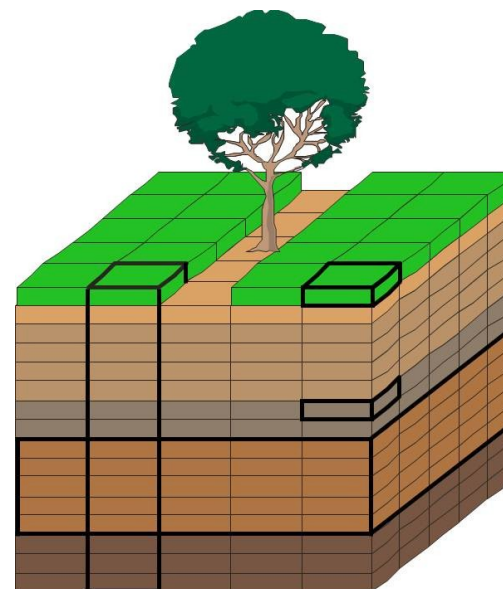


Les systèmes agroforestiers face au changement climatique :

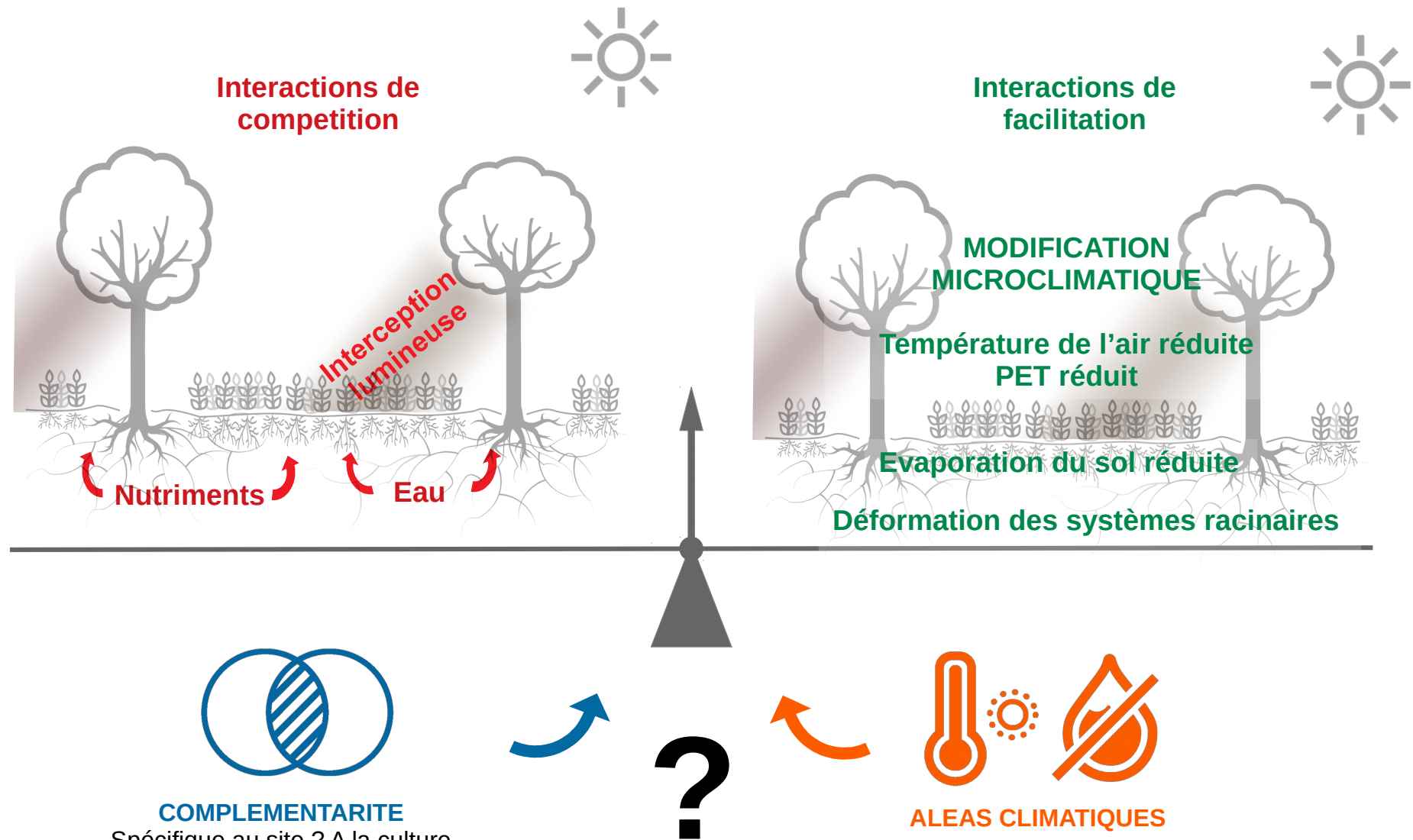


**Analyse des mécanismes de résilience face aux excès climatiques
par expérimentation au champ et modélisation numérique**

Guillaume Blanchet

Encadrement : Grégoire Vincent, Marie Gosme, Christian Dupraz

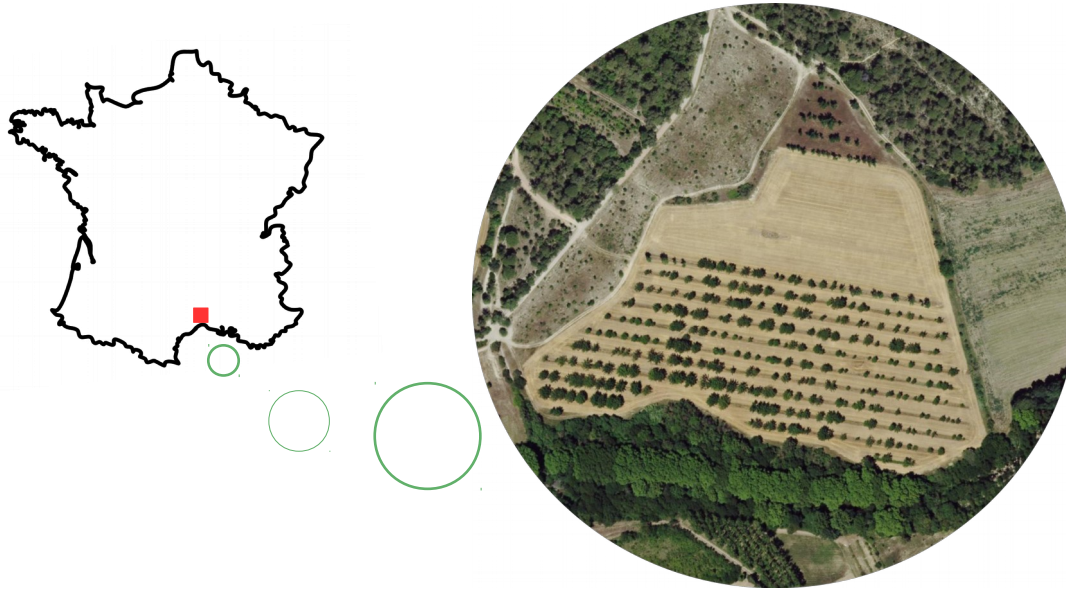
Une adaptation au changement climatique par l'agroforesterie ?



COMPLEMENTARITE
Spécifique au site ? A la culture
intercalaire choisie ?
Influence du type de gestion ?

ALEAS CLIMATIQUES

Expérimentation : la parcelle A2 au domaine de Restinclières (34)



Source : geoportail.gouv.fr

Climat méditerranéen (840 mm)

Fluvisol profond, sur couches géologiques calcaires

Arbres plantés en 1995, allées de 13 m de large

Agroforesterie intra-parcellaire :

- Noyer noir hybride (92 arbres.ha⁻¹)
- Rotation de céréales d'hiver (Blé dur-**Orge d'hiver**-Pois)



Récolte 2018

Expérimentation : des dispositifs pour une sécheresse artificielle



Grand dispositif

Sur deux allées, *i.e.* ~900 m²

Structures cablées au arbre, bâches amovibles

3 arbres intégralement exclus

Un bloc unique

Petit dispositif

Patch d'exclusion, Ø 4.5 m *i.e.* ~15 m²

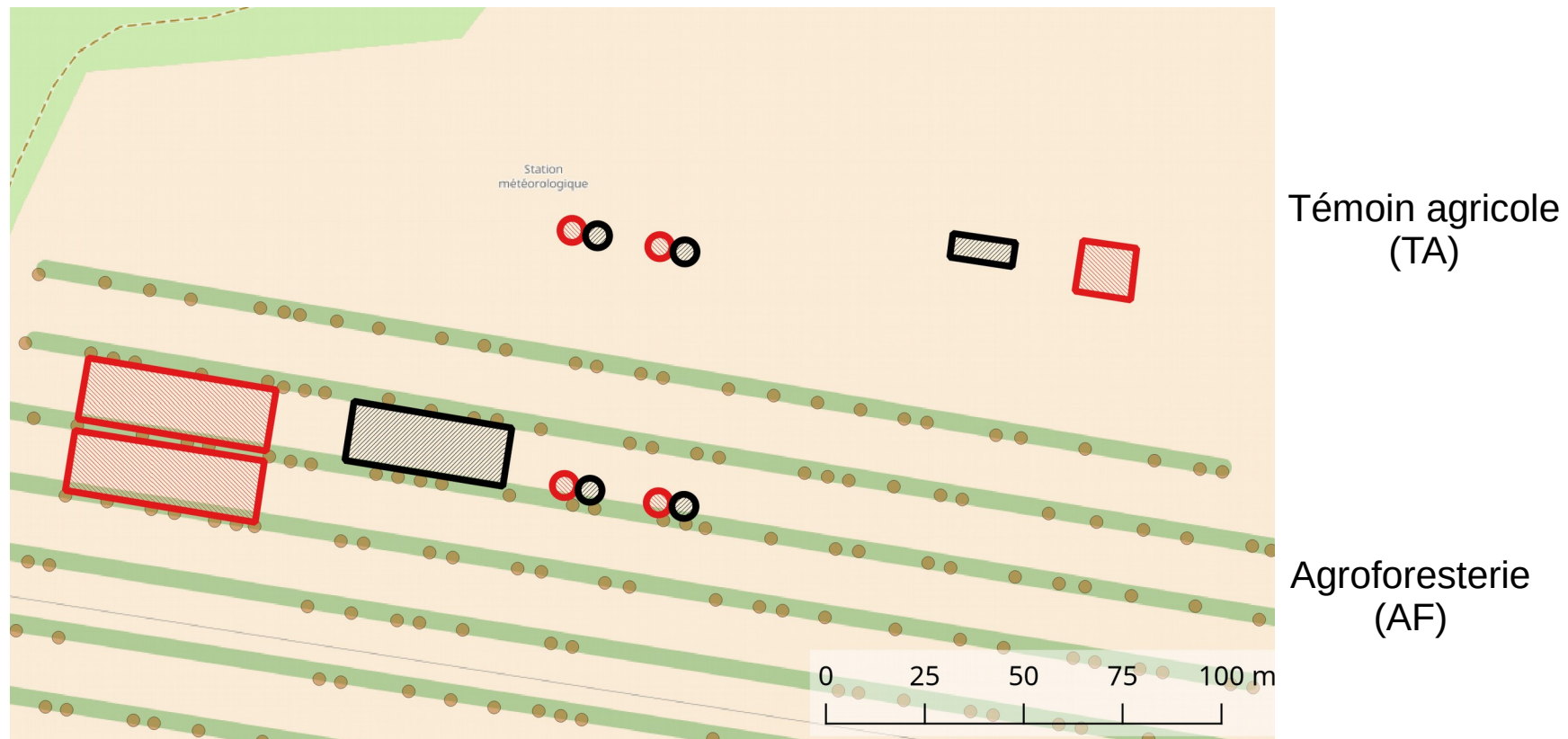
Structure tubulaire, disque bâché amovible

A proximité d'un arbre, idéalement autour de celui ci

Réplication à travers la parcelle



Expérimentation : plan de parcelle 2017-2018



Mesures réalisées au champ cette année :

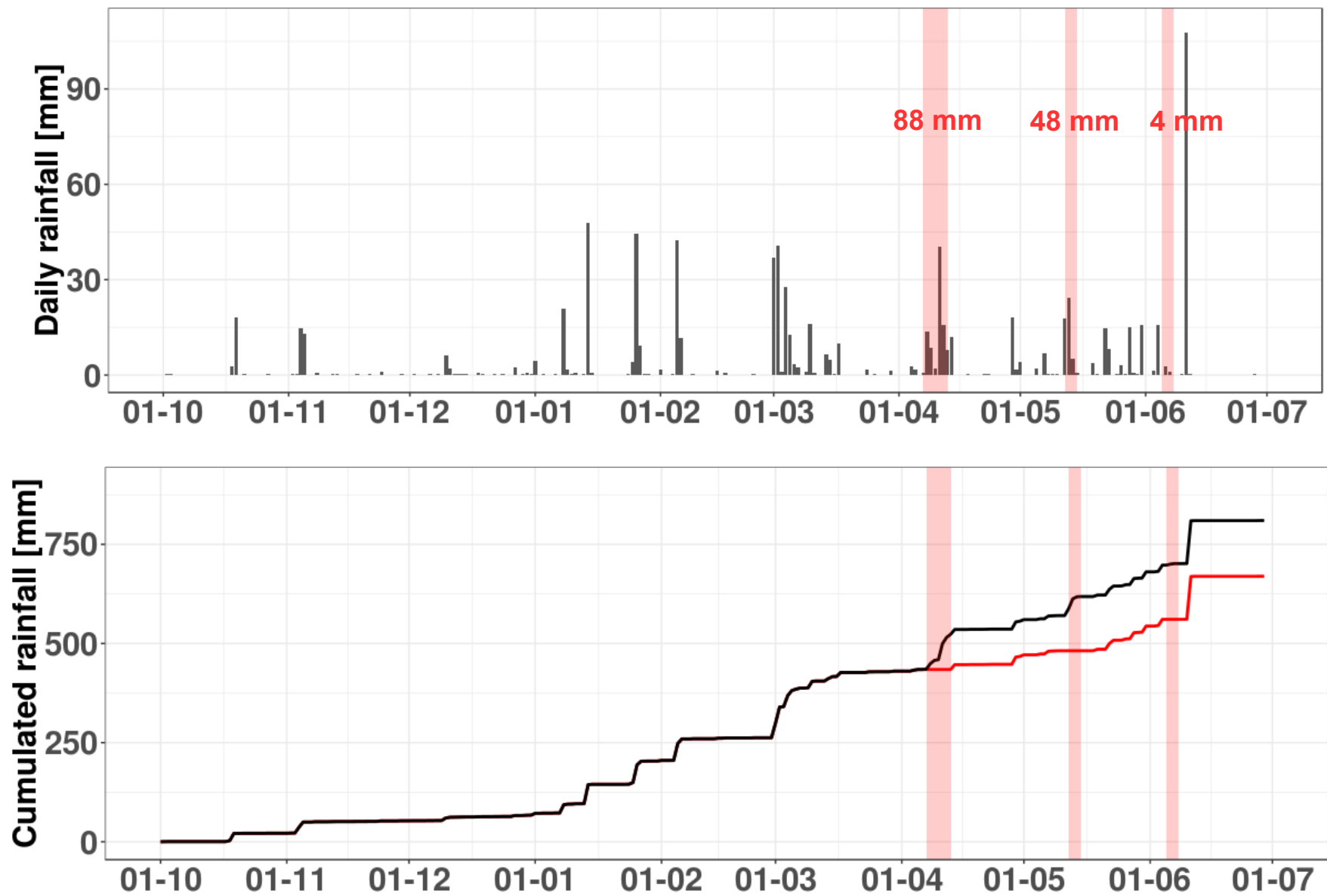
Variables climatiques:

- Rayonnement
- Température et humidité (sol et air)
- Vent
- Pluie

Variables biologiques :

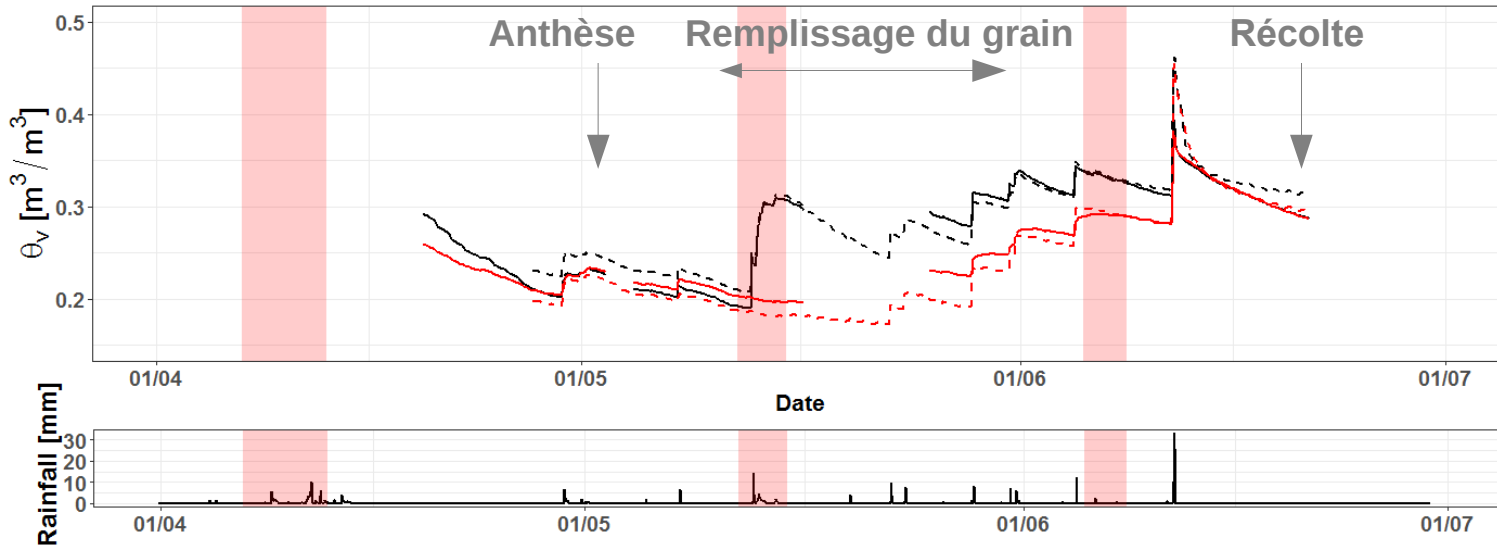
- Rendements et ses composantes
- Phénologie
- Conductance stomatique
- Température de culture

Pluies interceptées



Impacts des exclusions de pluie sur la disponibilité en eau

TDR (0-30 cm)



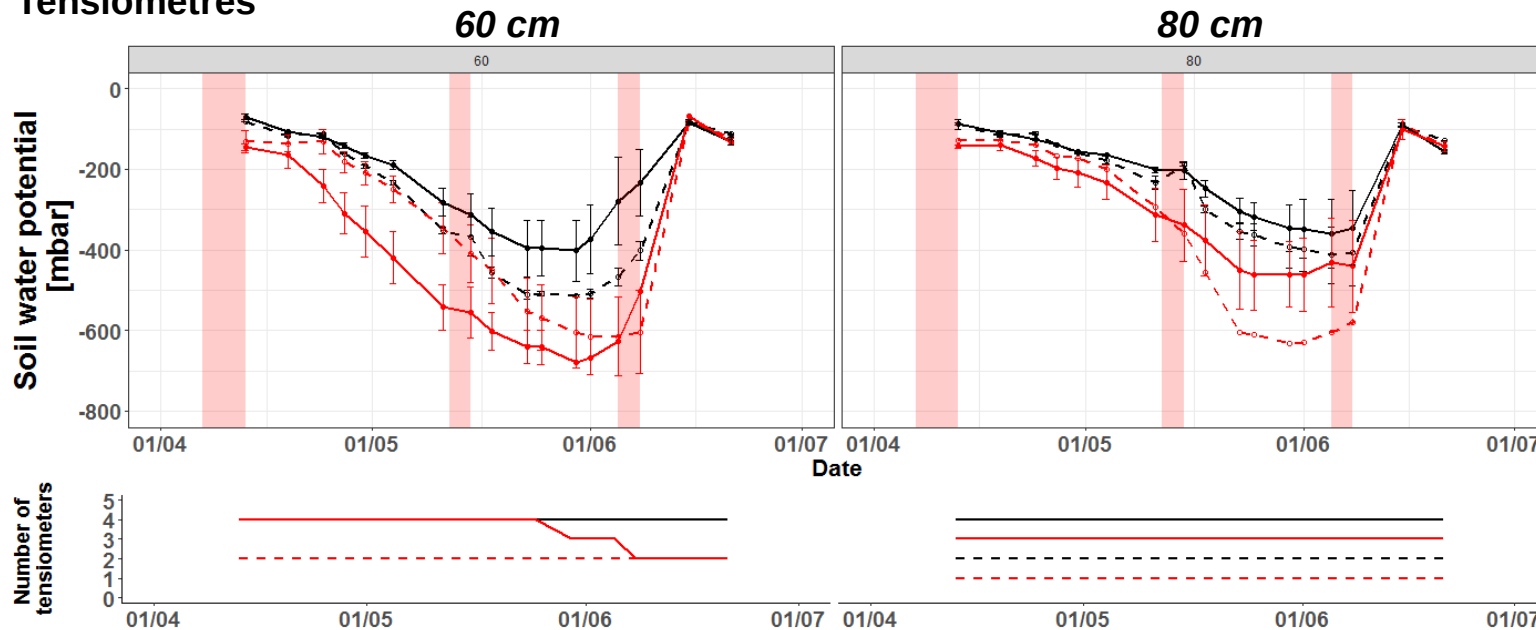
AF - CTRL

AF - EXCL

TA - CTRL

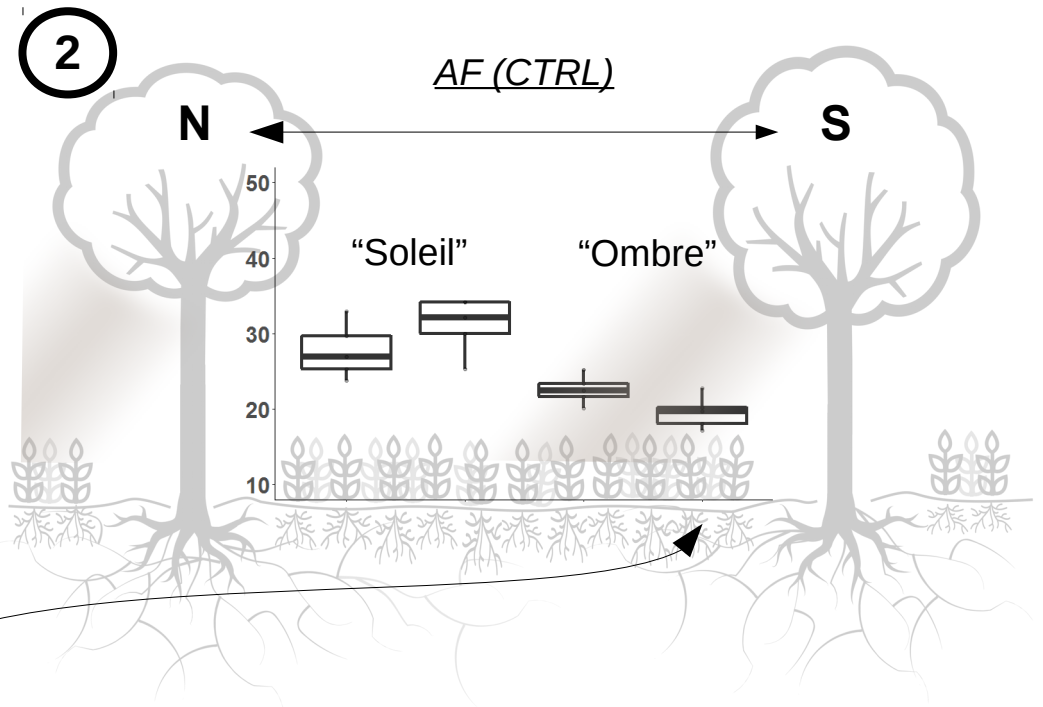
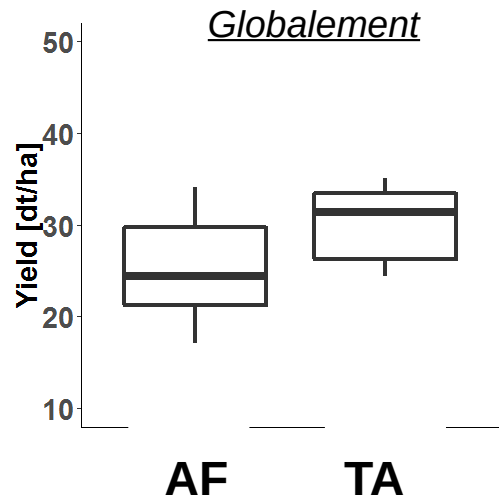
TA - EXCL

Tensiomètres



Expérimentation : Rendements

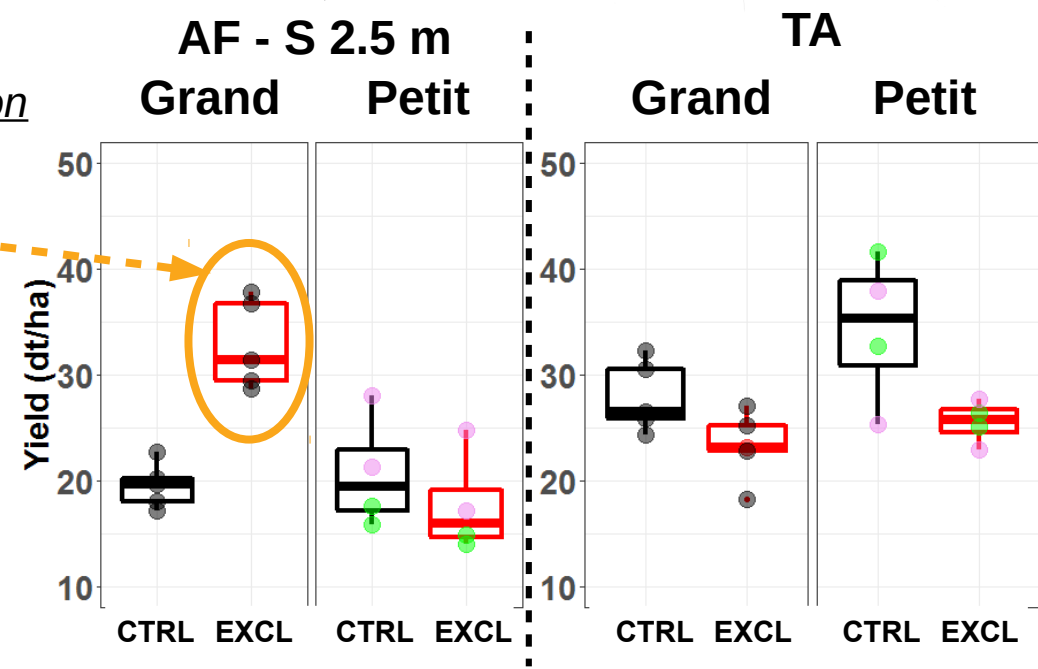
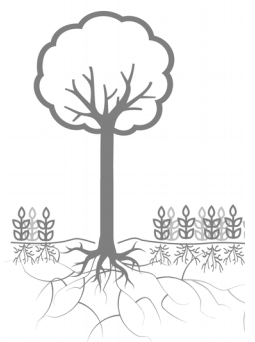
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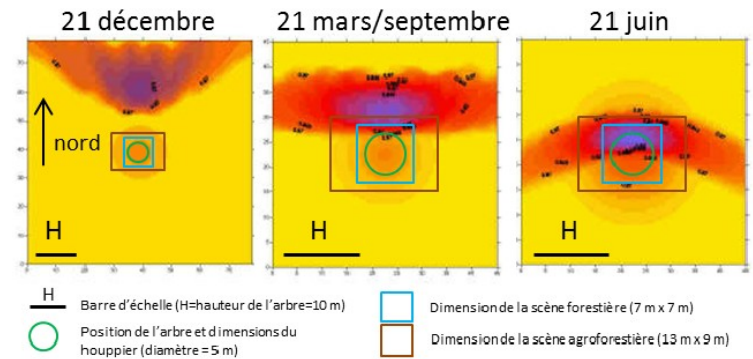
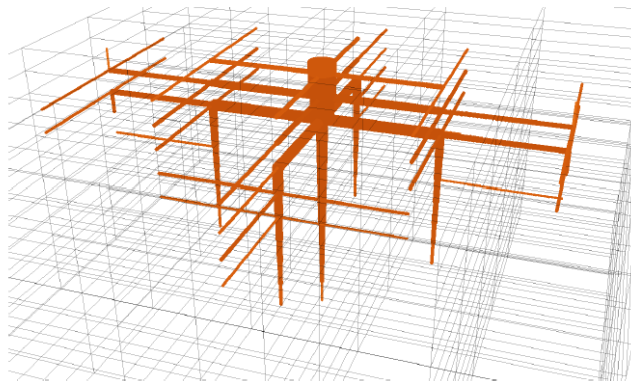
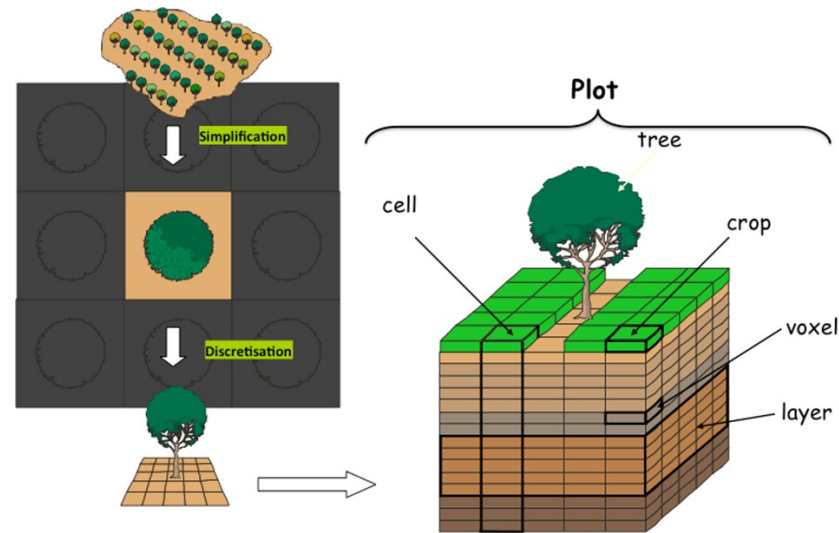
3

Dispositifs d'exclusion

Artefact



Modélisation : Hi-sAFe

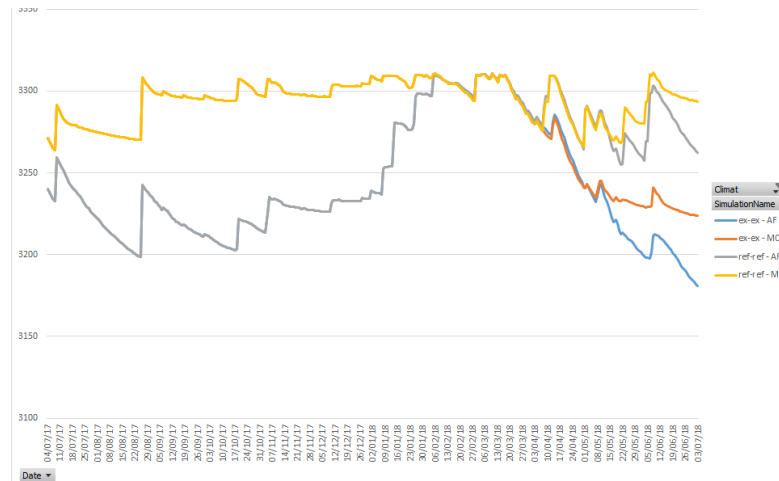


Modélisation : simulation cognitive

Simulation pour aider l'interprétation des données expérimentales obtenues sur l'expérimentation d'exclusion de pluie

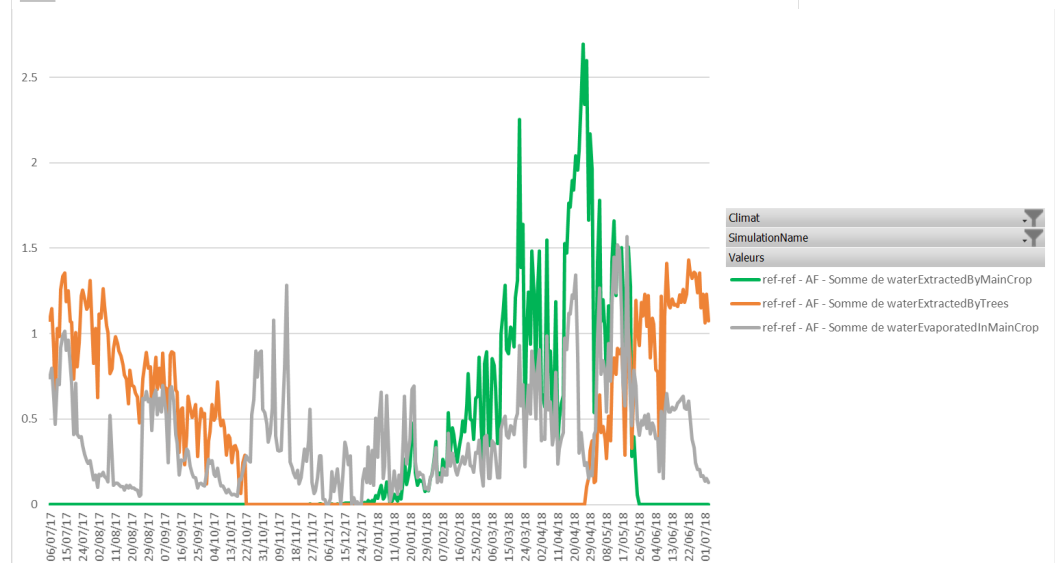
Prévision des stocks d'eau dans le sol

- Culture pure, pluie "normale"
- Culture pure, pluie "réduite"
- Culture associée, pluie "normale"
- Culture associée, pluie "réduite"



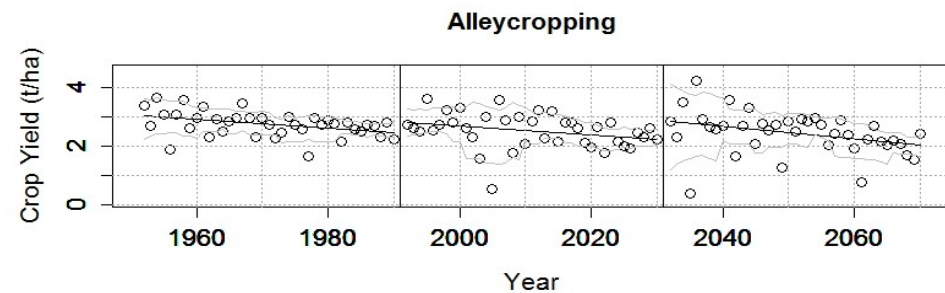
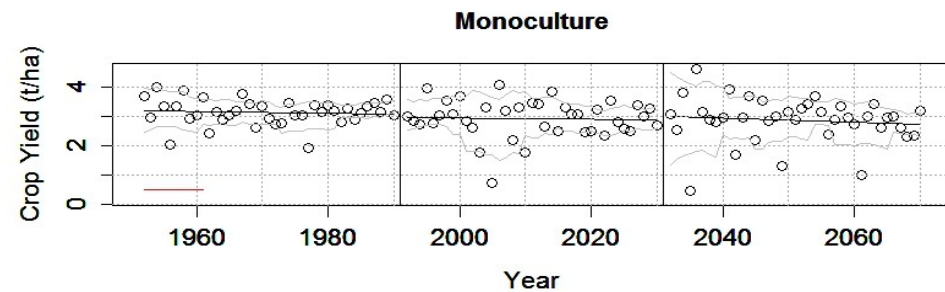
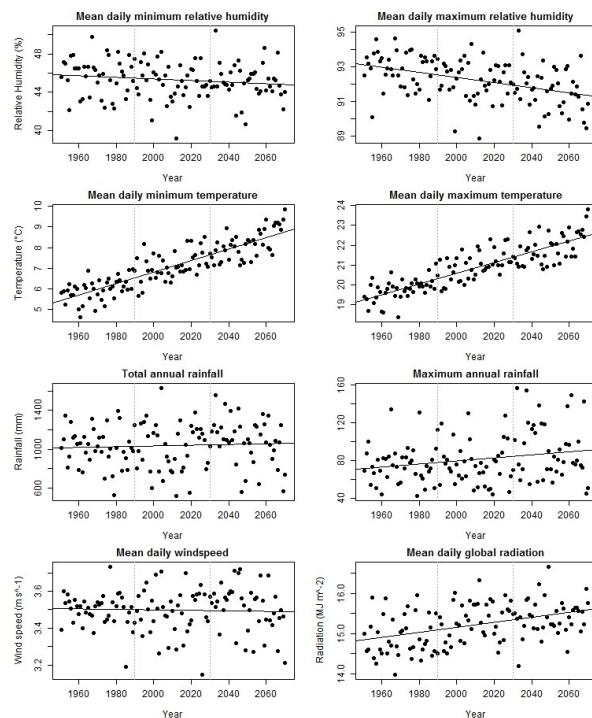
Compétition pour l'eau

- Arbre
- Culture intercalaire
- Sol



Modélisation : simulation prospective

Simulation du comportement à long terme des systèmes agroforestiers pour différents scénarios climatiques





Merci pour votre attention !

Guillaume BLANCHET

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Rainout Shelter(s) – experimented designs for total rainfall exclusion

“Big” rainout shelter

Covering 2 alleys, *i.e.* ~900 m²

Guyed structure across trees, foldable tarpaulins

3 trees “integrally excluded”

Constitute a block





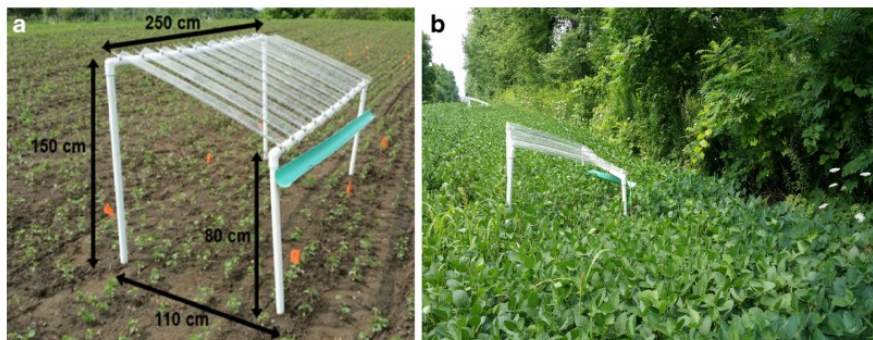
Experimental drought – a short review of rainout shelters design...



Puechabon experimental site, CNRS, France



Pheno3C, INRA, France



Canada, Nasielski et al, 2015



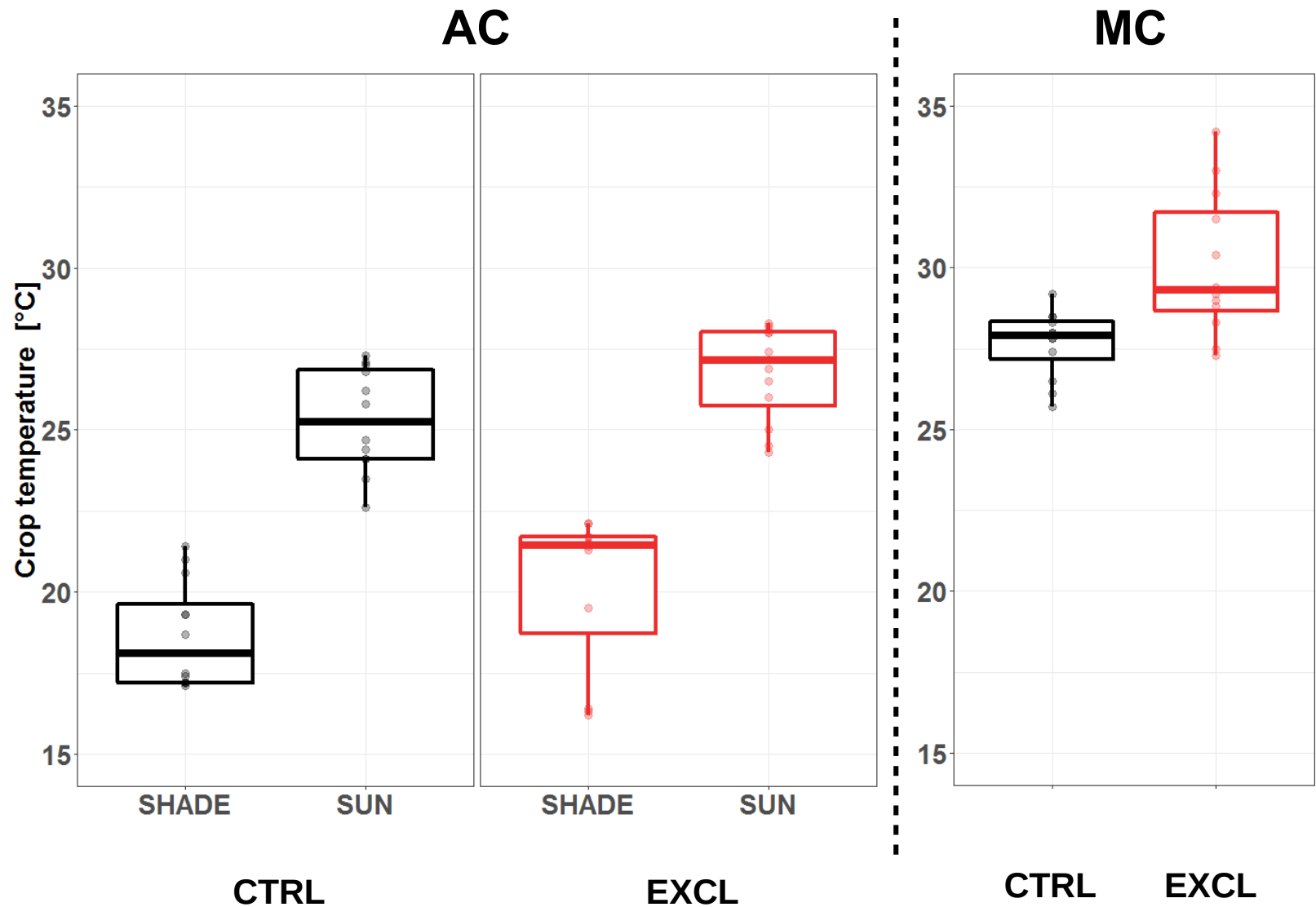
Germany, Erbs et al, 2012



Crop physiological responses to rain exclusion – first leads

Crop temperature

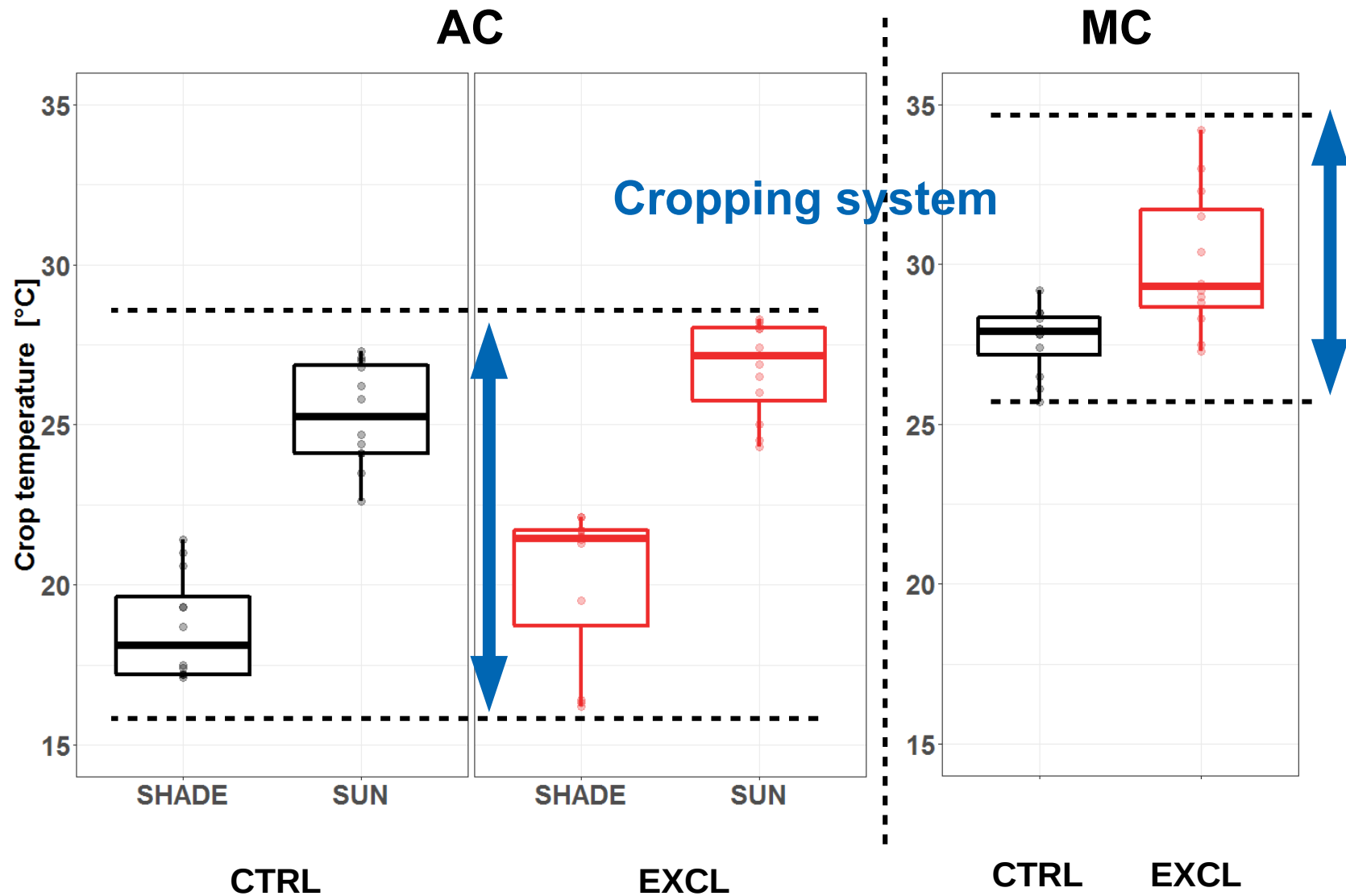
24th May, clear sky conditions, $T_{\text{air}} = 22.7 \text{ }^\circ\text{C}$





Crop physiological responses to rain exclusion – first leads

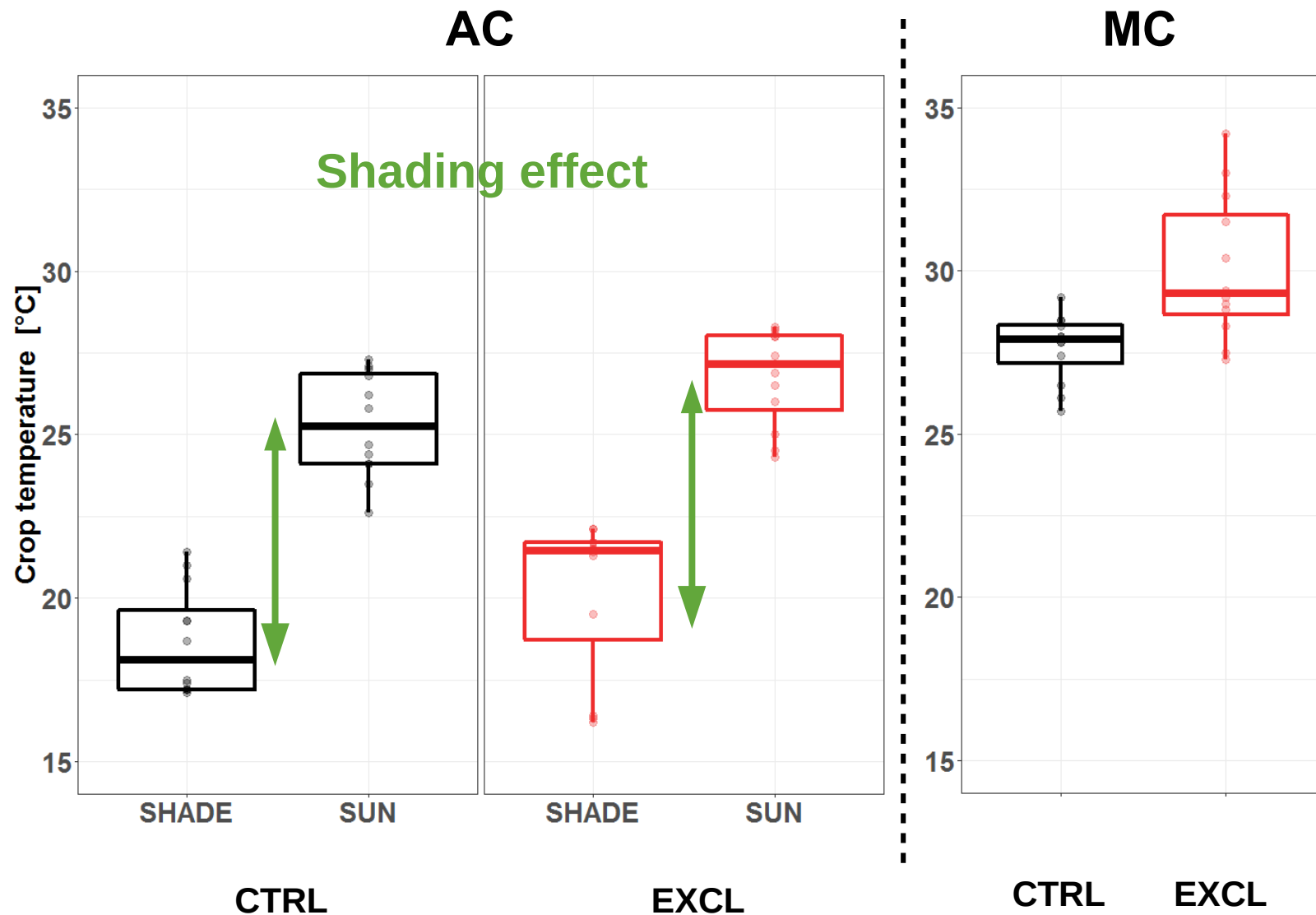
Crop temperature





Crop physiological responses to rain exclusion – first leads

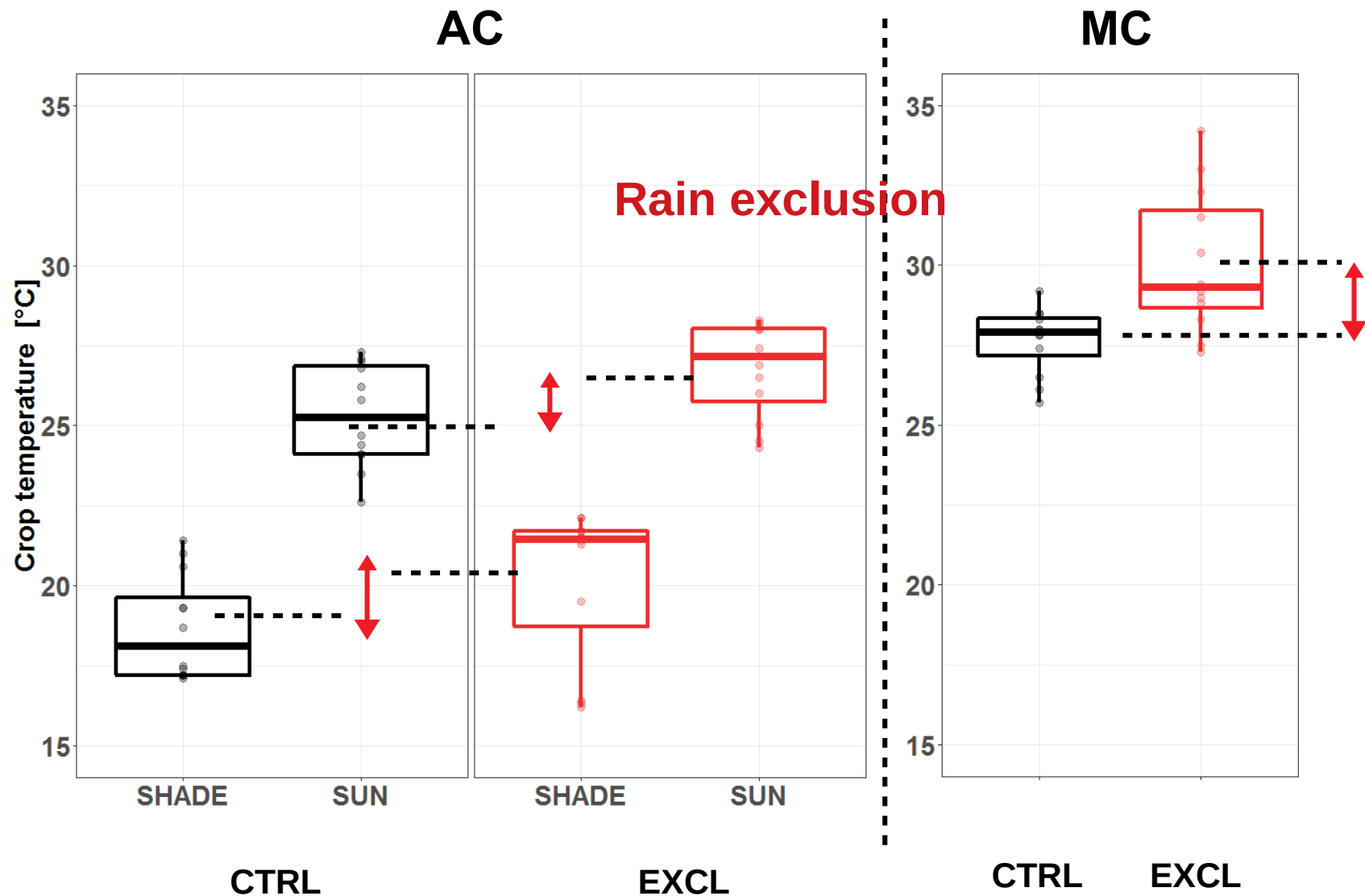
Crop temperature





Crop physiological responses to rain exclusion – first leads

Crop temperature

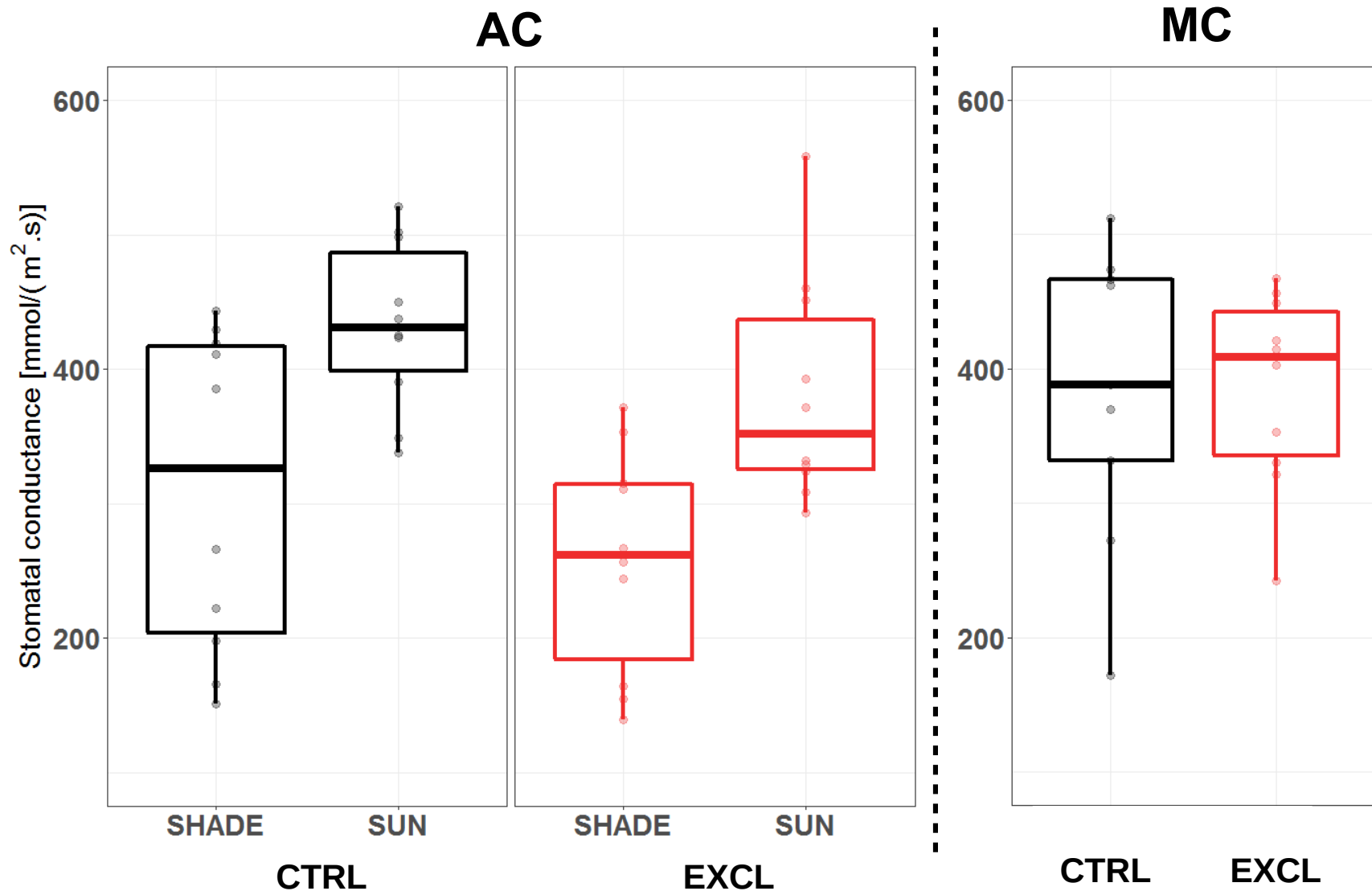




Crop physiological responses to rain exclusion – first leads

Stomatal conductance

Same day as for crop temperature's measurements

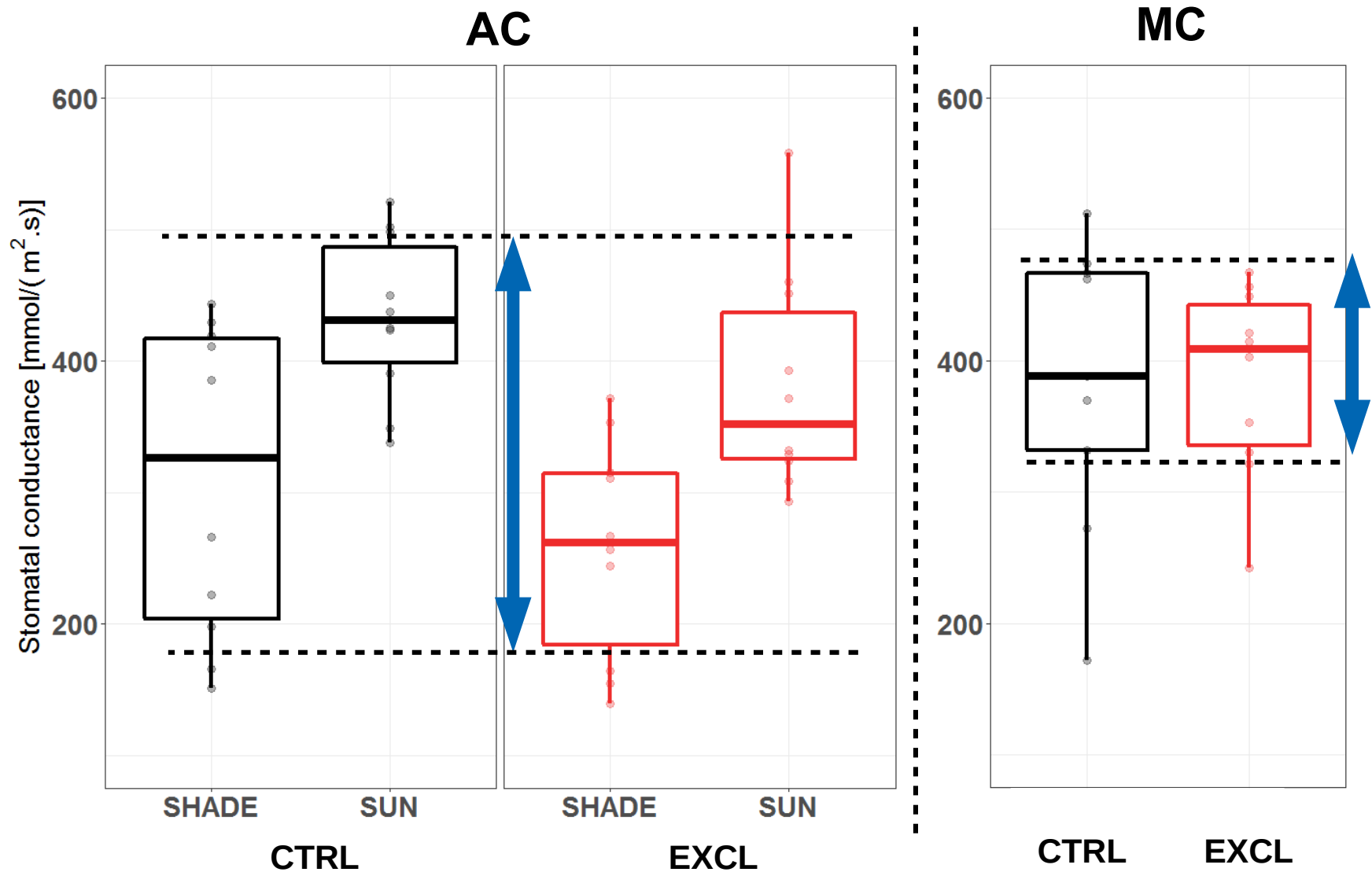




Crop physiological responses to rain exclusion – first leads

Stomatal conductance

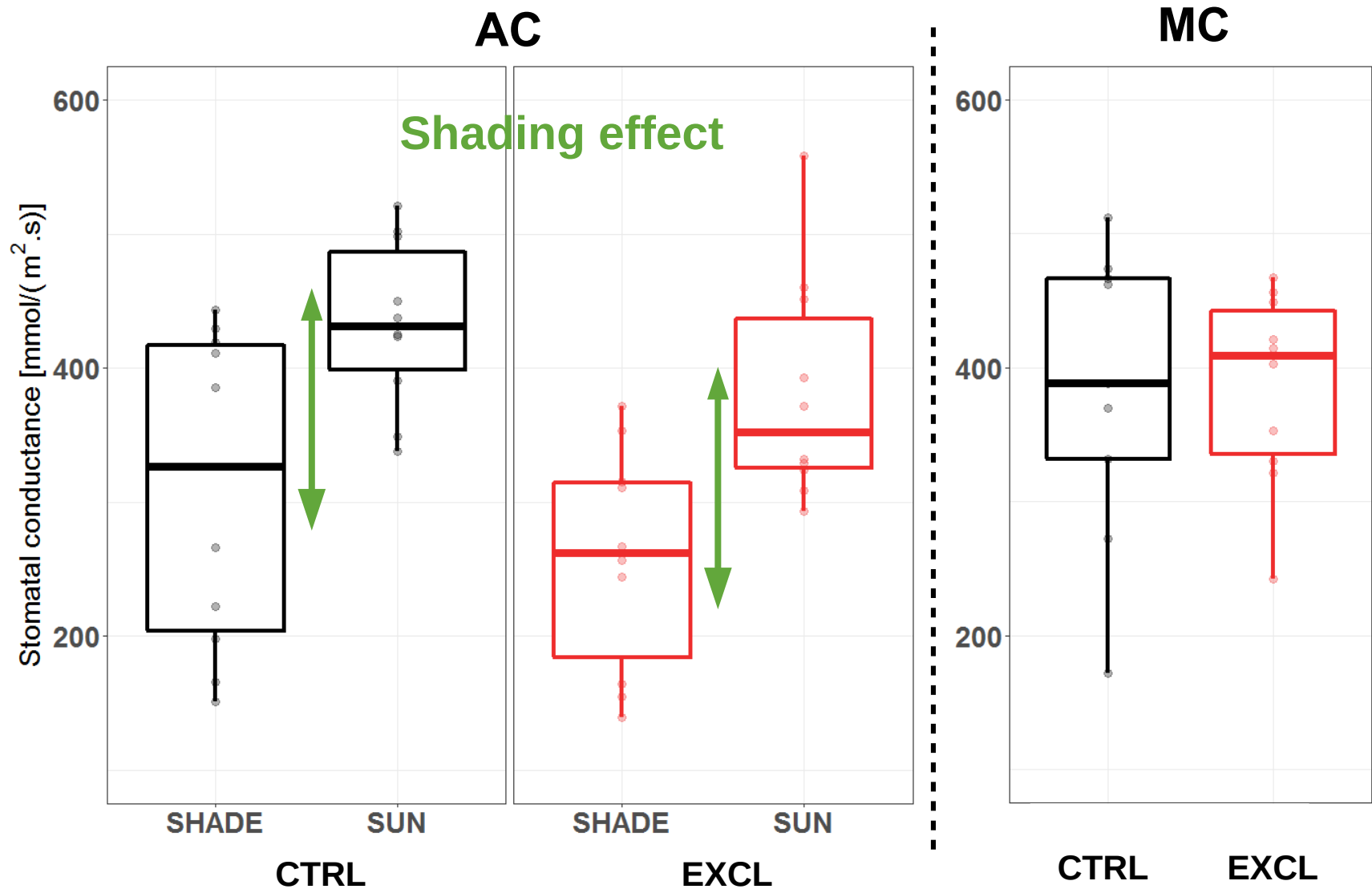
Cropping system





Crop physiological responses to rain exclusion – first leads

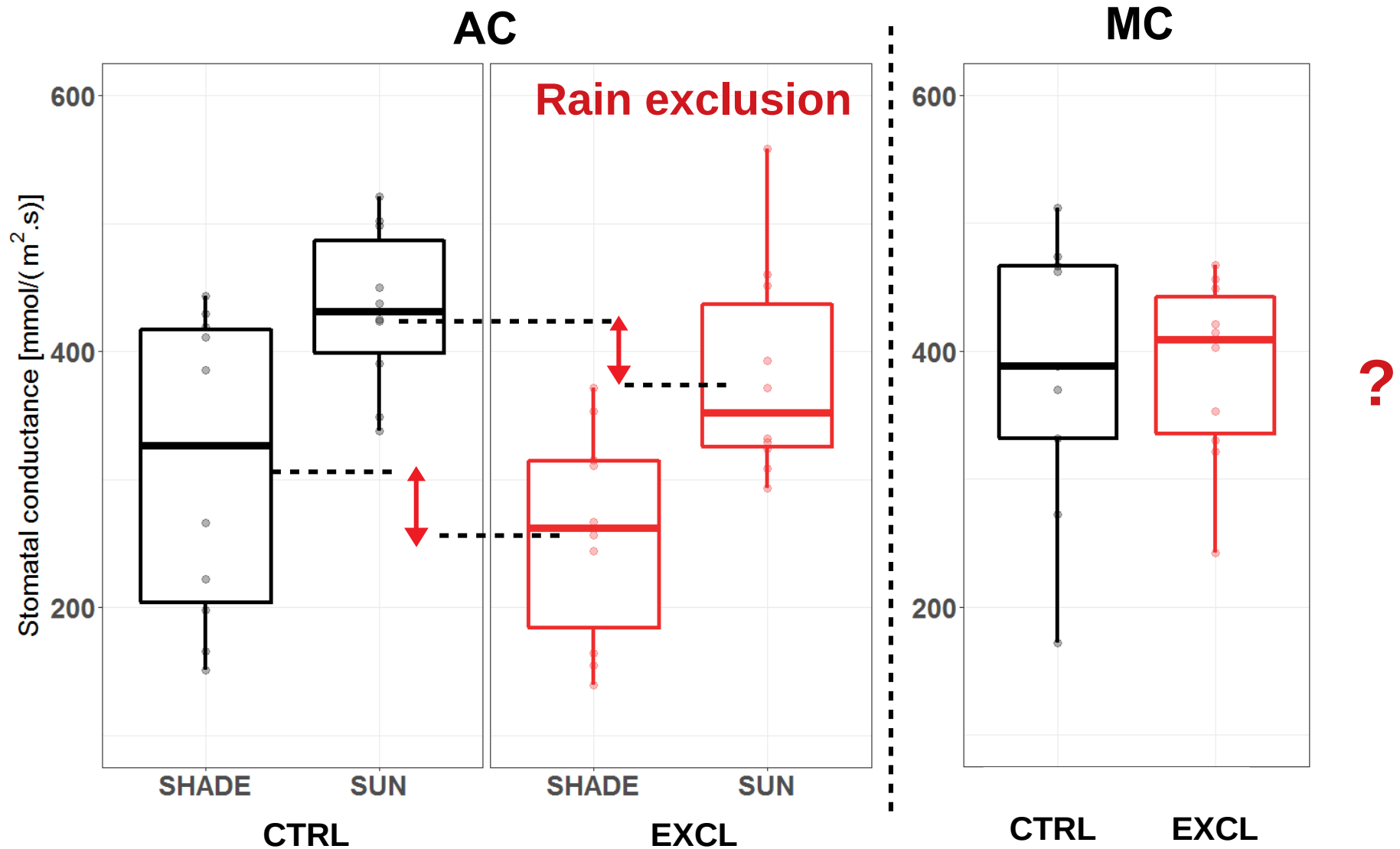
Stomatal conductance





Crop physiological responses to rain exclusion – first leads

Stomatal conductance



Synthesis

Methodology

Both rainout shelters (ROS) succeeded to induce significant drought conditions

Performing rain exclusion in AC systems appears to be a matter of compromise :

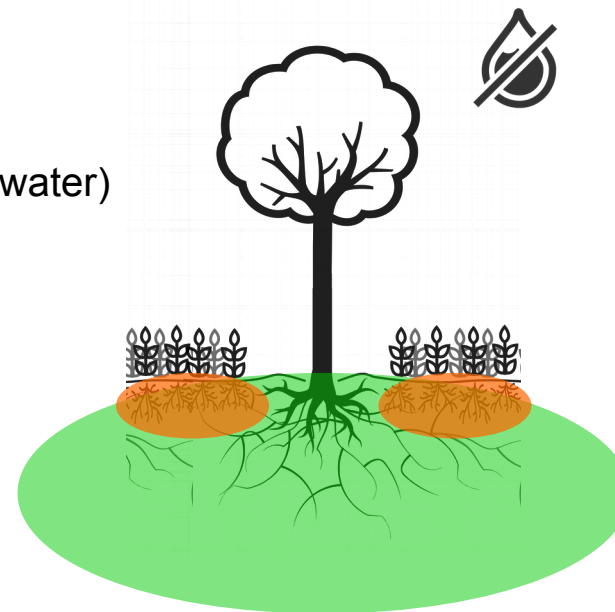
Potential artefacts

→ split-root effects
(→ dependency of tree to groundwater)

Spatial heterogeneity

→ in soil
→ among trees

Size of rainout shelters
(Experimentation site)



Replication

Technical feasibility
Costs

- Big ROS : better “exclusion scale” at the tree-crop level but heavy management (and replication issues)
- Small ROS : reasonable management load, replication possibility but higher risk of artefacts for tree-crop interaction study



Synthesis

Results

(Unbiased) yields data from this year are limited but tend to show reduced yield gap in AC compared to MC in case of drought – *need for reiteration of the experimentation*

Physiologically, crops responded to :

“System” > “Position within the alley” > “Drought”

But climatic conditions this year were “particular”...



References

den Herder, M., Burgess, P.J., Mosquera-Losada, M.R., Herzog, F., Hartel, T., Upson, M., Viholainen, I. and Rosati, A. (2015). Preliminary stratification and quantification of agroforestry in Europe. Milestone Report 1.1 for EU FP7 AGFORWARD Research Project (613520)

Erbs, M., Manderscheid, R., Weigel, H.-J., 2012. A combined rain shelter and free-air CO₂ enrichment system to study climate change impacts on plants in the field: Experimental drought stress and elevated CO₂. *Methods Ecol. Evol.* 3, 81–88. <https://doi.org/10.1111/j.2041-210X.2011.00143.x>

IPCC (2001): Climate change 2001: The scientific basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change (Houghton, J. T., Ding, Y., Griggs, D. J., Noguer, M., Van der Linden, P. J., Dai, X., Maskell, K. and Johnson, C. A. (Eds.)) Cambridge University Press, Cambridge and New York.

Schemas were designed with the help of open-source icons found on the Noun Project (thenounproject.com). Authors of the icons are : Reinnardio ("Tree") ; Brand Mania ("Crops") ; Grégory Montigny ("Root") ; Guilhem ("Roots") ; Juraj Sedlák ("Tractor") ; NAS ("Hot") ; Delwar Hossain ("No rain") ; Danielle Torres ("Join") ; Luisa Iborra ("France") ; Mike Rowe ("Drone")

Acknowledgements

Projet
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