Boosting Nutritional Power: How Organic Amendments Enhance a Traditional Cabbage Cultivar's Health Benefits

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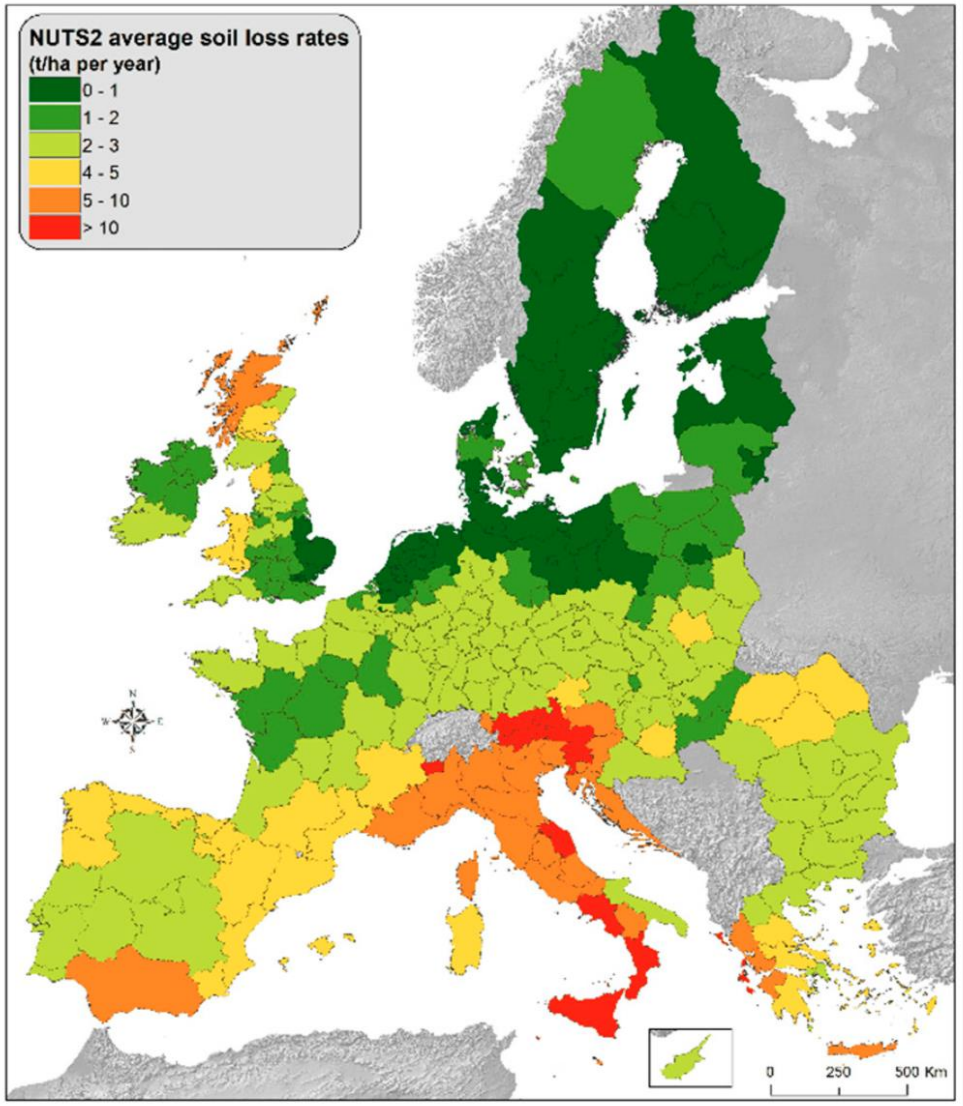
Universitat de Barcelona

Outline

- Introduction
- Aims and hypotheses
- Experimental design & methods
- Results & discussion
- Conclusions

Soil loss rate by water erosion in the EU

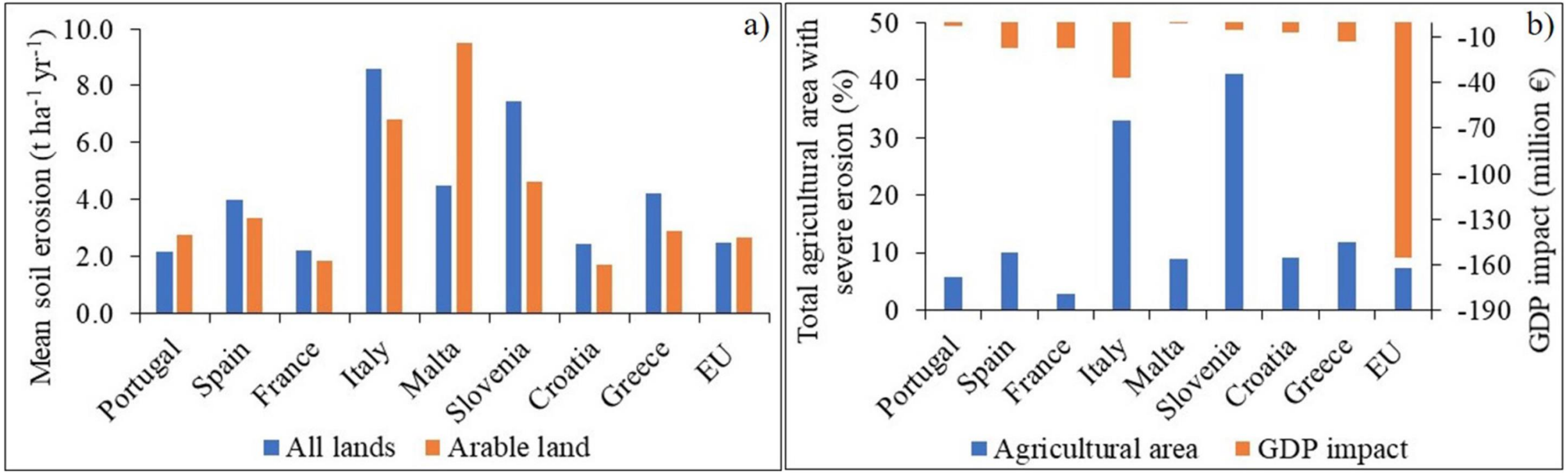


SOIL EROSION

- Organic matter and nutrients
- Biodiversity
- Long-term productivity

Panagos et al. 2020. *Remote Sensing*

Soil erosion and total agricultural area with severe erosion in the EU



Ferreira et al. 2022. Sci Tot Environ

Conventional agriculture

- Tilling
- Uses chemicals (*i.e.* pesticides & fertilisers)
- Prioritises yield over the environment
- No weed (*i.e.* no plant cover)

Nitrogen inputs through mineral fertilisers lead to eutrophication and acidification in 65-75% of EU agricultural areas

European Comission, 2020

83% of European soils are contaminated with pesticide residues

European Comission, 2020

14.1% of groundwater stations in EU exceed the maximum allowable NO_3 concentration of 50 mg NO_3/l and the average nitrate concentration is of 21 mg NO_3/l

European Environment Agency, 2019

Organic agriculture

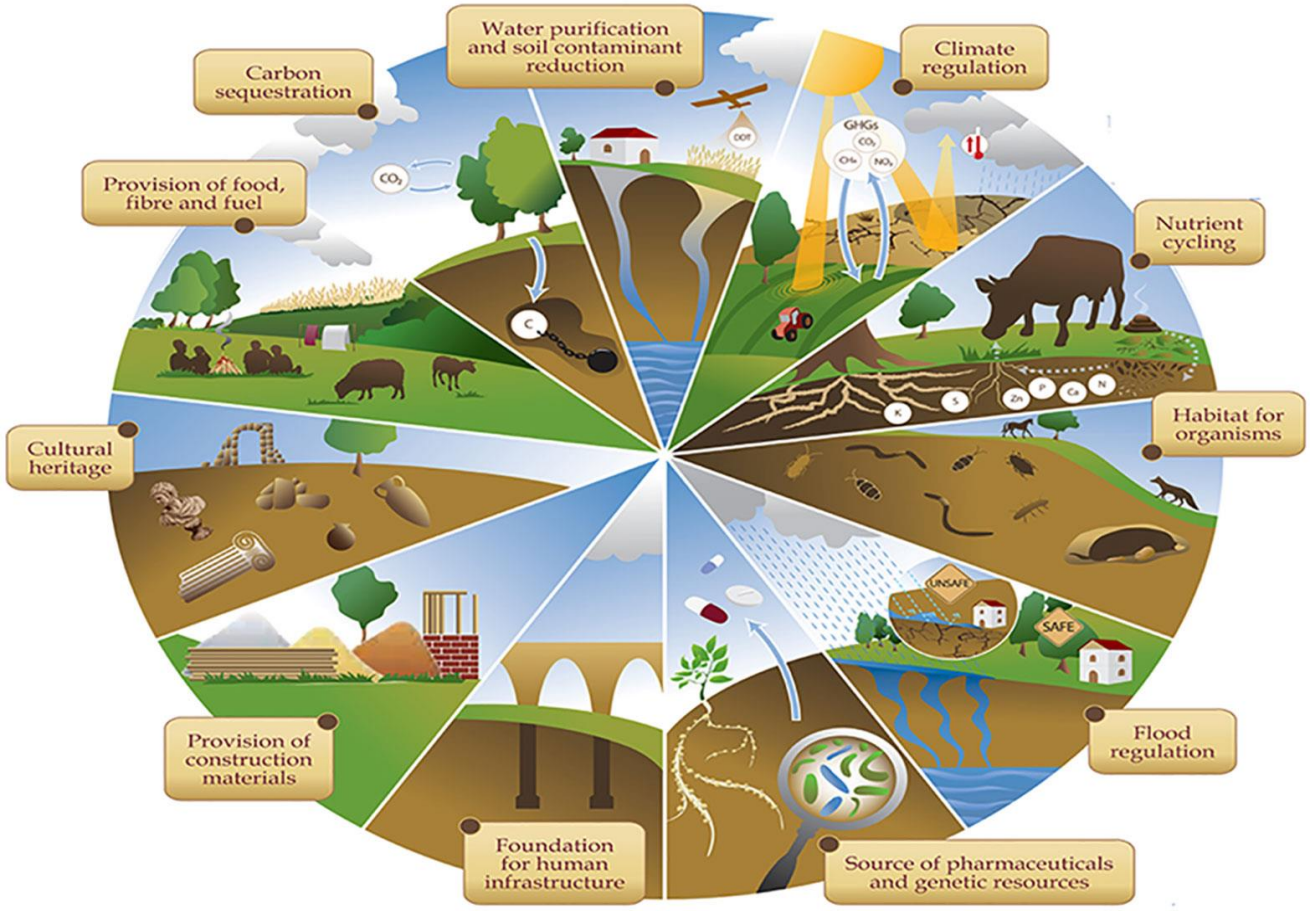
- Limited or no tilling
- Chemicals are prohibited
- Prioritises the environment
- Weeds grow in the field with minimal intervention
- Intercropping and crop rotations

- Soil organic matter
- Nutrient recycling
- Decrease in soil erosion
- Increase in water retention
- Higher biodiversity

Photo credit: Joan Romanyà

Regenerative agriculture

Emphasizes **improving and restoring** ecosystems, particularly soil health, through farming practices.



Anikwe and Ife. 2023. *Front Soil Sci*

How do we regenerate degraded soils?

ORGANIC AMENDMENTS

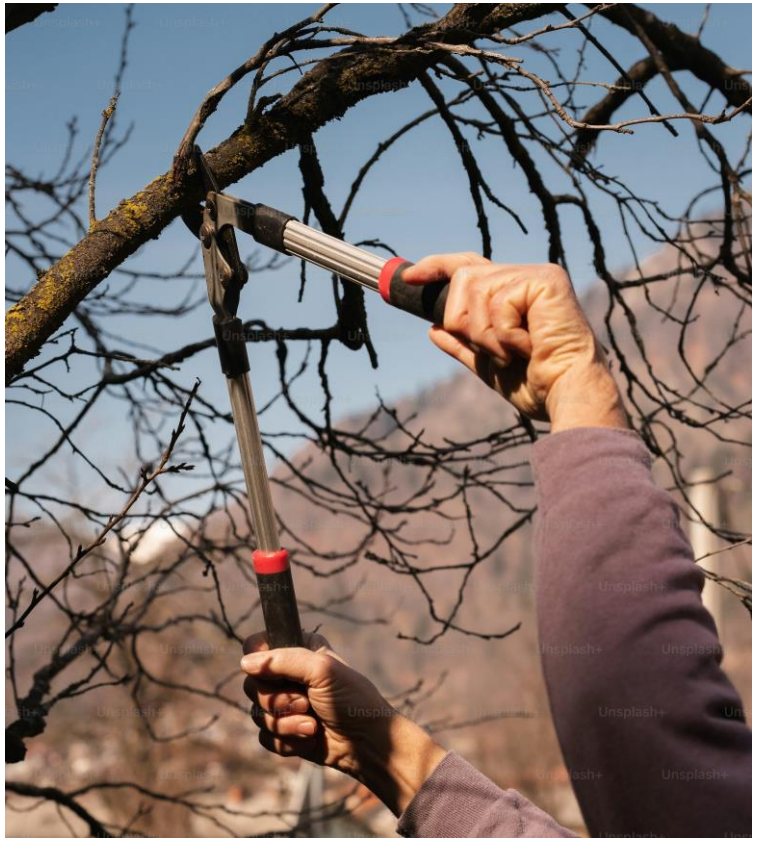
- Crop residues
- Compost
- Animal manure
- Biochar
- Woody residues

Biochar

Animal manure

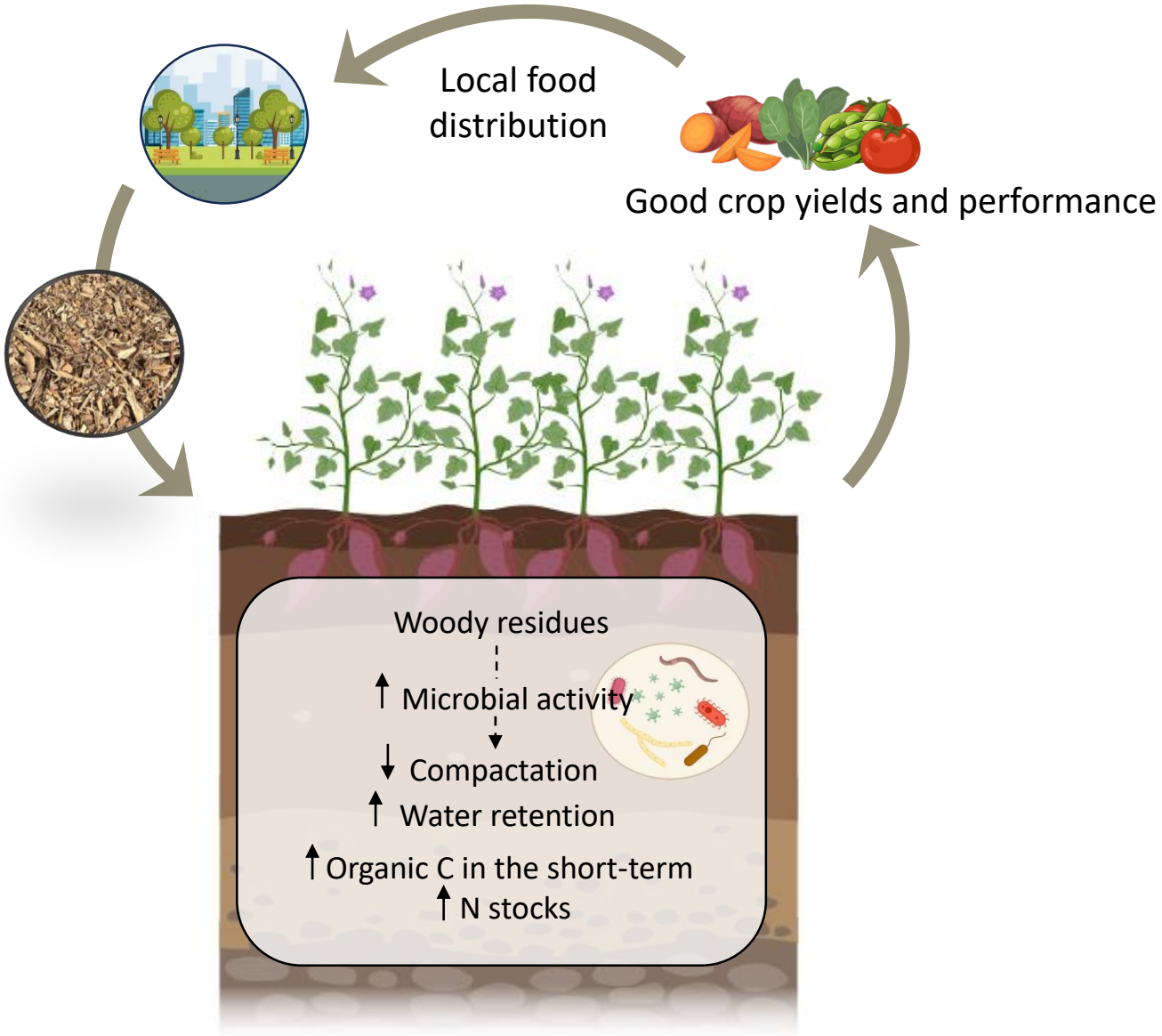
What are woody residues???

Organic materials derived from pruning trees and shrubs. They are **rich in carbon**, along with small amounts of nutrients such as nitrogen and phosphorous.



The use of woody residues as an organic amendment originates from Canada and seeks to imitate a forest ecosystem.

Effects of woody residues



There are some handicaps…

Crop performance is highly dependable on species and cultivar

Some studies have reported reduced crop yields under organic management

In Catalonia, obtaining woody residues locally is challenging as authorities prioritise directing these materials to the bioenergy industry.

↑ CO_2
↑ PM2.5

BROTONERA CABBAGE (COL BROTONERA O D'ESPIGALL)

Traditional variety of cabbage characterized by developing more than one stem and axillary branches. It is grown in various regions such as Garraf and Vallès Occidental.

Photo credit: Joan Casals

July: Planting

October: Brotons

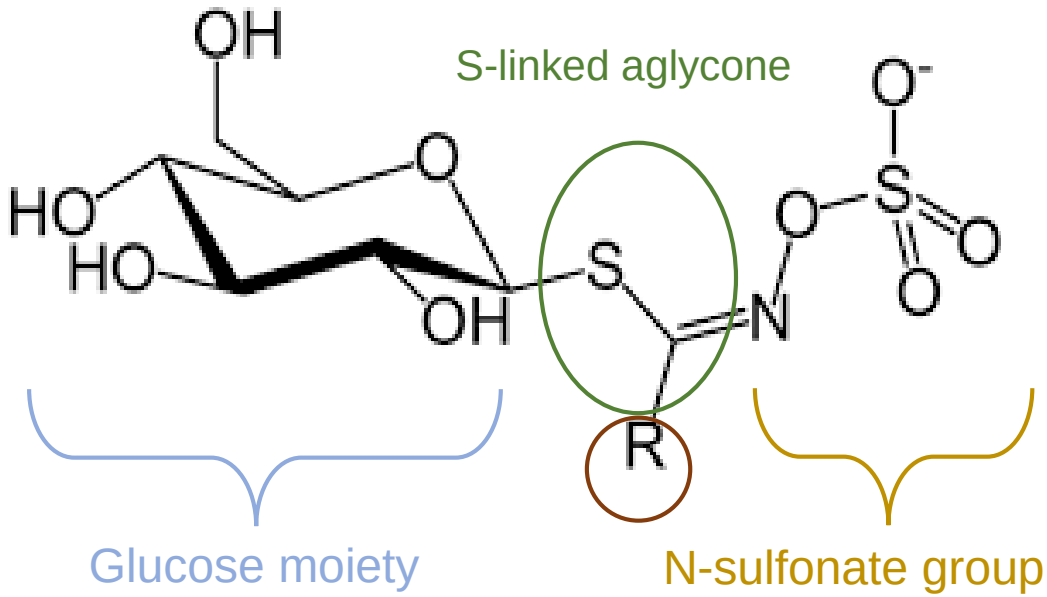
February: Espigalls

Brotons Espigalls

Photo credit: Aurora Rull

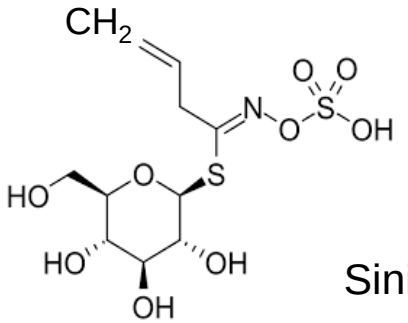
Glucosinolates, a group of defence compounds in *Brassica* spp.

A class of amino acid-derived compounds with nutraceutical properties that contain sulfur and nitrogen



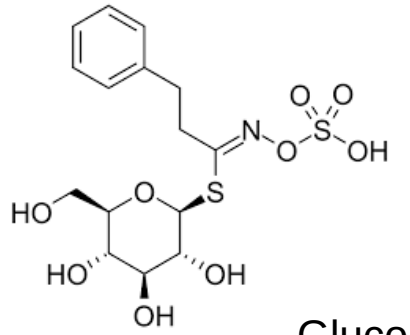
GSL Classification

Aliphatic



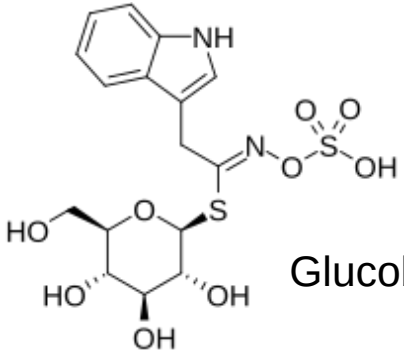
Sinigrin

Aromatic



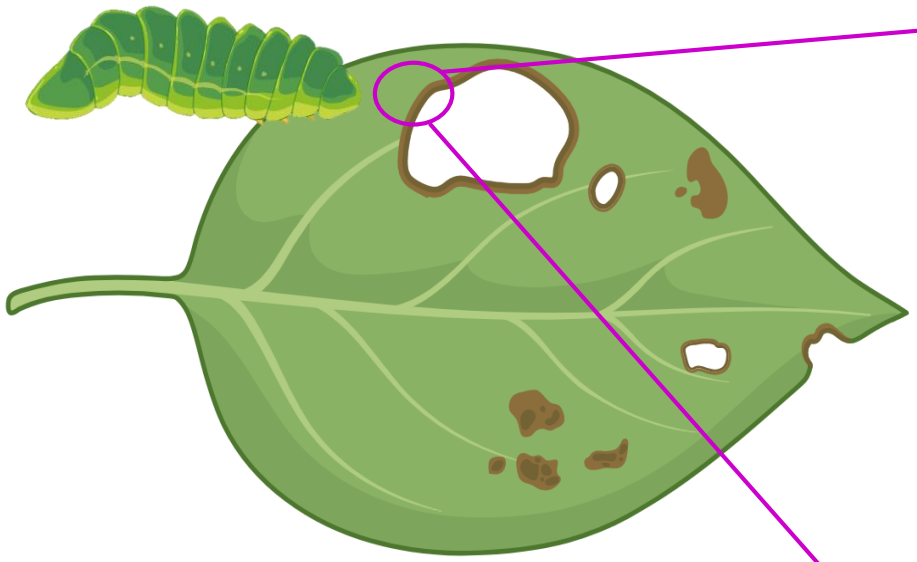
Gluconasturtiin

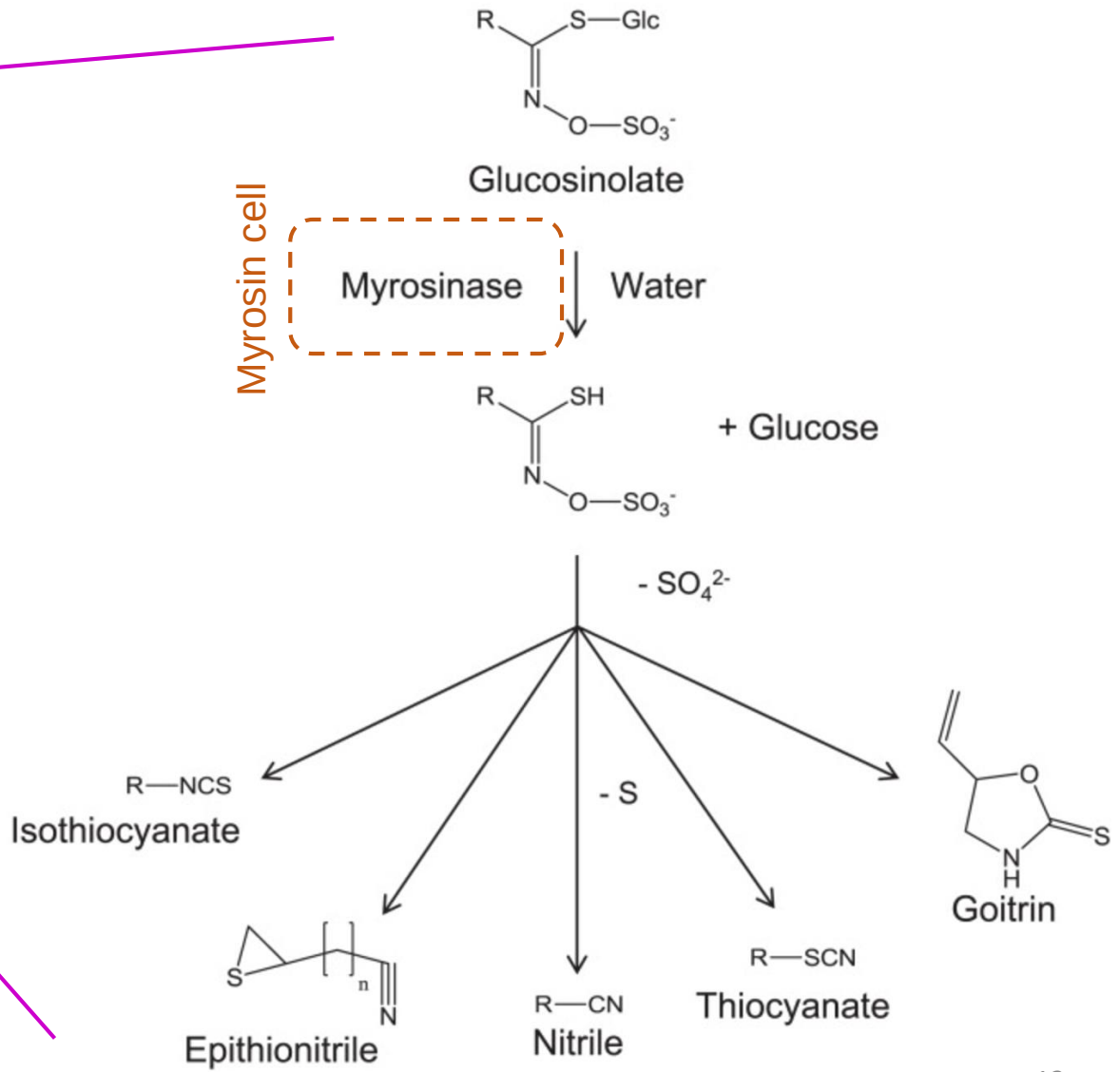
Indole



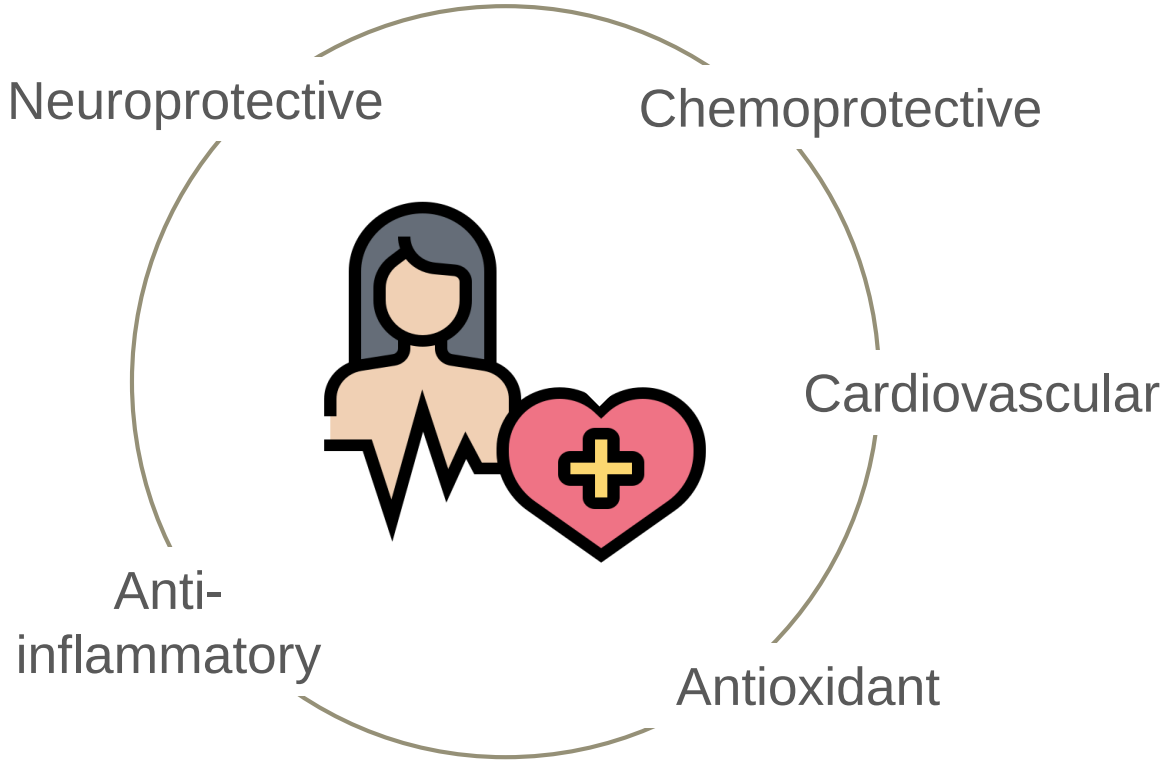
Glucobrassicin

The mustard oil bomb – GSL compartmentalisation

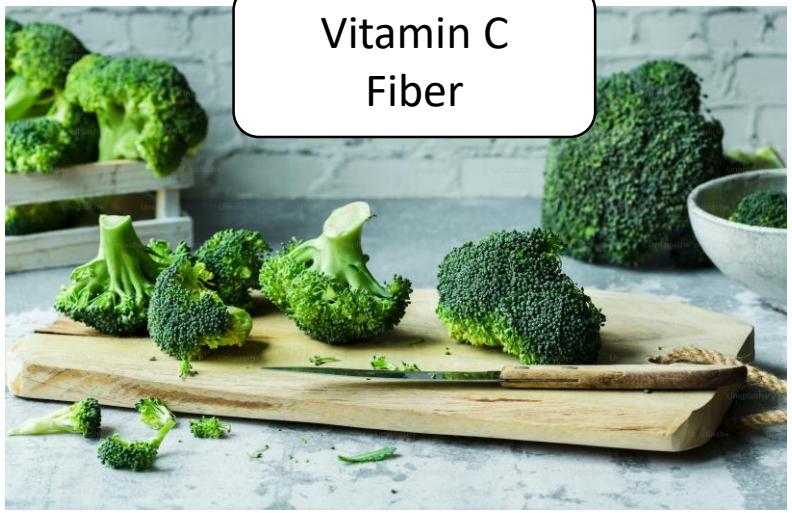


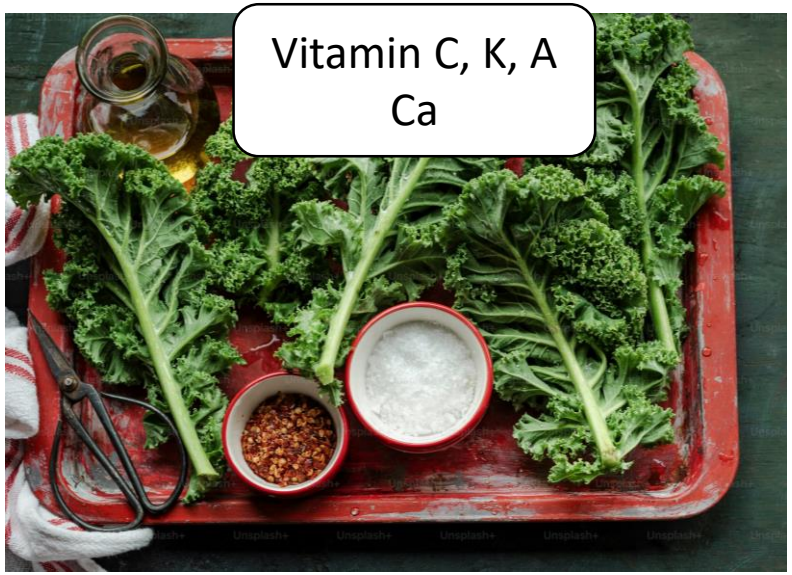


GSL and their derivatives health benefits



Superfood





Factors that influence GSL concentration in plants

Genotype

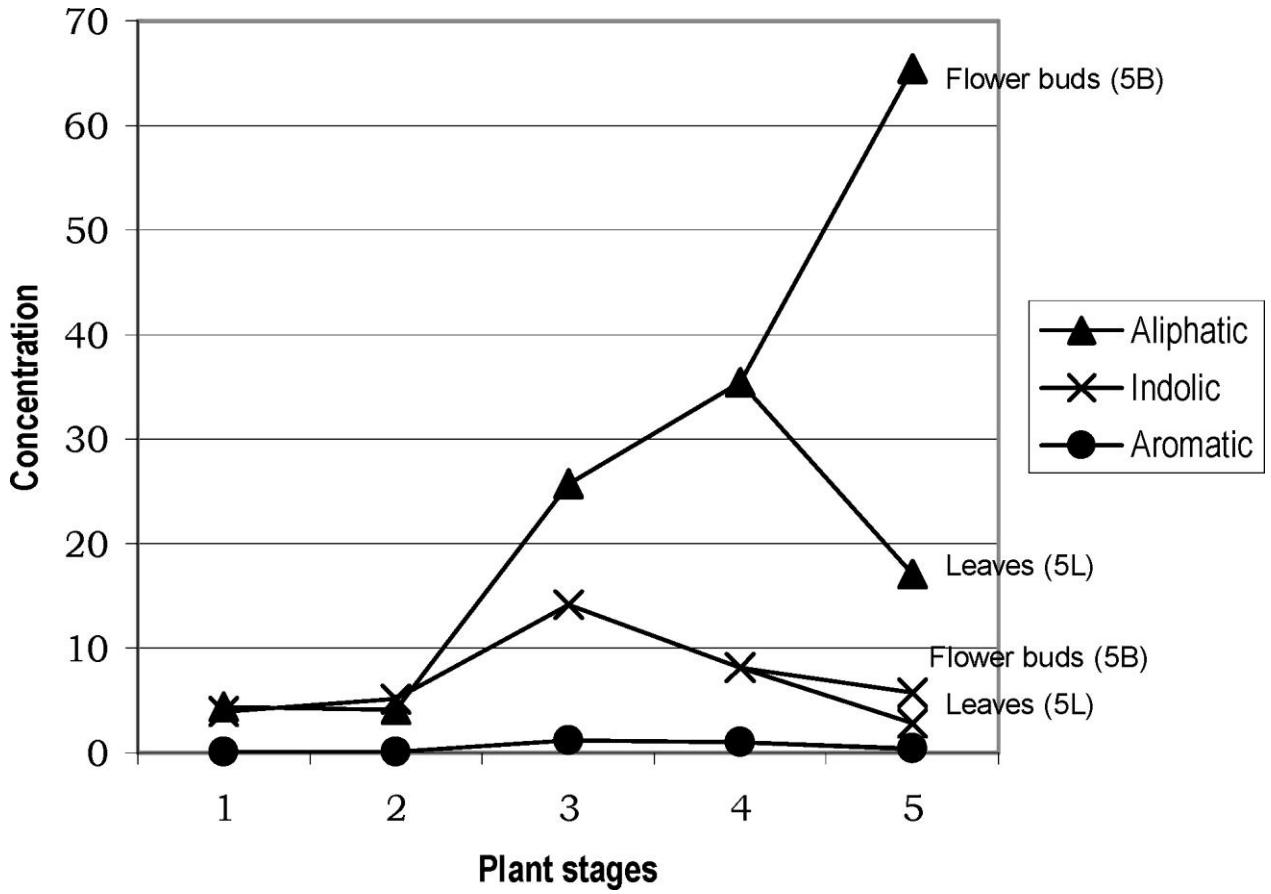
Abiotic and biotic stress

Tissue

Agricultural practices

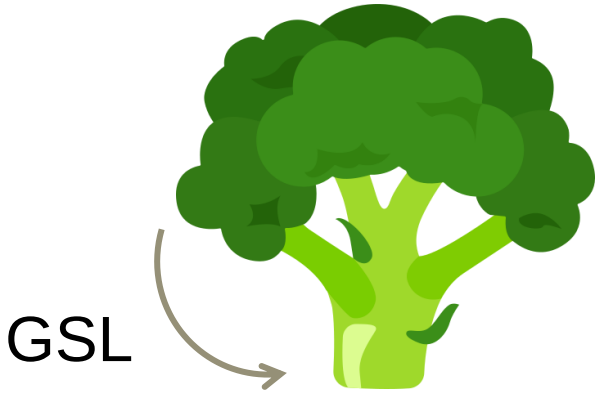
Post-harvest conditions

Flower buds



Velasco et al. 2007. *J Agric Food Chem*

During postharvest



Casajús et al. 2007. *Plant Physiol Biochem*

Mechanical stress

Total GSL after processing and storage at 20ºC

Shredding	Control	5’	30’	2h	12h	27h
Thin	890 ± 110 ^{a}	454 ± 100 ^{dy}	715 ± 23 ^{bcy}	819 ± 36 ^{aby}	595 ± 67 ^{c}	442 ± 190 ^{dy}
Thick	890 ± 110	890 ± 210 ^{x}	1090 ± 290 ^{x}	1330 ± 320 ^{x}	925 ± 270	955 ± 220 ^{x}

Požrl, et al. 2015. *J Chem*

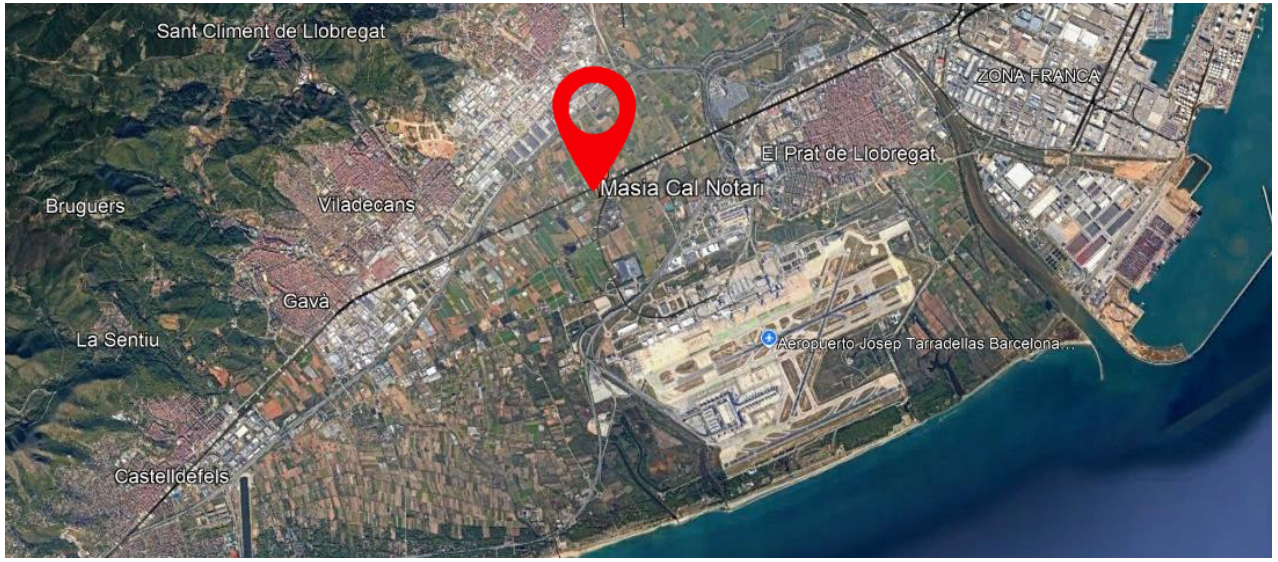
Aim

To investigate the variations in glucosinolate content in the Brotonera cabbage cultivar across different tissues and developmental stages, as well as to examine how glucosinolate levels are influenced by various organic amendments – including woody residues – in a regenerating horticultural system.

Hypotheses

- Brotonera cabbage, as a traditional cultivar, is expected to exhibit higher glucosinolate (GSL) concentrations compared to commercially available cultivars.
- The glucosinolate (GSL) concentration is anticipated to be higher in the flower buds than in the leaves of cabbage.
- The use of woody residues is expected to result in decreased cabbage yield.

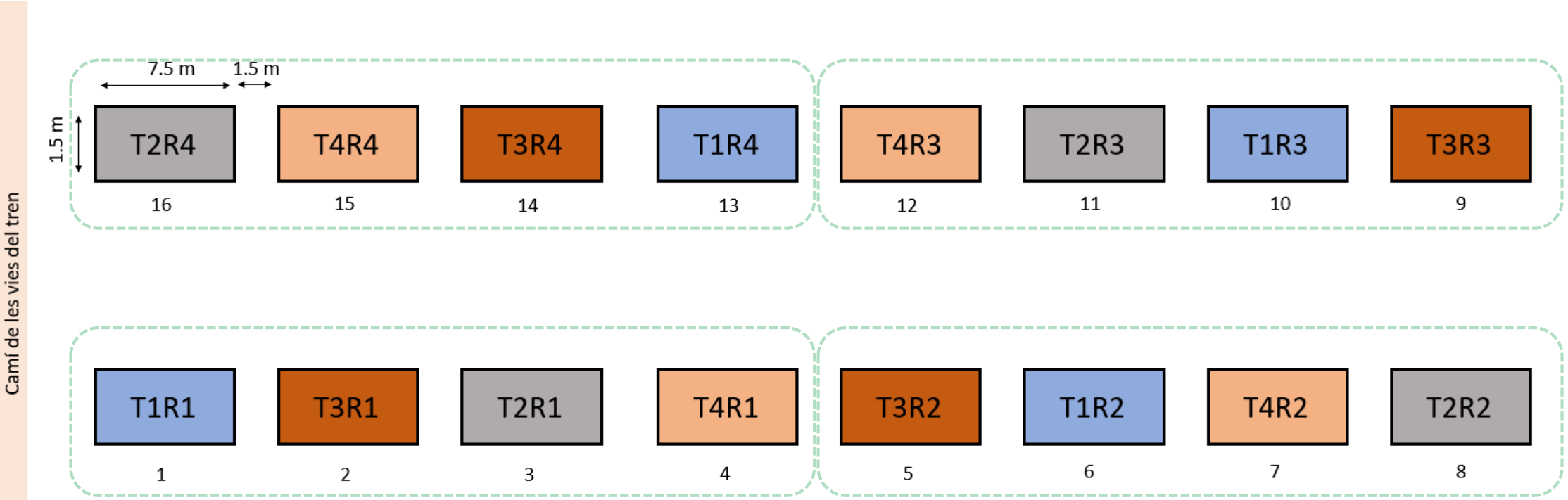
Experimental design



Cal Notari

Parc Agrari del Baix Llobregat

«Un granet de sorra per la Sobirania Alimentària des del Baix Llobregat»



T1

Plant residues
compost
Tilled

T2

N-rich granulated fertiliser
(animal origin)
Tilled

T3 & T4

Woody residues (WR) from pruning
High dose: 15 kg/m^2
Low dose: 7.5 kg/m^2
No tilled

Fertilisation calendar

Spring 2021

T1: 170 UF N/ha compost
T2: Nothing
T3: 15 kg/m^2 WR
T4: 7.5 kg/m^2 WR

Spring 2022

T1: 170 UF N/ha compost
T2: 210 UF N/ha labin
T3: 120 UF N/ha labin
T4: 120 UF N/ha labin

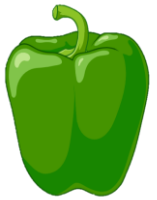
Autumn 2023

T1: 170 UF N/ha compost
T2: 100 UF N/ha labin
T3: 4 kg/m^2 WR
T4: 4 kg/m^2 WR

Application



+

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Soil regeneration

May 2021

February 2024

SAMPLINGS

Plant development

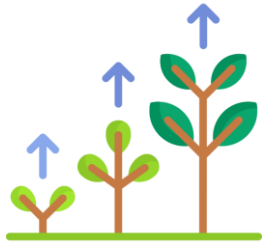
Onset of flowering
Leaves

First harvest
Leaves
Flower buds

Resprout (second)
Leaves
Flower buds

Crop performance

Growth parameters (onset of flowering)
Flowering
Yield

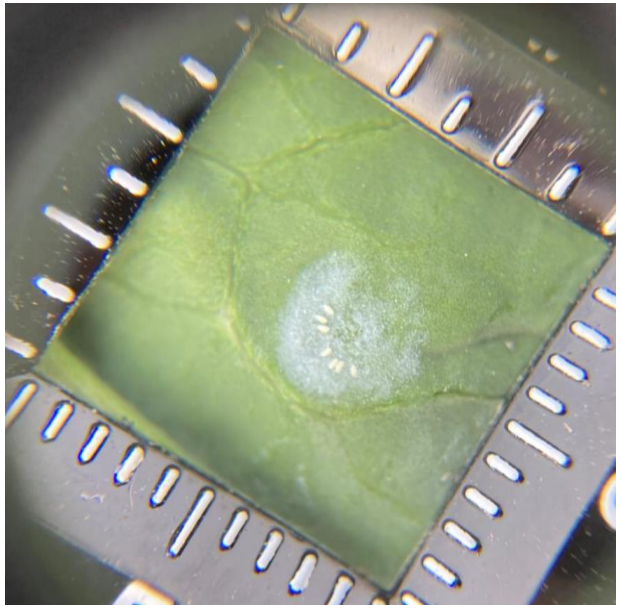


Crop stress

CSI (vegetation index)
RWC
White fly affectation (onset of flowering)
Photosynthetic pigments

Nutritional quality

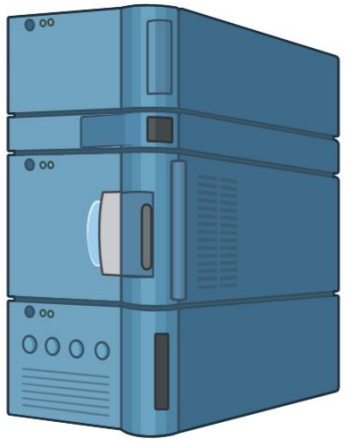
Carotenoids & Flavonoids
Glucosinolates (GSL)



Spectrophotometry

Photosynthetic pigments
Flavonoids

UPLC H-Class



GSL

Phenology and growth parameters

Treatment	Flowering (%)	Height (cm)	Stem diameter (mm)	Canopy (m^2)
T1	58.34 ± 17.35 ab	47.50 ± 3.18 b	18.06 ± 1.39 ab	0.17 ± 0.02 b
T2	66.67 ± 6.80 a	56.85 ± 1.77 a	21.53 ± 0.71 a	0.28 ± 0.01 a
T3	20.83 ± 7.98 b	45.92 ± 3.21 b	16.98 ± 0.99 b	0.15 ± 0.02 b
T4	20.83 ± 7.98 b	47.90 ± 2.66 ab	15.85 ± 1.02 b	0.17 ± 0.03 b

- The N-rich fertiliser resulted in an increased growth
- The WR treatments had a slower development

- La col Brotonera mostra concentracions significativament més altes de glucosinolats (GSL) en comparació amb els cultius comercials, donant suport al seu potencial com alternativa rica en nutrients.
- S'ha detectat nivells elevats de neoglucobrasicina (NGBS), un tret poc comú entre les varietats de *Brassica oleracea*.
- Els rebrots poden proporcionar més beneficis per a la salut gràcies a les seves altes concentracions de compostos bioactius.
- La combinació de fulles i botons florals resulta en una concentració global més alta de compostos bioactius en comparació amb els cultius comercials on només es consumeixen fulles. Aquest enfocament també es podria aplicar a altres cultius per augmentar el seu valor nutricional.
- Si bé dosis baixes de residus llenyosos redueixen el creixement de la planta, augmenten significativament la qualitat nutricional de la col Brotonera.
- L'ús de residus llenyosos també podria conferir protecció contra patògens estimulant la producció de compostos bioactius.
- Quan s'utilitzen esmenes orgàniques, és crucial equilibrar el creixement de la planta (i.e. el rendiment) i les respostes a l'estrès (i.e. la producció de compostos bioactius) mitjançant un monitoratge adequat dels nutrients.

GRÀCIES PER LA VOSTRA ATENCIÓ

Projectes Hortbiosòl i SOILCARE (TED2021-130783B-C21 i PID2023-146650OB-I00)
Projecte Regensòl i Regensòl + (56 30126 2021 P4 i ACC_2023_EXP_SIA001_13_0000070)

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