Genetic, transcriptomic and physiological characterization of cold tolerance in sunflower

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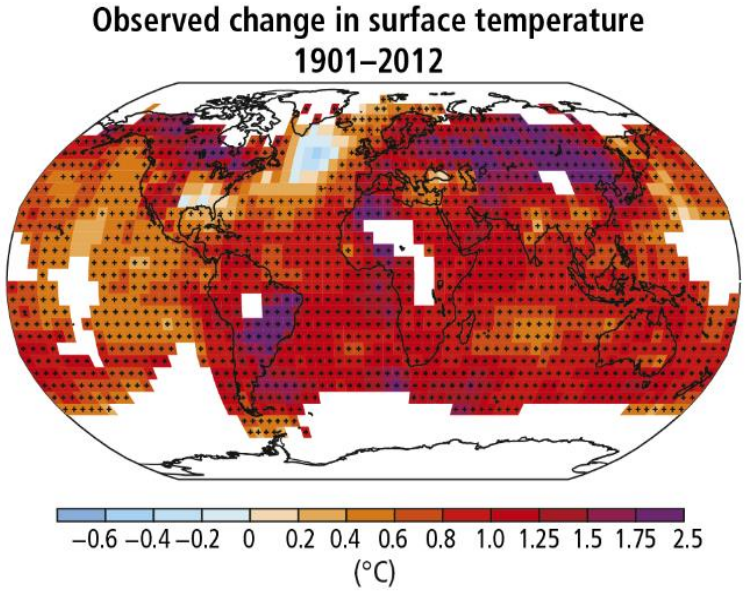
Project background



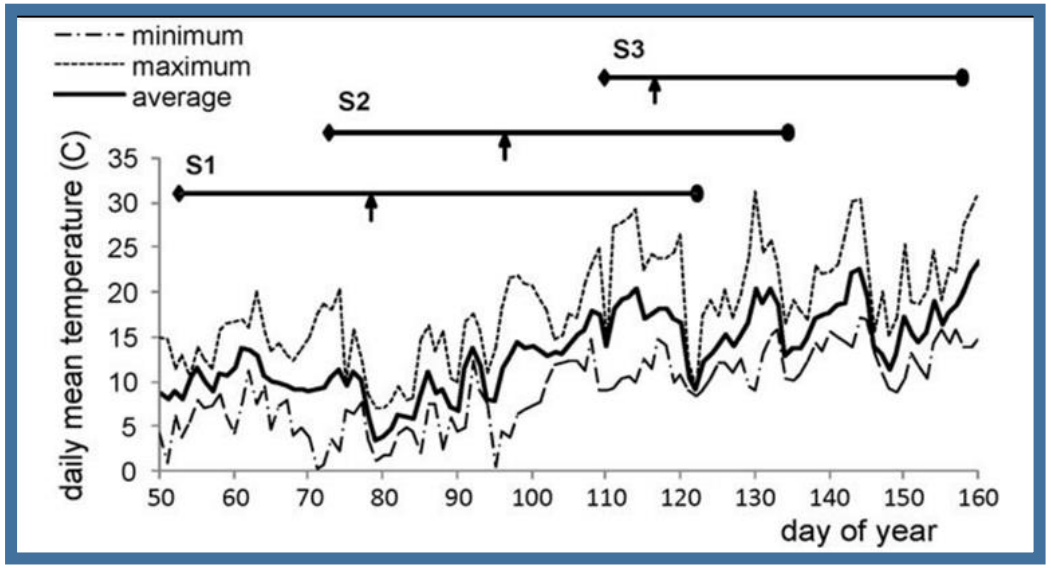
(IPCC. 2014)

Drought during grain filling
-0.135q/ha/day
(Mangin et al., 2017)

Early sowing
→ Escape strategie

Project background

February March April



(Allinne et al., 2009, ps)

→ Plantlet exposed to low temperature

-0.345q/ha/day
(Mangin et al., 2017)

→ Low temperatures have a strongest negative impact on yield

→ But sunflower has a shorter exposure time to cold

→ Improving chilling resistance → Strong positive impact on oil yield

→Need to study cold tolerance

Project goals

Describe sunflower response to cold

- Improve our understanding of response to chilling at a molecular and physiological level
- Produce basic knowledge as reference for further works
- Development of new high throughput phenotyping technologies
  → Facilitate the use of these new tools

→ To perform these characterization, three different protocols are used

Differents protocols

Genotype used

XRQ

Growth chamber

18°C day	18°C day
5°C night	18°C night

1.

3 weeks

- Morphological phenotyping
- Transcriptomic analysis

2.

3 weeks

Heliaphen platform

- Morphological phenotyping
- Physiological phenotyping

3.

Field under early and normal sowing

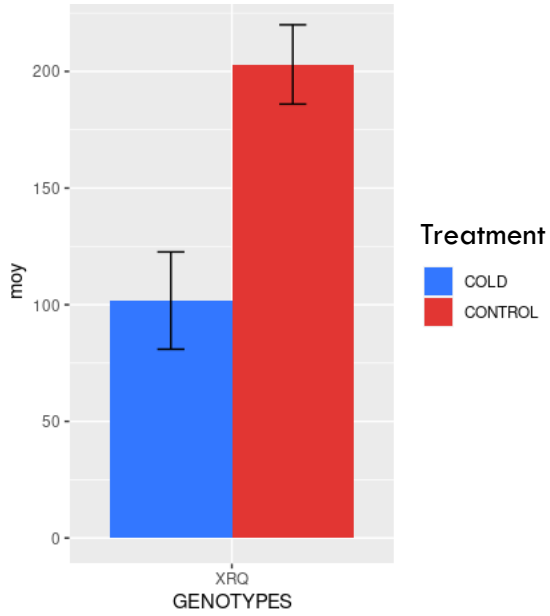
- Morphological phenotyping

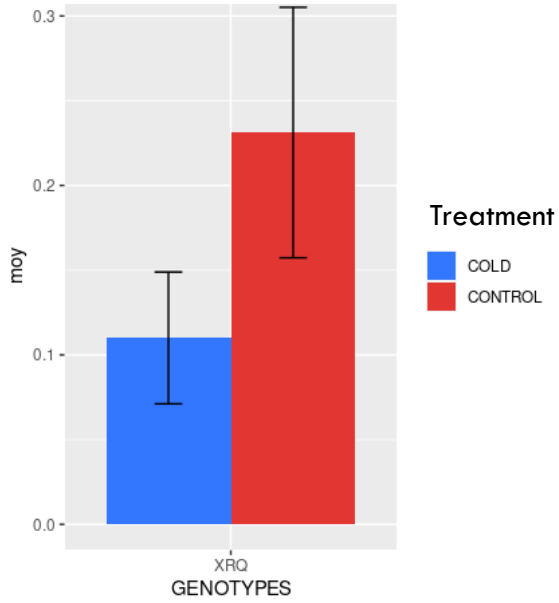
Growth chamber

Physiological caracterization

Plant height

Root weight





Chilling

Control

At three weeks old :

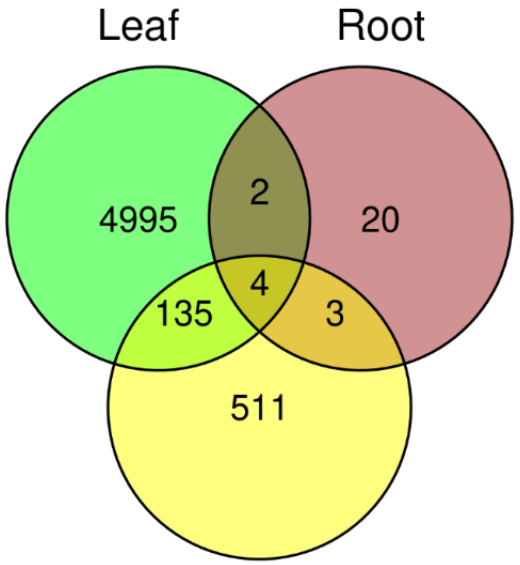
- Chilling decreases plant height
- Chilling decreases root weight

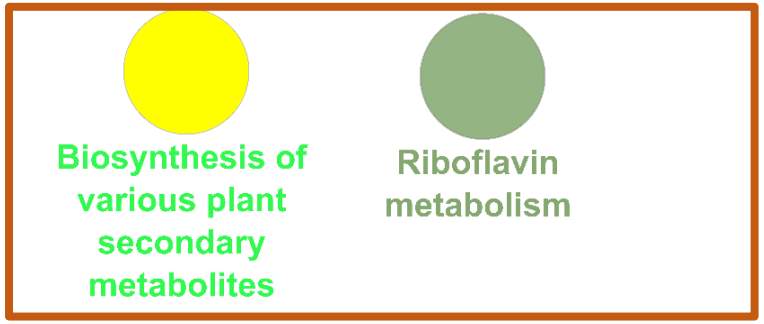
→ Look at the transcriptomic level

Growth chamber

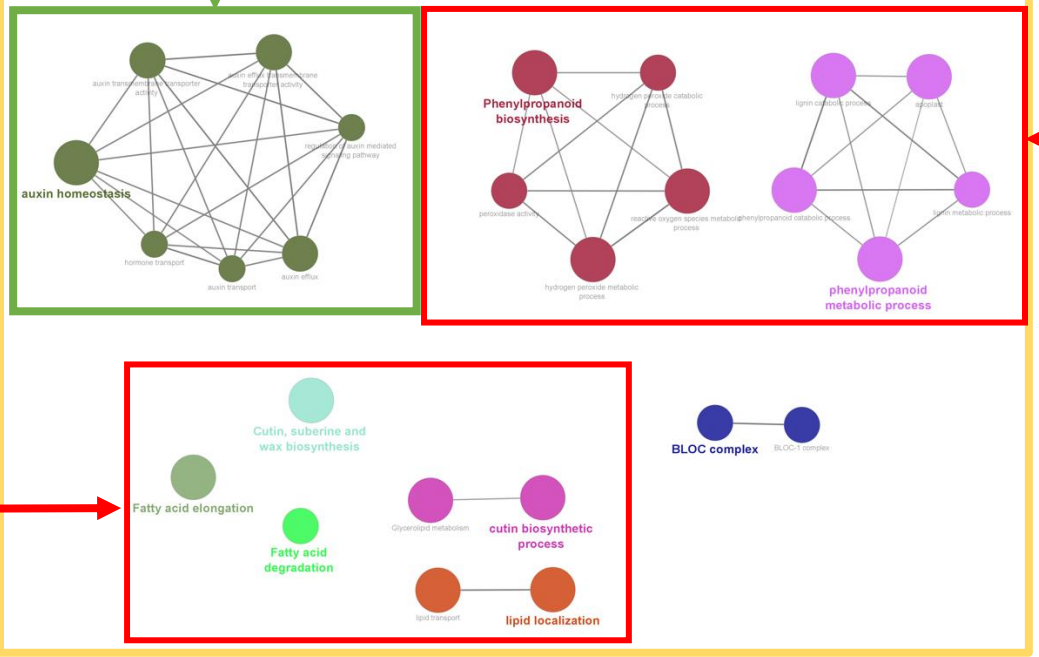
Transcriptomic characterization

Differencial expressed genes (DEG)





Auxin metabolism

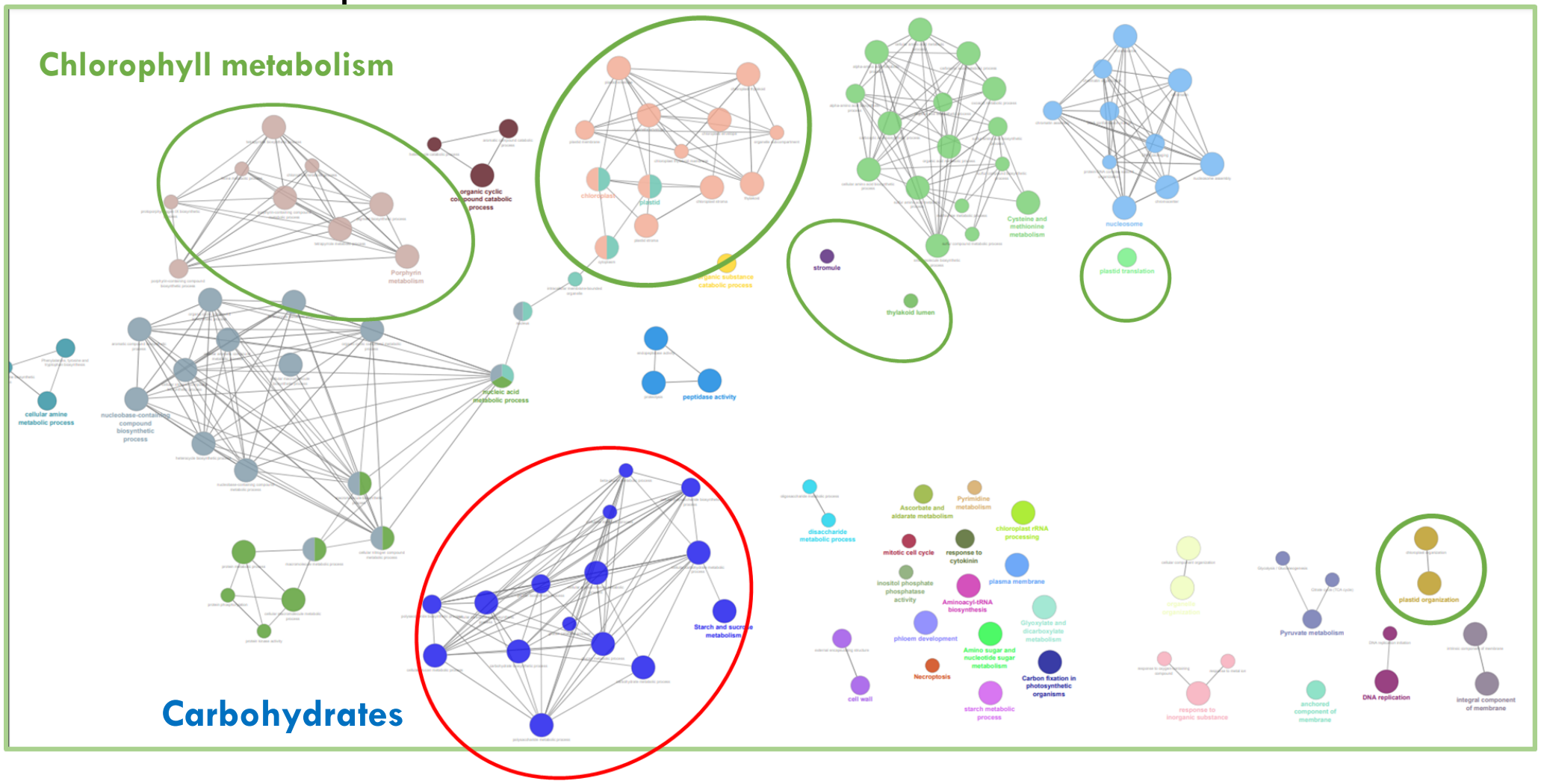


ROS metabolism

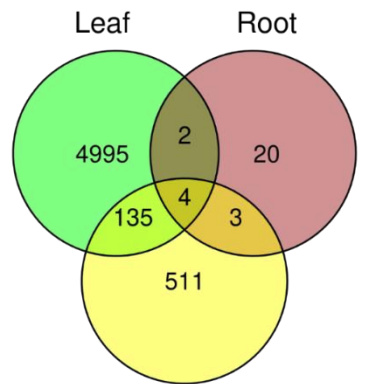
Lipid metabolism

Growth chamber

Transcriptomic characterization



Differencial expressed genes



Heliaphen platform

Robot performs daily phenotyping

Drought stress if necessary

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2. Protocol :

5°C night
18°C day

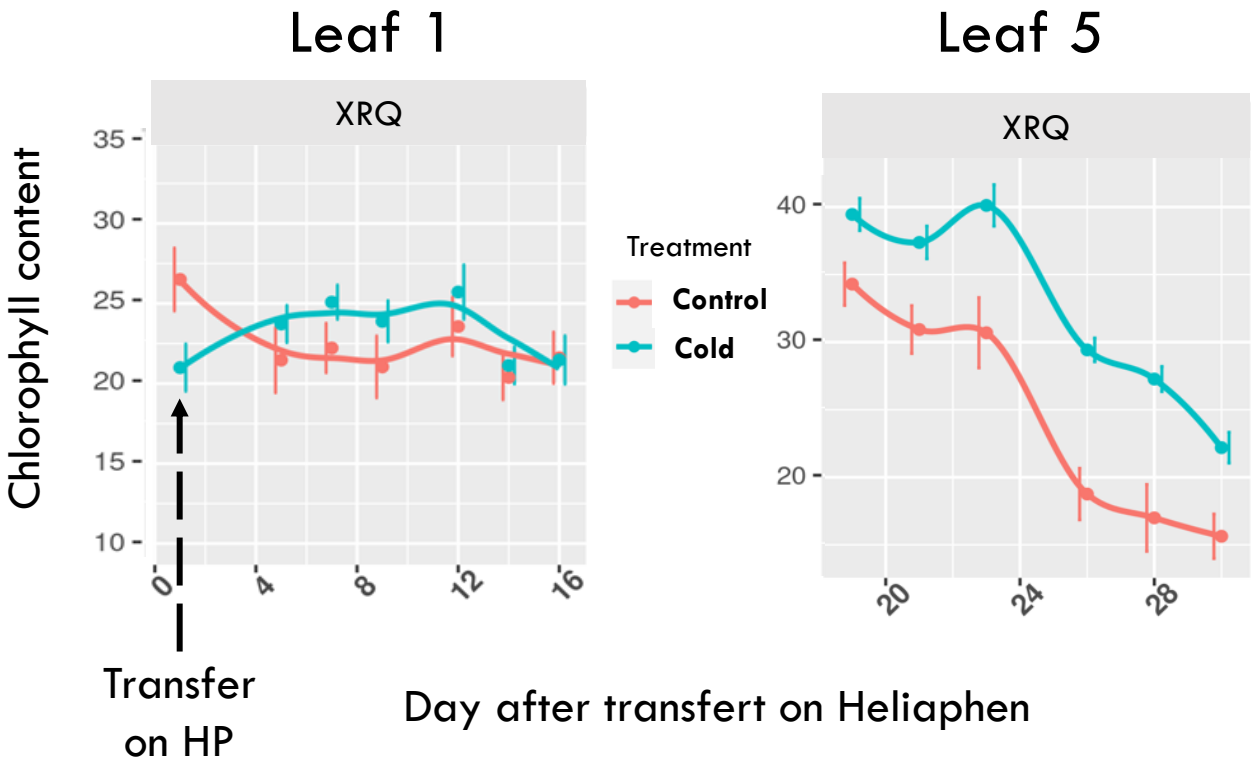
18°C night
18°C day

3 weeks in chamber culture

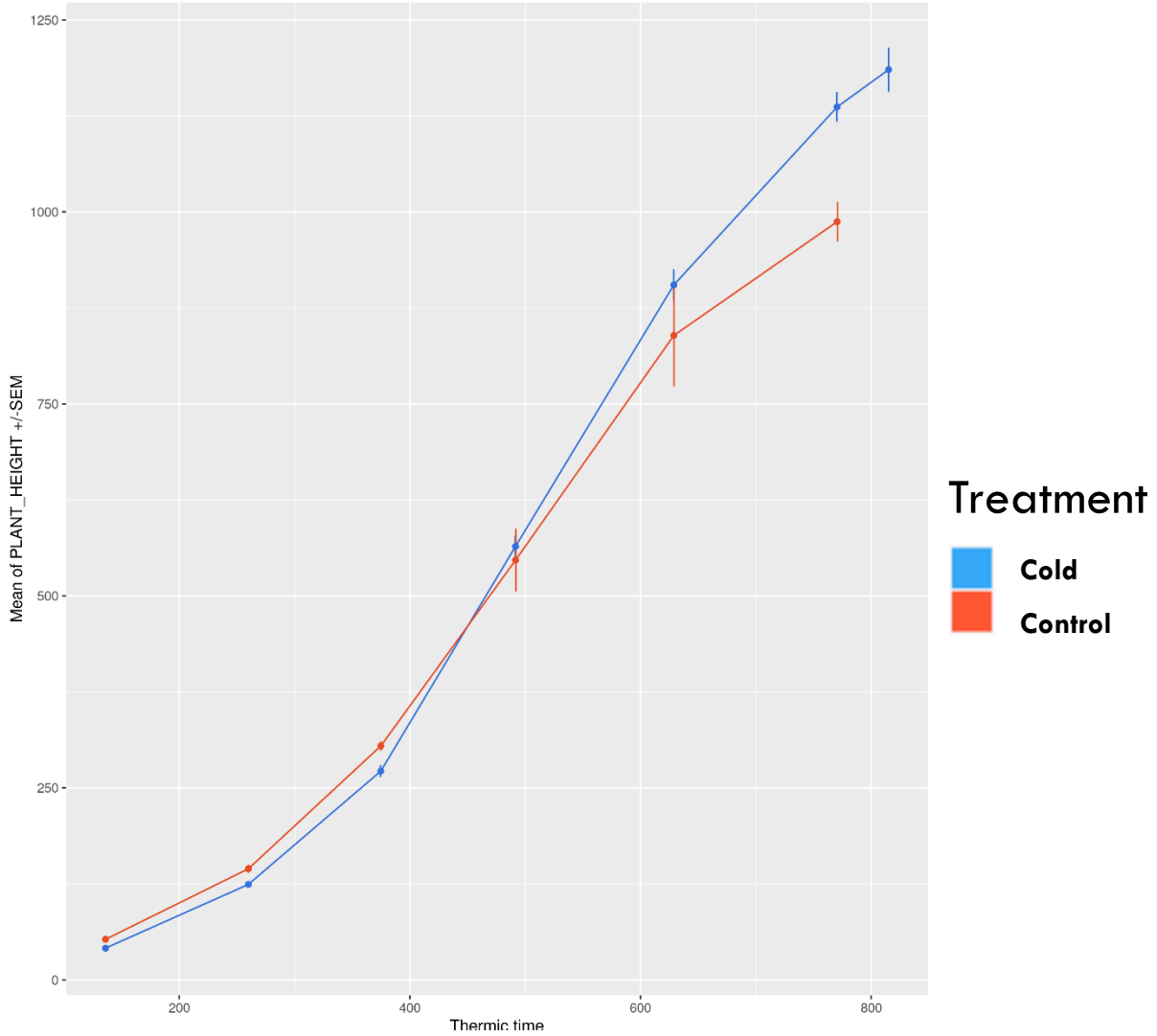
Transfert on Heliaphen platform

Until the end of the cycle

Heliaphen platform : early stage



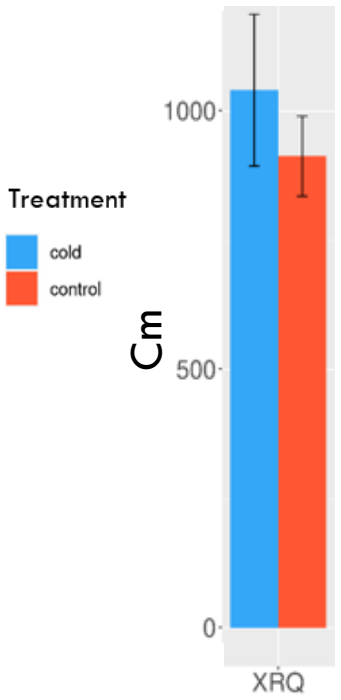
Plant height of XRQ



- Chilling decreases chlorophyll content in growth chamber
- But increase chlorophyll content once transfered on Heliaphen
- Chilled plants growth faster than control plant

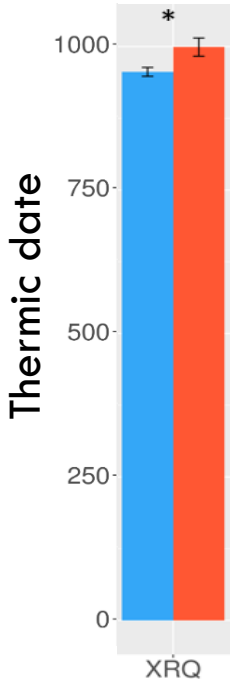
Heliaphen platform : late stage

Plant height



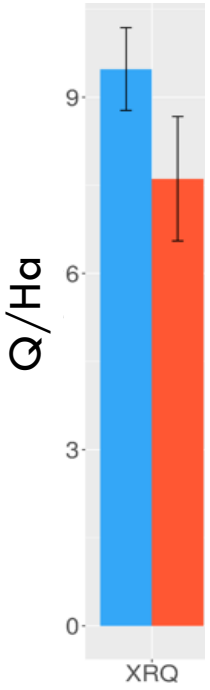
Plants are higher in chill treatment

Flowering date



Flowering occurs earlier in chill treatment

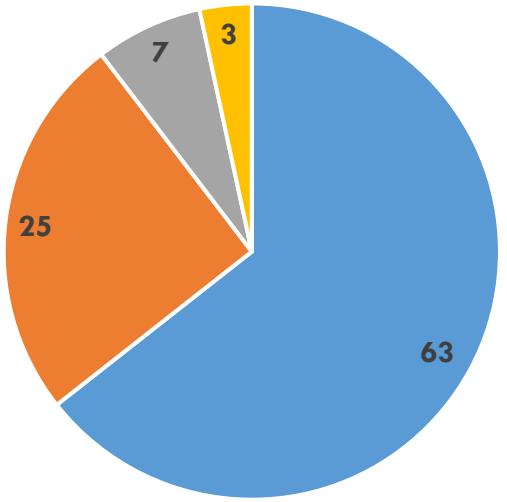
Oil yield



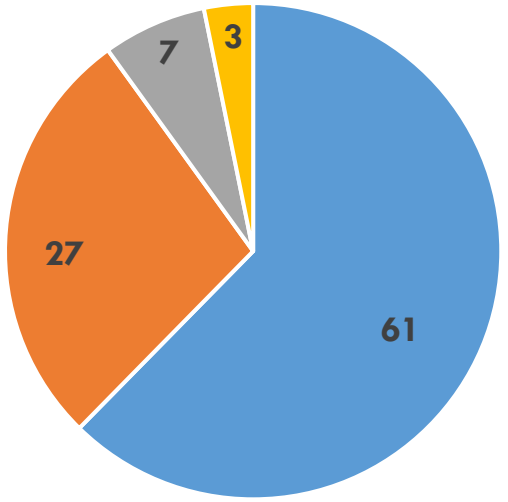
Oil yield is higher in chill treatment

Seeds oil composition (%)

XRQ Chilling



XRQ control



Linoleic acid

Palmitic acid

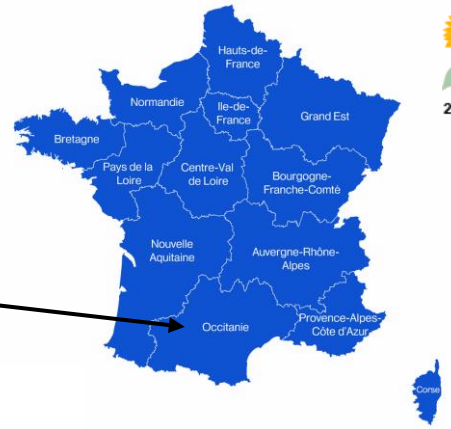
Oleic acid

Stearic acid

No difference in lipid composition between chilled and controlled treatment

Caracterization in field

Two experimentations performed in France Occitanie

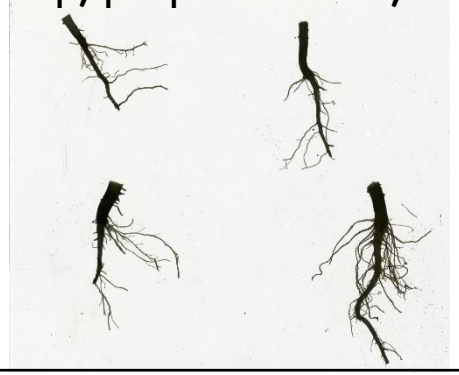


Early sowing : 01/03
Normal sowing : 15/04

Manual and numeric phenotyping :

Sprouting
Vigor
Plant height
Hypocotyl height

Root achitecture
(number of tip, projected area, total length)



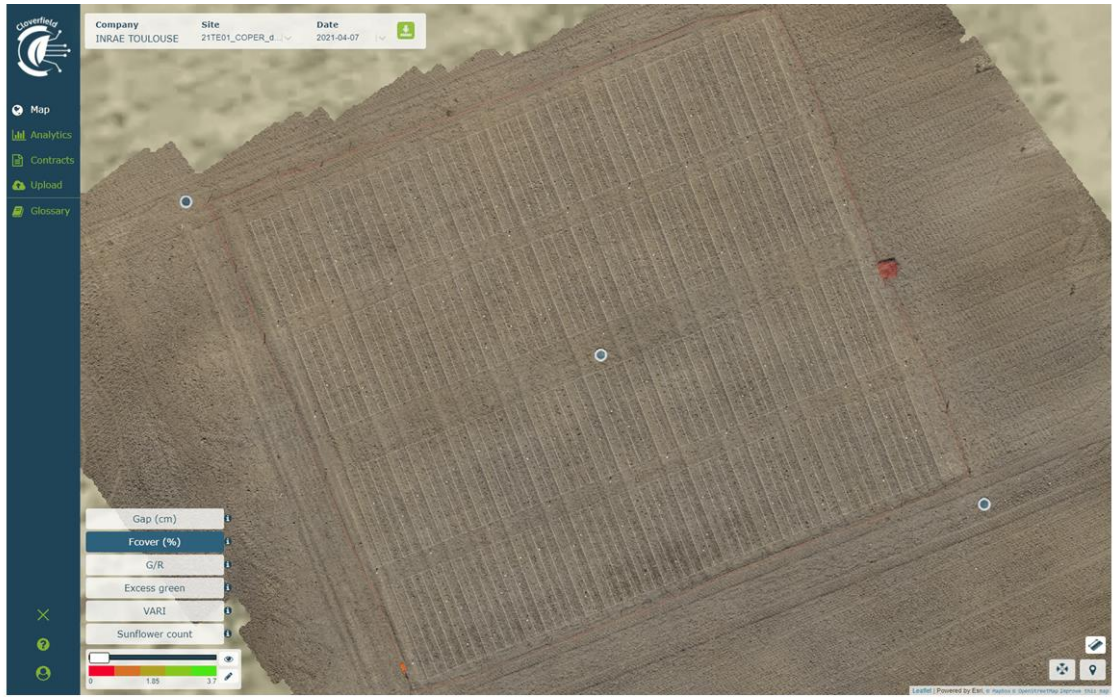
High throughput phenotyping :

Drone flight

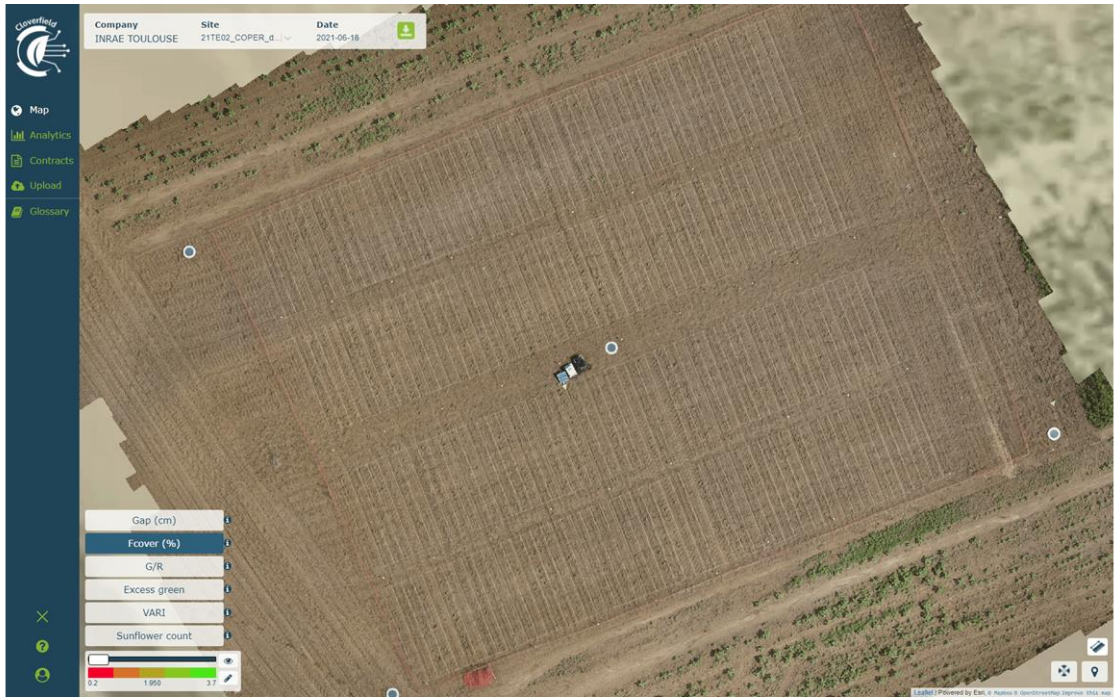
Phenomobile

Characterization in field

Early sowing



Late sowing



→ It provides data such as counting, aerial covering, plant height for each plant

→ Phenomobile provides vegetation architecture (leaf area, leaf angle, chlorophyll content, height), organs counting, stages detection, disease symptoms

Conclusion

Early

Middle

Late

Cold stress

↘ Plant height

↘ Root weight

DEG in :

- Auxin
- Lipid
- ROS
- Chlorophyll
- carbohydrates

↗ Chlorophyll content

↘ Flowering date

↗ Oil yield

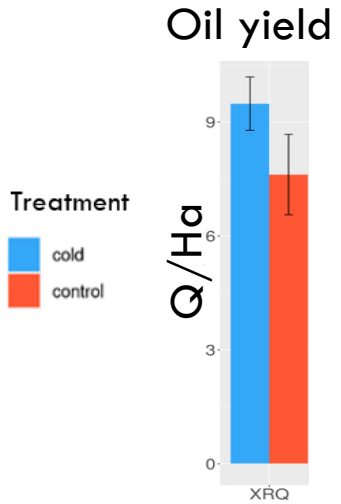
↗ Growth

↗ Plant height

Futur analysis

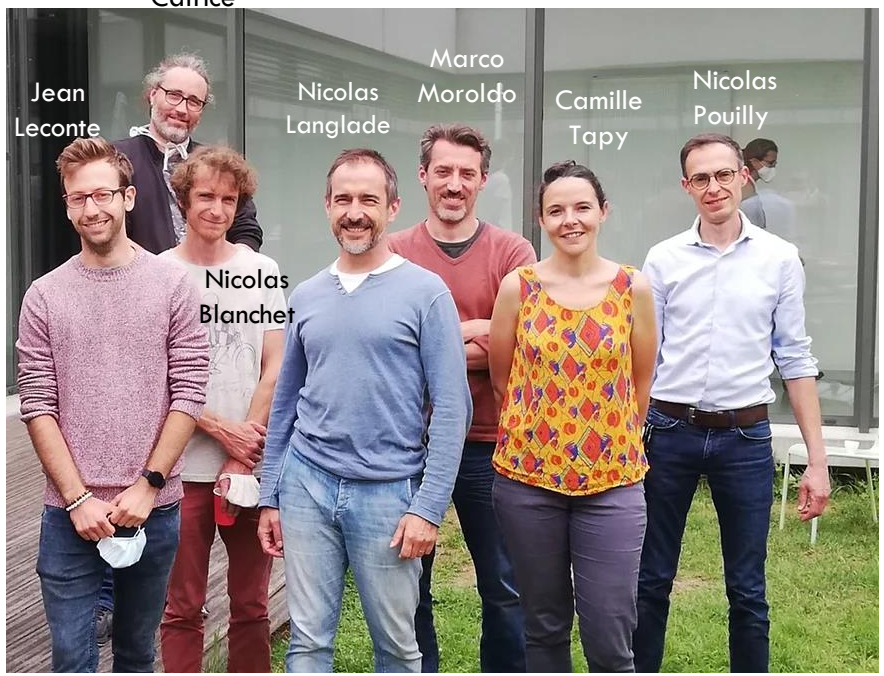
- Transcriptomic : Isoseq sequencing → identification of variant splicing

- Cross stressed between cold and drought on Heliaphen platform



- Analysis of phenomobile and drone picture

ASTR team



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Thank you for your attention