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Do agroforestry practices improve tree performance compared to monoculture?

Case study of agroforestry plantations including fast-growing trees

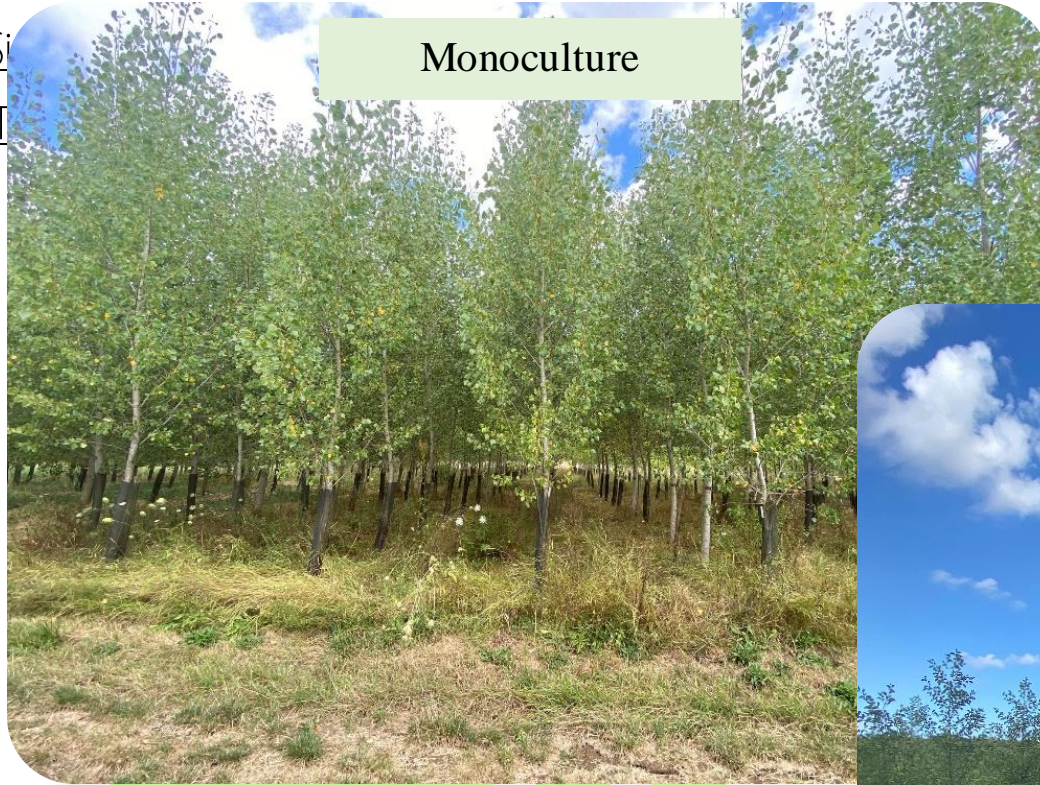
Anaïs THOMAS - Pierrick PRIAULT – Nicolas MARRON

5th European Agroforestry Conference – May 2021, Online Event

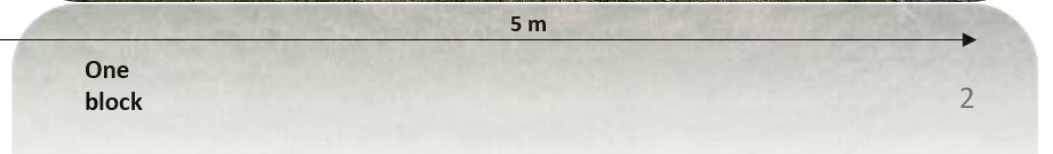
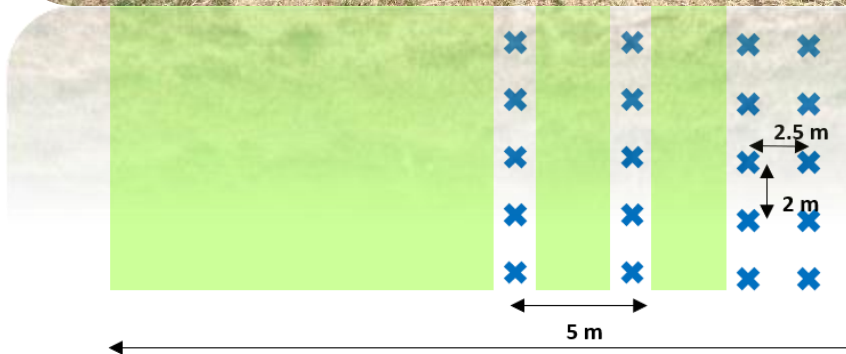
Experimental design

Site
I

Monoculture



Agroforestry





Objective

Compare growth performance of fast-growing trees (poplar, alder) in agroforestry to their respective monoculture.

→ Through the study of the effects of agroforestry on the intra / inter-annual growth dynamics of trees, compared to the respective monocultures.

Hypotheses

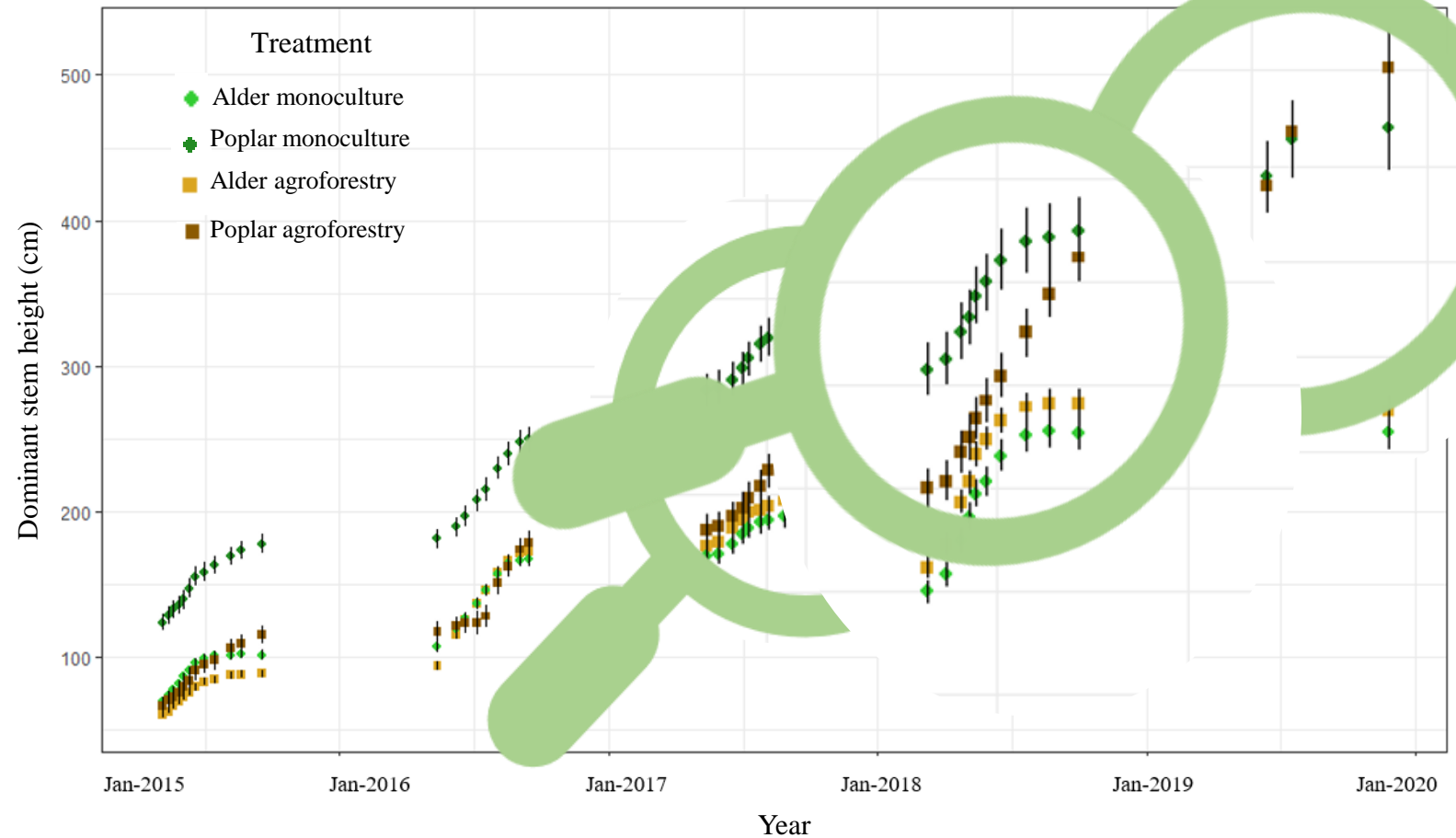
Trees will have better growth performances in agroforestry than in monoculture due to a combination of:

- (1) a *reduced competition* between species
- (2) a *facilitation* effect due to the presence of N₂ fixing species (alfalfa/clover)



Results

- Tree growth: height



- Until 2018, the mean height of poplars was higher in the monoculture than in AF.
- From 2018, poplars in agroforestry plots are catching up with poplars in monoculture.
- At the end of 2019, the mean height of poplars was higher in AF than in monoculture.
- For alders, the treatment had no significant effect on height during the five growing seasons.

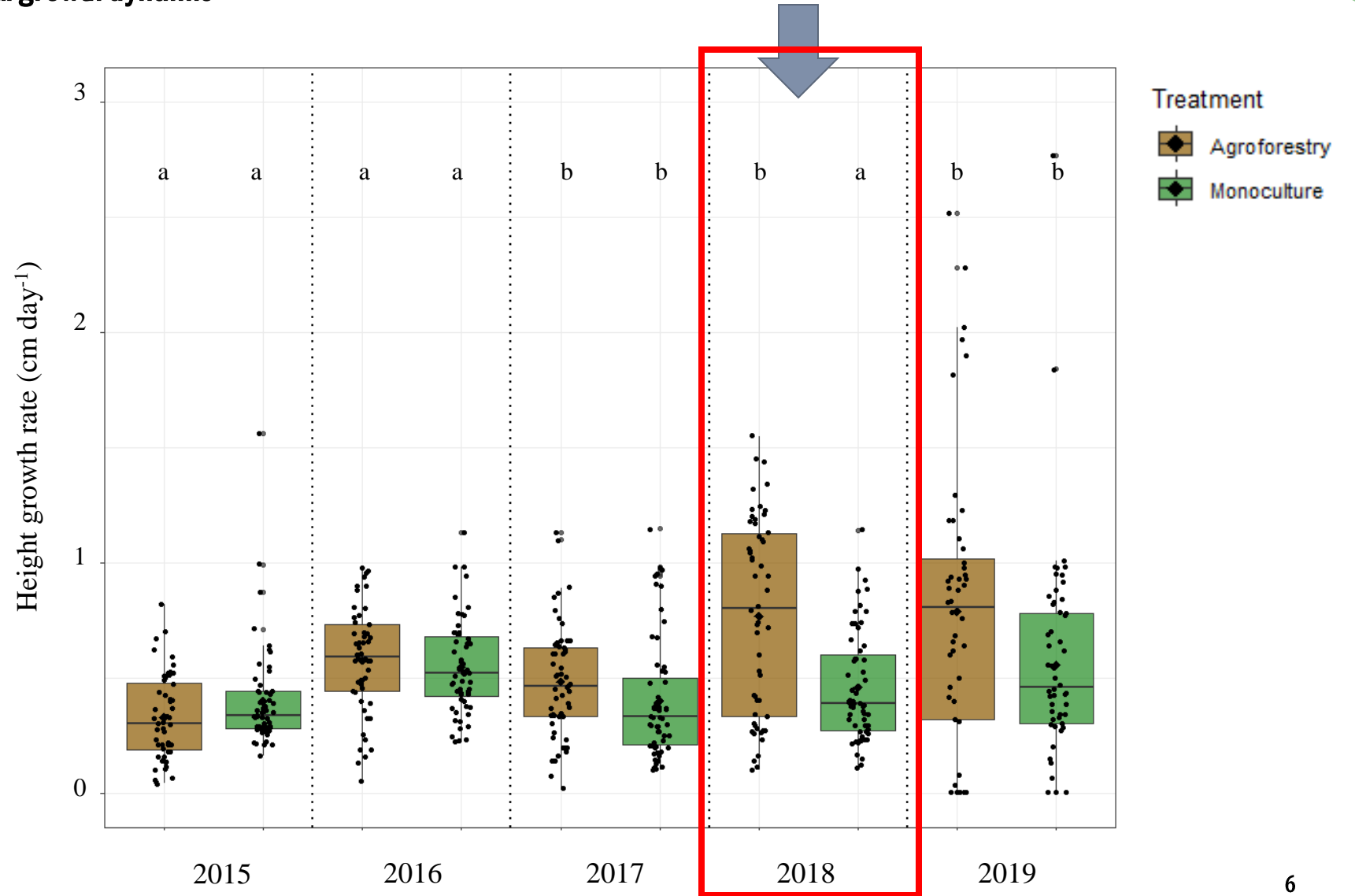


Results

- Inter-annual growth dynamic

In 2018, poplars had a higher height growth rate in agroforestry than in monoculture ($P \leq 0.001$)

Poplars

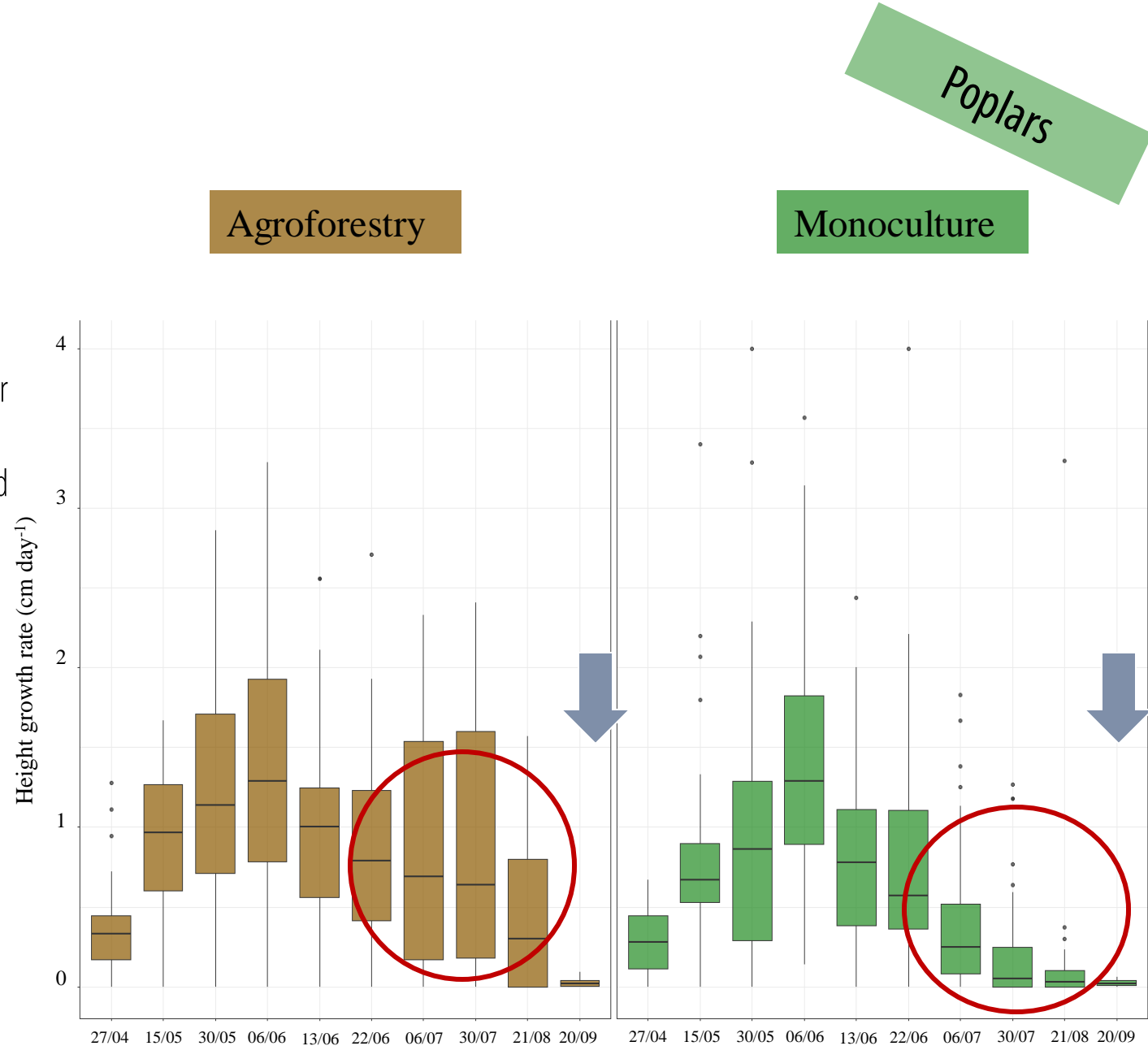




Results

- Intra-annual growth dynamic

- Poplars in agroforestry exhibited a higher height growth rate than poplars in monoculture over the July-August period ($P \leq 0.001$)
- The growth of poplars in monoculture was stopped from August
- In september, poplar growth was stopped in monoculture and agroforestry





Results

- Height to DBH ratio

		H/DBH ratio (m.cm ⁻¹)		
		2017	2018	2019
Poplar	Monoculture	1.75 ± 0.03 ^a	2.07 ± 0.1 ^b	1.53 ± 0.04 ^b
	Agroforestry	2.26 ± 0.08 ^b	1.66 ± 0.04 ^a	1.25 ± 0.03 ^a
Alder	Monoculture	2.19 ± 0.04 ^b	1.79 ± 0.03 ^a	1.49 ± 0.02 ^b
	Agroforestry	2.16 ± 0.05 ^b	1.61 ± 0.03 ^a	1.36 ± 0.02 ^a
		S NS	S NS	S *
		T NS	T NS	T **
		SxT ***	SxT NS	SxT *

- In 2017, h/d ratio was higher for poplars in agroforestry plantation than poplars in monoculture.
- From 2018, there was a clear decrease of the h/d ratio where poplars in agroforestry showed a lower ratio than poplars in monoculture.
- In 2019, agroforestry alders had a lower h/d ratio than alders in monoculture.



Discussion

Change in the type of interaction over time between alfalfa (- clover) and poplars in the agroforestry treatment.

- 2015 to 2018: poplars in AF had a lower growth rate compared to these in monoculture.
 - ✓ Due to the presence of crops which can reduce resource availabilites of tree, thereby reducing their growth.

(Dawson et al., 2001 ; Gakis et al., 2004 ; Burgess et al., 2005)

PREDOMINANT COMPETITION

- Since 2018:

(1) Growth rate of

(2) There was a lo

For alders, agroforestry practices didn't impact growth performances after 6 years.

in agroforestry compared to monoculture

- ✓ Alfalfa/Clover → as a N₂-fixing species, tree growth could be improved.

(Taghiyari and Efhami, 2001 ; Rivest et al., 2009)

- ✓ Every second row of trees having been replaced by the crop → reducing the competition for light between the trees possible.

(Benomar et al., 2013)

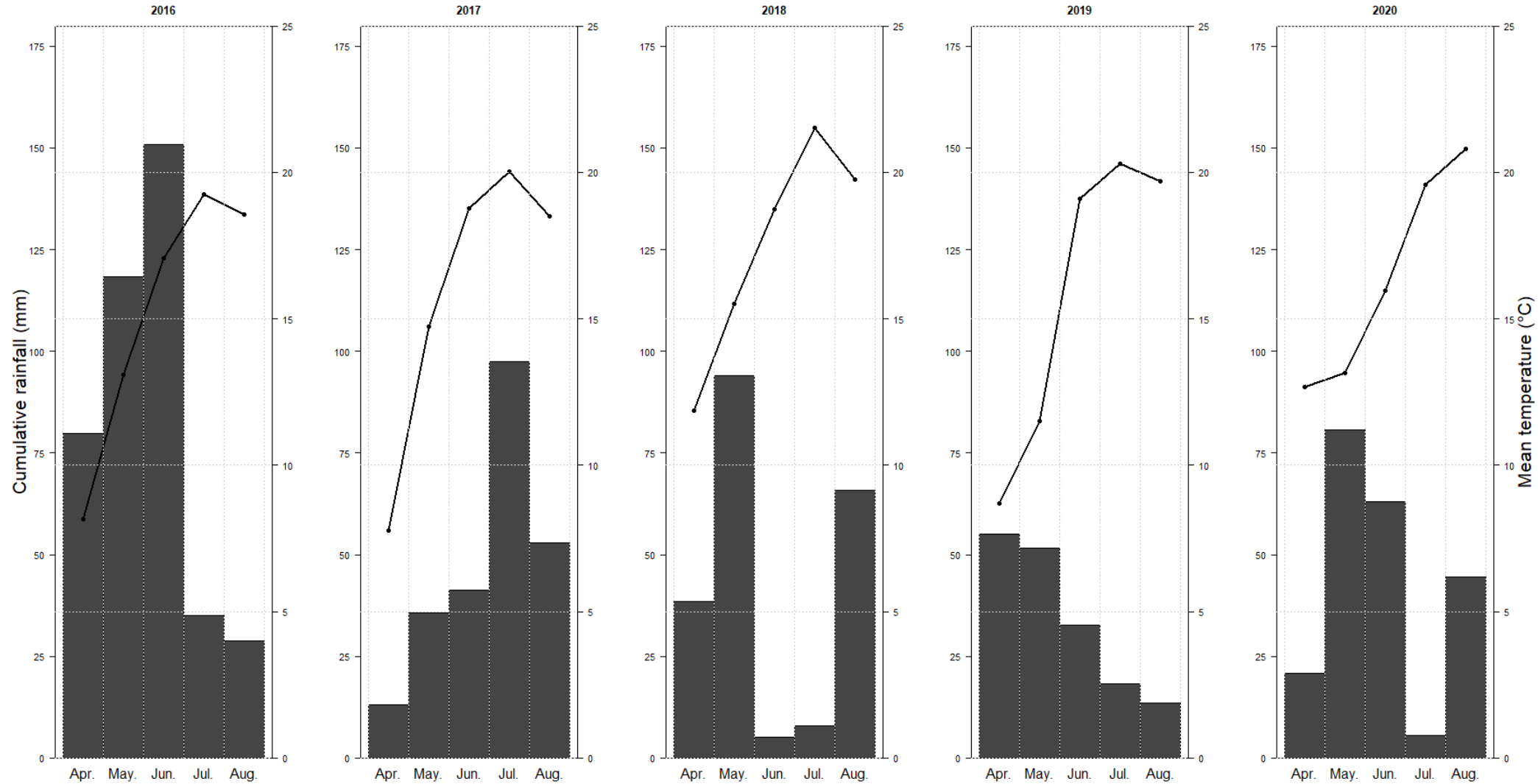
COMBINATION OF FACILITATION AND NICHE DIFFERENTIATION

A photograph of a grassy field with several cars covered in green plastic sheeting, surrounded by young trees in a plantation setting. The sky is blue with scattered white clouds. The text "Thank you for your attention" is overlaid in the upper center of the image.

Thank you for your attention

For more details: Thomas et al., 2021. Growth dynamics of fast-growing tree species in mixed forestry and agroforestry plantations. *Forest Ecology and Management*, 480, 118672.

Supplementary data – Climate conditions



Supplementary data – Soil organic nitrogen content (N-NO_3^-)

