LIÈGE université Gembloux Agro-Bio Tech

Plant Sciences axis

« Current ecotron experiment »

SEA2LAND

Bio-based fertilisers for the food of the future – from fishery waste to growing organic broccoli in the year 2095

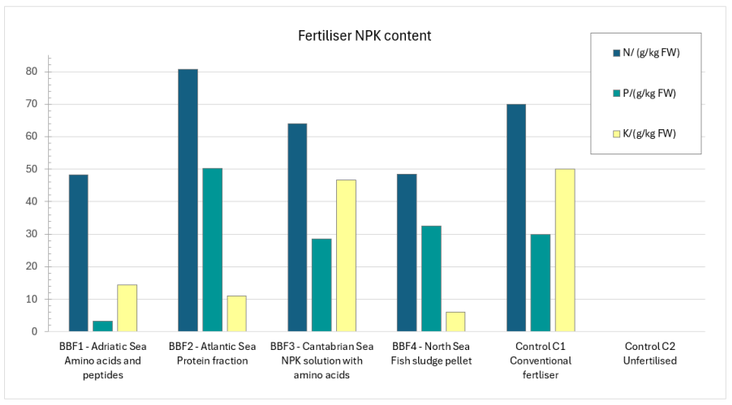
Lucas Bergenhuizen, Pierre Delaplace, Cécile Thonar, Florian Vanden Brande, Jimmy Bin, Caroline De Clerck, Jérôme Pierreux, Jingsi Zhang, Çağrı Akyol, Marta Aranguren Rivas, Bente Føreid, Hervé Vanderschuren, Vincent Leemans & Jennifer Michel

SEA2LAND

The **SEA2LAND project** is a 4-year collaborative Innovation Action funded by the Horizon2020 programme of the European Union that aims to provide **solutions to overcome challenges related to food production, climate change and waste management.** Based on the circular economy model, the project **promotes the production of large-scale bio-based fertilisers (BBFs) from fishery by-products** in different areas representative of the European fisheries sectors **to help reduce the soil nutrient imbalance in Europe**. A series of studies are underway to investigate the effects of these BBFs on local crops, as well as their **impact on soil functionality and environmental sustainability**. Eventually, **the BBFs will partially replace imported nutrients for agriculture in Europe**.

https://sea2landproject.eu/

BBFs composition



Four BBFs representative of **four European fisheries sectors** were selected and characterised in terms of their NPK content. Their formulations include two solids (BBF2&4), one liquid (BBF3) and one slurry (BBF1). As a point of comparison, a conventional liquid fertiliser close to the nutritional values of the BBF was applied. Unfertilised plants are also present as an additional control.

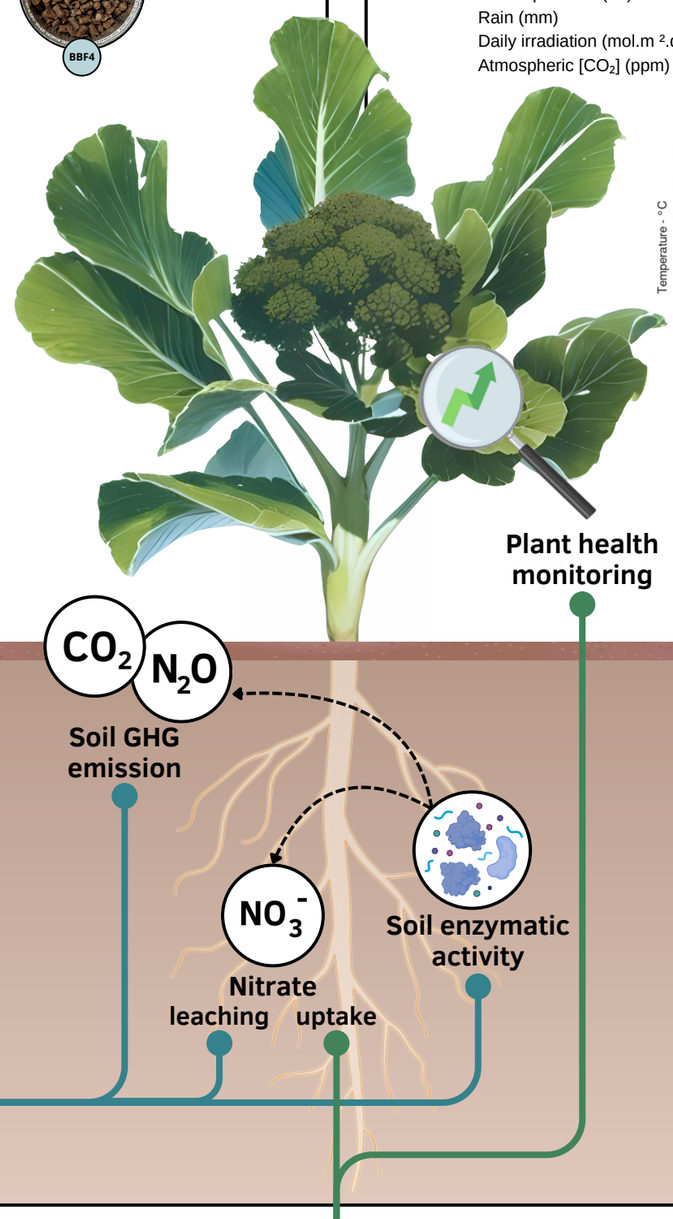
Local field conditions

An ecotron experiment complements previous field trials carried out across Europe to evaluate BBF efficiency under climate change. Intact **undisturbed soil monoliths** were sampled in an arable field at the experimental farm of Gembloux Agro-Bio Tech (50°33'54.8104"N, 4°42'9.9349"E). Prior to the start of the experiment, the **soil was biochemically characterised** to adjust the amount of fertilisers to be applied to reach a final equivalent of **120 kgN/ha** for all treatments.

Experimental design

1981-2017	2095
C1 BBF3 BBF2	BBF4 BBF3 BBF2
BBF1 BBF4 BBF1	BBF2 C1 C1
C1 BBF3 BBF2	C2 BBF4 BBF3
C2 BBF3 BBF2	C1 BBF2 BBF4
BBF1 C1 C1	BBF4 BBF1 C2
BBF3 BBF1 BBF4	BBF2 BBF1 BBF3
BBF4 BBF1 BBF2	BBF1 C1 BBF1
BBF3 C2 BBF4	BBF3 BBF3 BBF4
BBF4 BBF2 C1	C1 BBF2 BBF1

The **five replicates per treatment (BBF x climate)** were equally distributed amongst the controlled environment rooms (CERs) in a completly **randomised block design**.



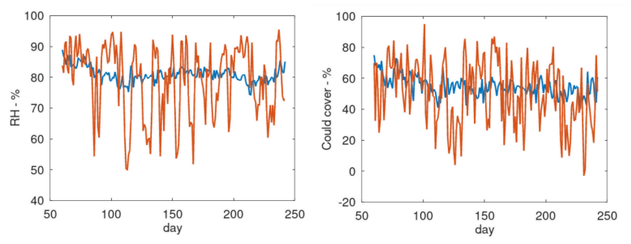
Climate change

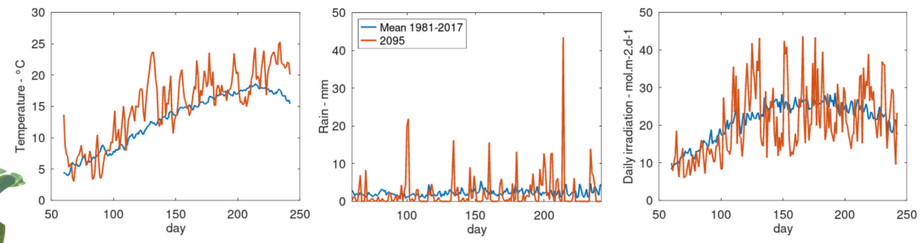
Can bio-based fertilisers be an effective alternative for crop nutrition in the present and the coming decades ?

The ecotron facility of Gembloux Agro-Bio Tech can simulate any climatic conditions based on sufficient meteorological data. In the framework of this experiment, the smoothened mean of historical climate data of **the period 1981 to 2017 was chosen as a control environment** that provides the optimum growing conditions for the fertilisers to reach their maximum potential. These conditions are compared to a simulated future climate projection using the Alaro-0 model (Giot et al., 2016) based on the RCP (Representative Concentration Pathway) 8.5 Wm^{-2} scenario (IPCC, 2014). The chosen period provides **weather predictions for the year 2095** in Belgium, where crops will have to cope with a significant increase in temperature and atmospheric CO_2 concentration, as well as more extreme precipitations.

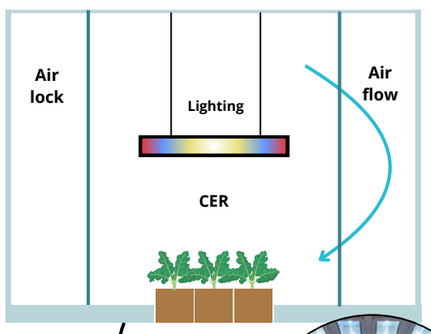
Climate conditions

Means	1981-2017	2095
Relative Humidity (%)	81,0	79,9
Cloud cover (%)	54,8	51,0
Air temperature (°C)	12,9	15,4
Rain (mm)	2,23	2,20
Daily irradiation (mol.m ^{2}.d $^{-1}$)	21,4	20,8
Atmospheric [CO_2] (ppm)	415	775





A closer look at the climate chamber



Measured variables

- Irradiation (µE(PAR) m ^{2} s $^{-1}$)
- Rain event volume (l)
- Air temperature (°C)
- Air relative humidity (%)
- [CO_2] (ppm)
- [N_2O] (ppm)
- Soil [NO_3^-] (ppm)
- Soil matrix potential (kPa)
- Soil temperature (°C)
- Volumetric soil moisture content (vMC%)

Environmental impact

How do the BBFs impact greenhouse gas emissions and nitrate leaching ?

- **To evaluate the environmental sustainability** of these innovative BBFs, the **leaching of nitrates (NO_3^-)**, a potential pollution factor, and **greenhouse gas emission (CO_2 and N_2O)** are measured weekly during plant development.
- In addition, Fluorescein Diacetate (FDA) activity is measured as a **proxy of total soil microbial activity** for the different BBF treatments and climate scenarios over time.

Efficiency assessment

- **To assess fertiliser efficiency over time**, several plant health and performance parameters are measured, such as: the **Nitrogen Balance Index** (NBI), **chlorophyll fluorescence** (Fv/Fm)**, leaf surface area** and **BBCH growth stages.**
- Once the harvesting stage is reached, above and below ground biomass are determined and crop **Nitrogen Use Efficiency** (NUE) is estimated. **Marketable yield** is quantified on the basis of the diameter of the broccoli heads.
- **To assess post-harvest nutrient dynamics** in the cropping system, **spinach will be sown as a follow-up crop** and the uptake of remaining N and P will be quantified, together with biomass production.

Crop model evaluation

In the framework of this experiment, two **crop models** are being tested.

DSSAT → **Decision Support System for Agrotechnology Transfer**

- To predict crop growth stages and yield

DNDC → **DeNitrification-DeComposition**

- To predict carbon and nitrogen dynamics

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