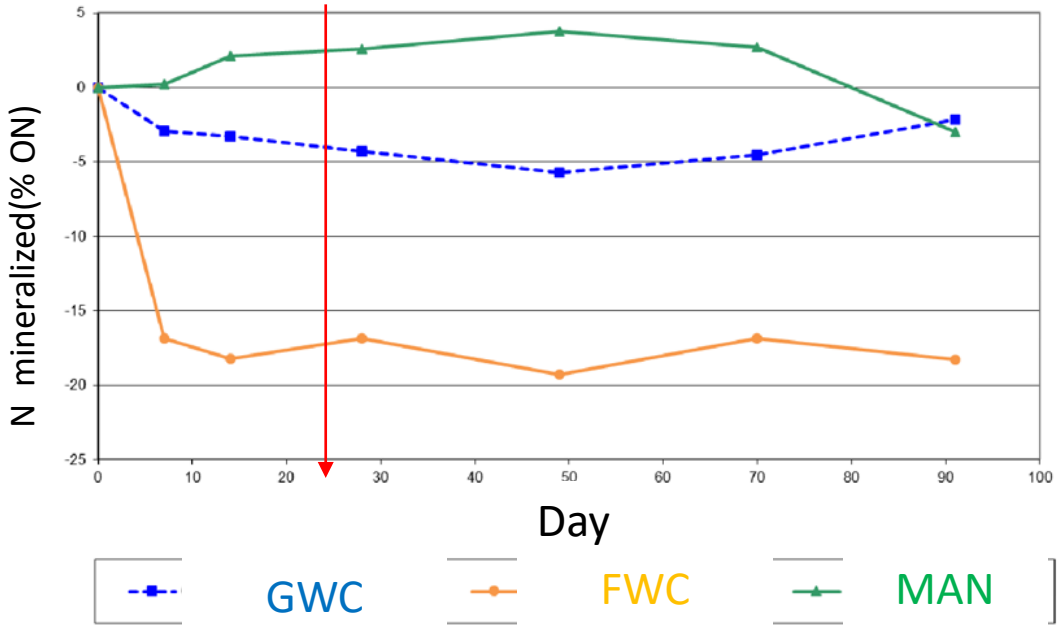
Check of the assumed composts and manure mineralized N

• Incubation in lab

- Application of ground composts or manure
- Measurements at different time of the mineral N
- Incubation conditions : 28 °C, humidity pF=2.5

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.860127"

Composts and manure mineralisation



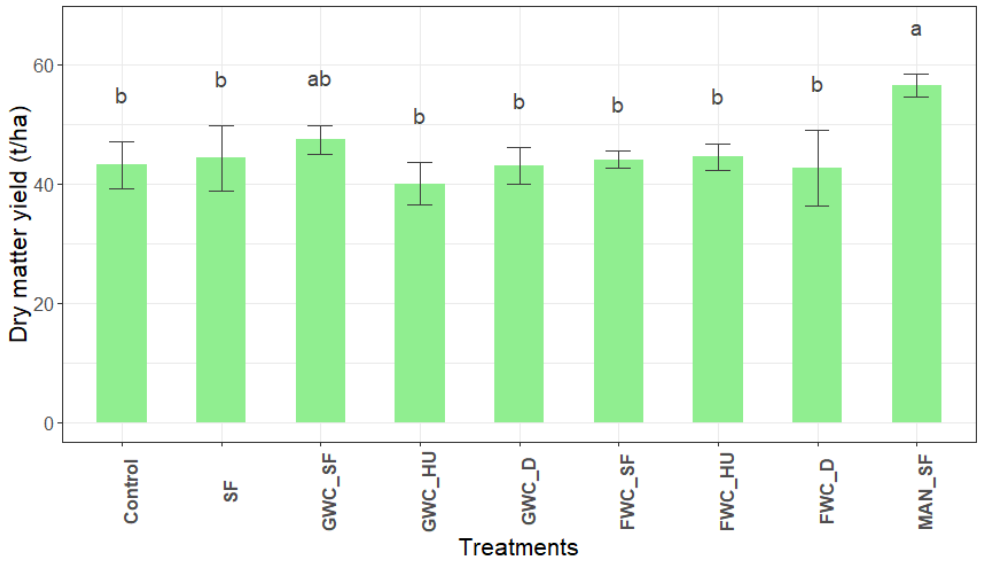
Amendments	GWC	FWC	MAN
C/N	18	14,73	12,3

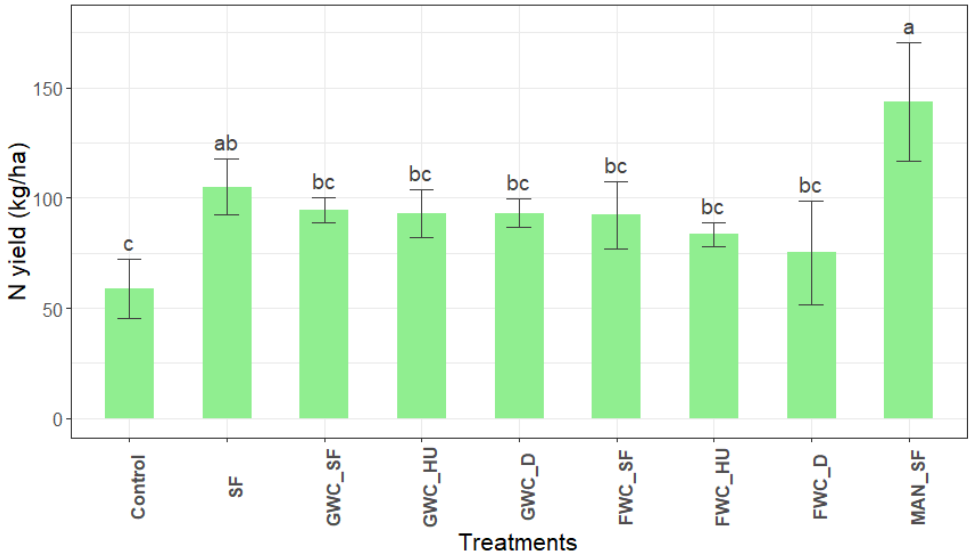
- Immobilisation FWC # mineralization of 11,2 % ON.
- Immobilisation GWC#0 % assumed
- Cow manure : 4% ON min, # 10% ON assumed

Actual applied BBF

Treatments	N mineral (amendment + fertilizer) (kg/ha)	N mineralized_50d (kg/ha)	Mineral N on growing period (kg/ha)
Control	0	0,00	0
SF	120	0,00	120
GWC-SF	118	-5,7	112
GWC-D	117	-5,7	111
GWC-HU	106	-5,7	100
FWC-SF	68	-31,8	37
FWC-D	68	-31,8	36
FWC-HU	63	-31,8	31
MAN-SF	79	7,4	86

- **Lettuce dry matter and N yield**

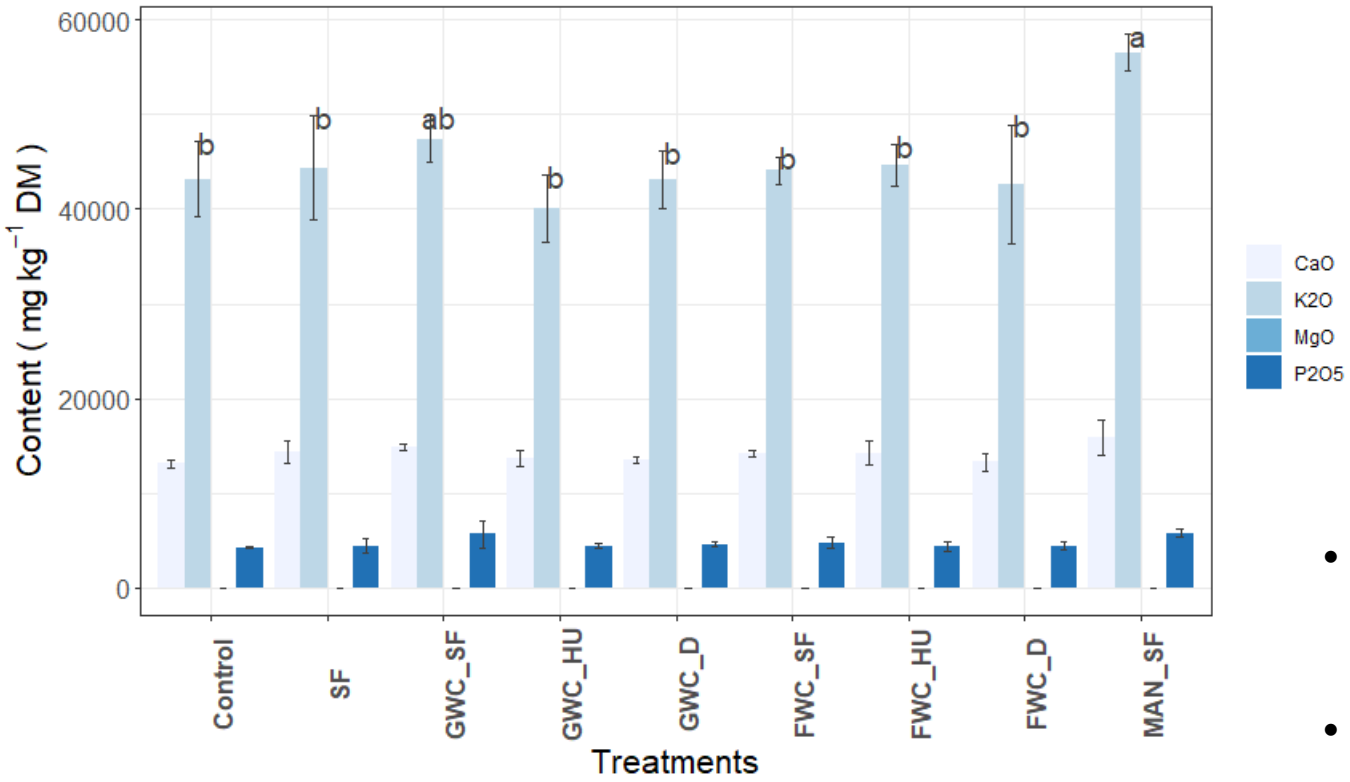


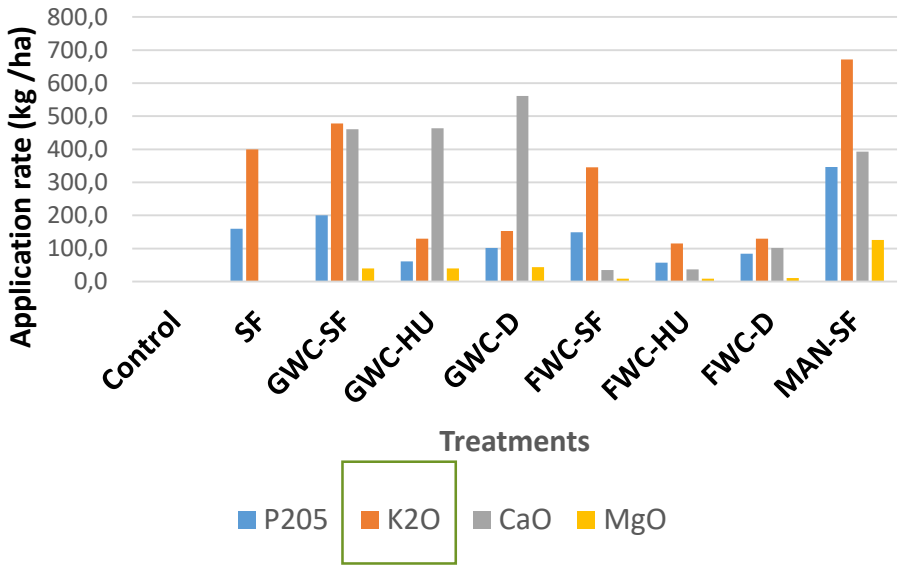


- ✓ Highest DM, N yield with manure + mineral fertiliser
- ✓ Limiting factors? No significant difference between treatments yield P_2O_5, K_2O, CaO, MgO
- ✓ Progressive release of N from manure allowed better uptake?

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.860127"

- Lettuce properties

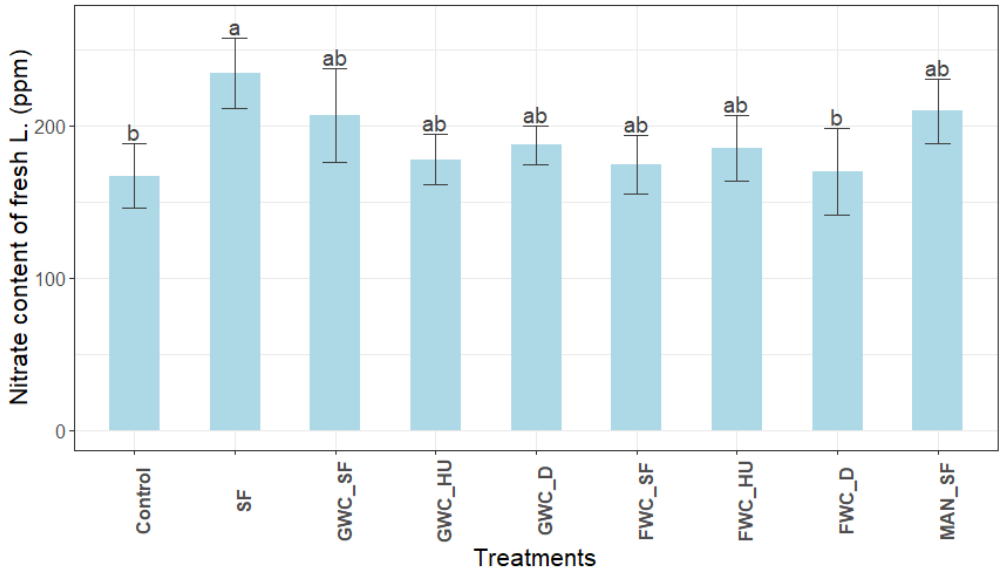




- Higher K content in plot fertilised with MAN-SF and GWC-SF probably due to the higher K_2O application
- P_2O_5, CaO, MgO did not differ

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.860127"

Effect of Bio-based fertilizers on nitrate and Cd content and other heavy metals



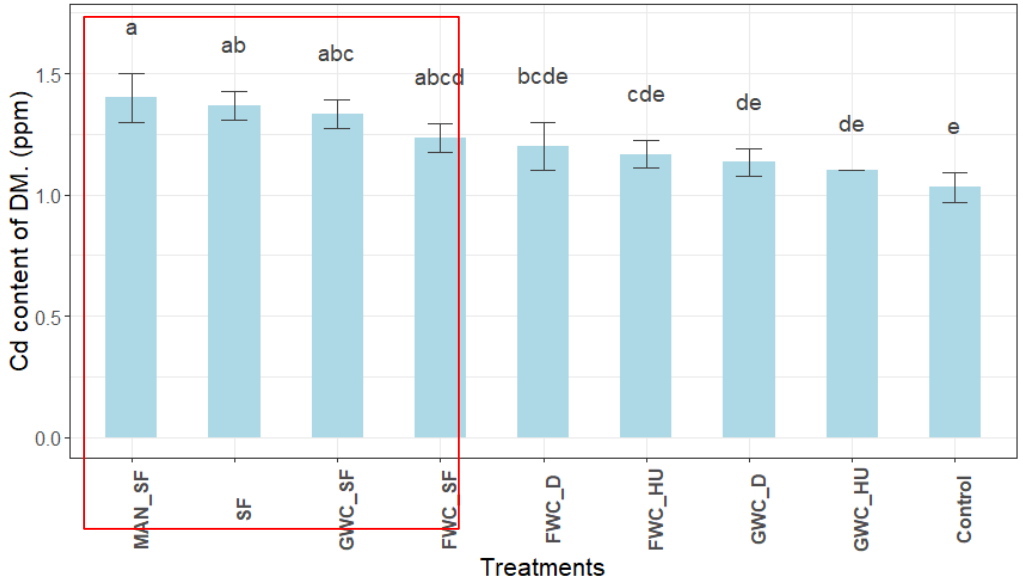
Below the limit of 3000 ppm

Trend of highest nitrate content with SF : more availability of nitrate from NPK (Antonious et al. ,2019)

Below the limit for Cd, Cr, Hg, Ni, Pb

Higher content with SF:

- Potential presence of Cd in NPK fertiliser (Mortvedt et Beaton, 1995)?



FertiCycle

- Pathogens on lettuce

harversted lettuce pathogens	All the treatments
37 °C coagulase positive Staphylococci	<100
Clostridium perfringens	<10
Salmonella in 25 g	Not detected
Listeria monocytogenes in 25 g	Not detected

✓ Temperature , solar radiation, humidity probably influenced the viability of pathogens (Picard-Bonnaud et al., 1989; Jiang et al., 2004, Oliveira et al., 2011)

Pathogens in the applied products	Greenwaste compost	Food waste compost	Manure	Digestate	Human urine	Limits (NF U 44-051)
Escherichia coli	<100	<100	< 400	< 100	< 100	< 1000 /g
Clostridium perfringens	<40	<10	> 15 000 ✖	50	<10	<10/g
Faecal enterococci	2862	94489 ✖	2567	965	129	< 10000 npp/g
Salmonella	Absent	Absent	Absent	Absent	Absence	Absent/ 25g
Listeria monocytogenes in 25 g	Absent	Absent	Absent	Absent		Absent/25g
Viable helminth	Absent	Absent	Present ✖	Absent	Absence	Absent/1,5g

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.860127"

Assessment of BBF on lettuce productivity and quality in open-field

- Highest DM and N yield recorded with MAN-SF
- FWC led to high N immobilization: need to characterize the new food waste compost produced with electromechanical processing.
- Heavy metals and nitrate below the limits in all treatments
- No Pathogen's harm observed with BBF in the cultivation period
- Pharmaceuticals ??

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.860127"

Thank you for your attention

@: lelenda-florent.kebalo@inrae.fr

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.860127"