



PINEA SPOT CONGRESS

LISBON 2023

21 TO 23 NOVEMBER





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“Enhancing *Pinus pinea* intra-annual growth dynamics in mixed species stands on the Spanish Northern Plateau – preliminary results”.

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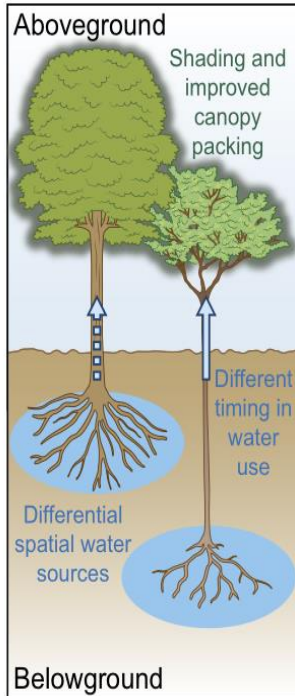
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1. Introduction

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Resource partitioning



Facilitation

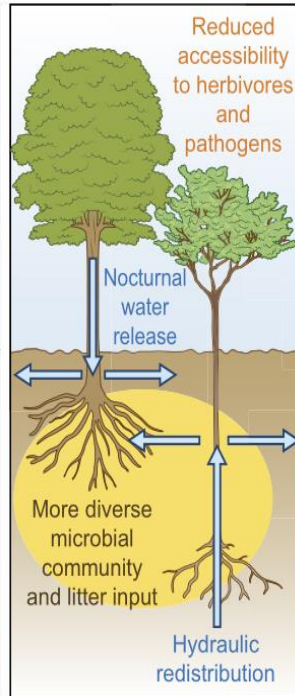


Fig. 2. Spatio – temporal complementarity mechanisms. Grossiord 2020

- 1) Growth in Mediterranean climate is controlled mainly by **water availability**.
- 2) **Bi-modal intra-annual growth** of trees : growth in spring and autumn, constrained in summer; dormancy in winter.
- 3) **Growth reduction and local decay** of *Pinus pinea* in the Mediterranean Basin.
- 4) **Spatio – temporal complementarity**: alleviating the stress effects (climate change context).

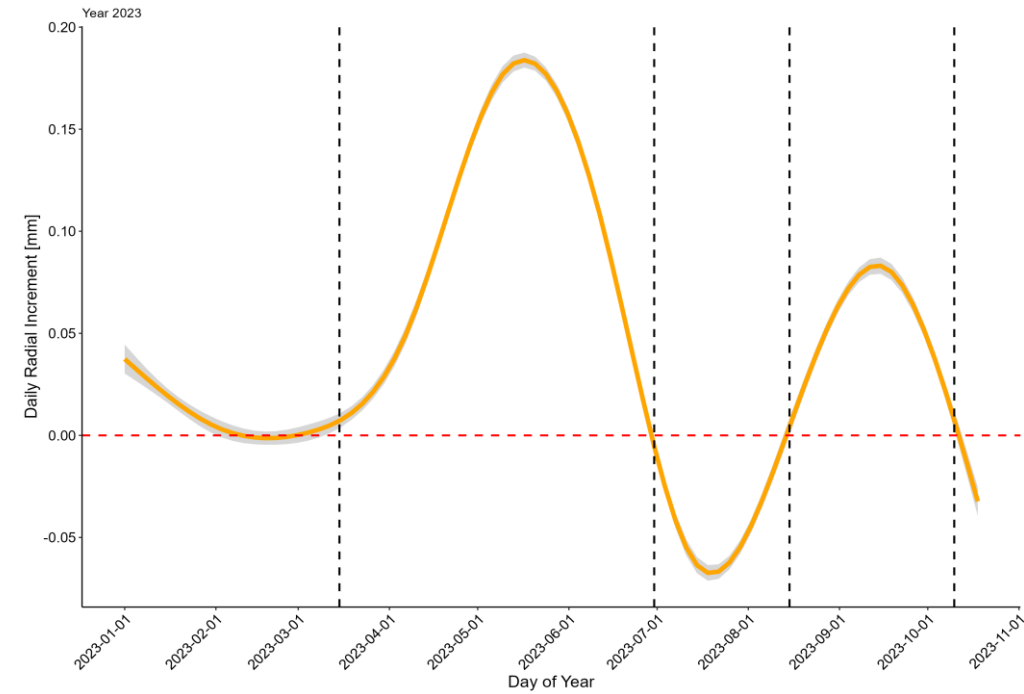


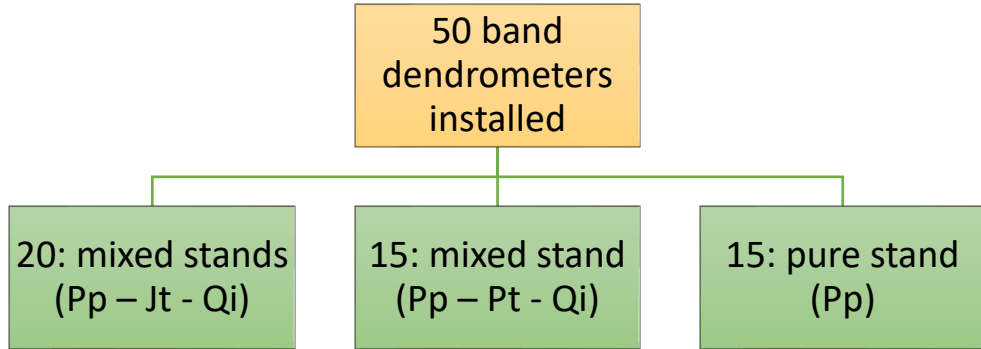
Fig. 1. *Pinus pinea* daily radial increment annual pattern.

Questions:

1. Does the **phenology** of *Pinus pinea* vary with **stand composition**?
2. Does **stand composition** have an effect on the **seasonal growth** of *Pinus pinea*?
3. Does the **daily growth** of *Pinus pinea* respond differently to **climate conditions** depending on **stand composition**?

2.1. Methodology

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- 1) On trees covering all DBH range
- 2) Bi-weekly (March - October) or monthly reading (November - February)
- 3) Period from 04.2022 – 10.2023
- 4) **Circumference change** reading with electronic calliper, up to 0.01 mm.

TREE	25.04.2022	18.05.2022	30.05.2022
1352	19.3	19.7	19.8

Climate: Continental Mediterranean
Average yearly temperature: 13.4 °C
Sum of precipitation: 432 mm
Potential Evapotranspiration : 1128 mm
Climatic Water Balance: - 696 mm

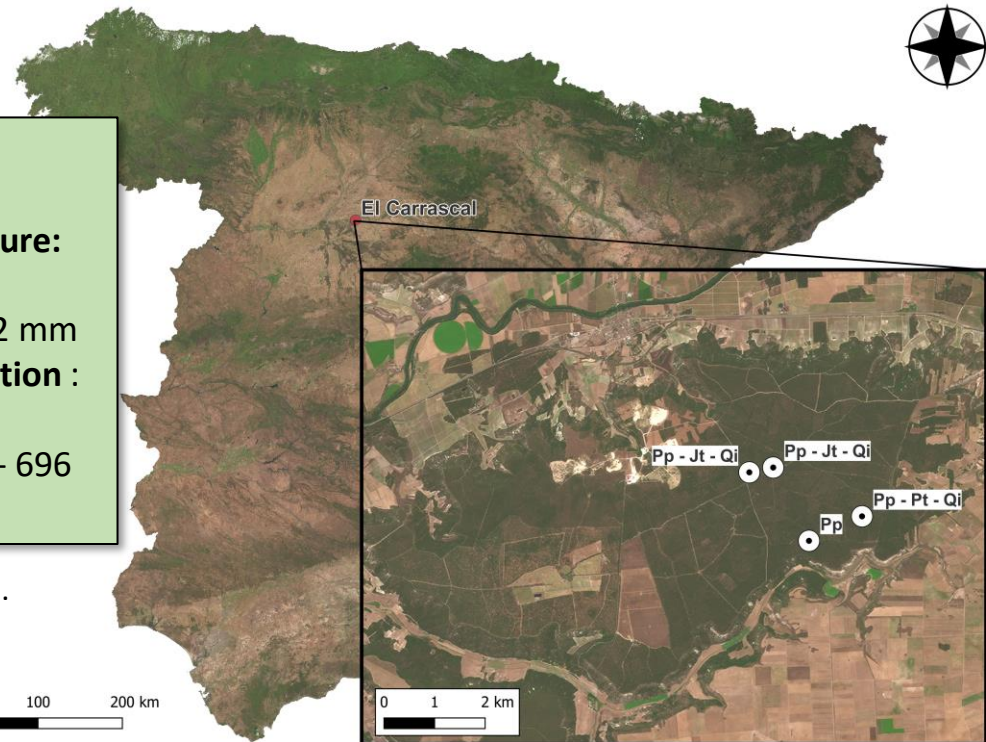


Fig. 3. Sample plots location.



Fig. 4-5. Band dendrometers.



2.2. Methodology

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1) Daily Radius Increment: $DRI = RI_t / (n \text{ days})$

2) Periodical Radius Increment:
 $PRI = \sum_{Month\ Init}^{Month\ End} DRI$

- March – June
- July – August
- September – November
- Annual

3) Cumulative Radius Increment:
 $CRI = \sum_{t1}^{tn} DRI$

Mixed models for corroborate questions 2 & 3:

$$2) PRI_{ijp} = \mu + Composition + Year + DBH_{init} + Composition \times Year + u_{Tree} + v_{Plot} + \epsilon_{ijp}$$

$$3) \log(DRI_{ijk} + 1) = \mu + Composition + DBH_{init} + TempMaxAvg7 + Precip14 + Composition \times TempMaxAvg7 + Composition \times Precip14 + u_{Tree} + v_{Plot} + z_{Month} + AR1(Month|Plot)$$

3. 1. Results: Does the phenology of Pinus pinea vary with stand composition?

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- Growth onset: **earlier** on both **mixed stands** types (2022)
- Growth recuperation: **similar** in all stands
- 5% of annual growth attained **earliest** in **mixed Pt stand** (2022)
- 95% of annual growth reached **earliest** in **mixed stands**
- Growing season extended to December (2022)

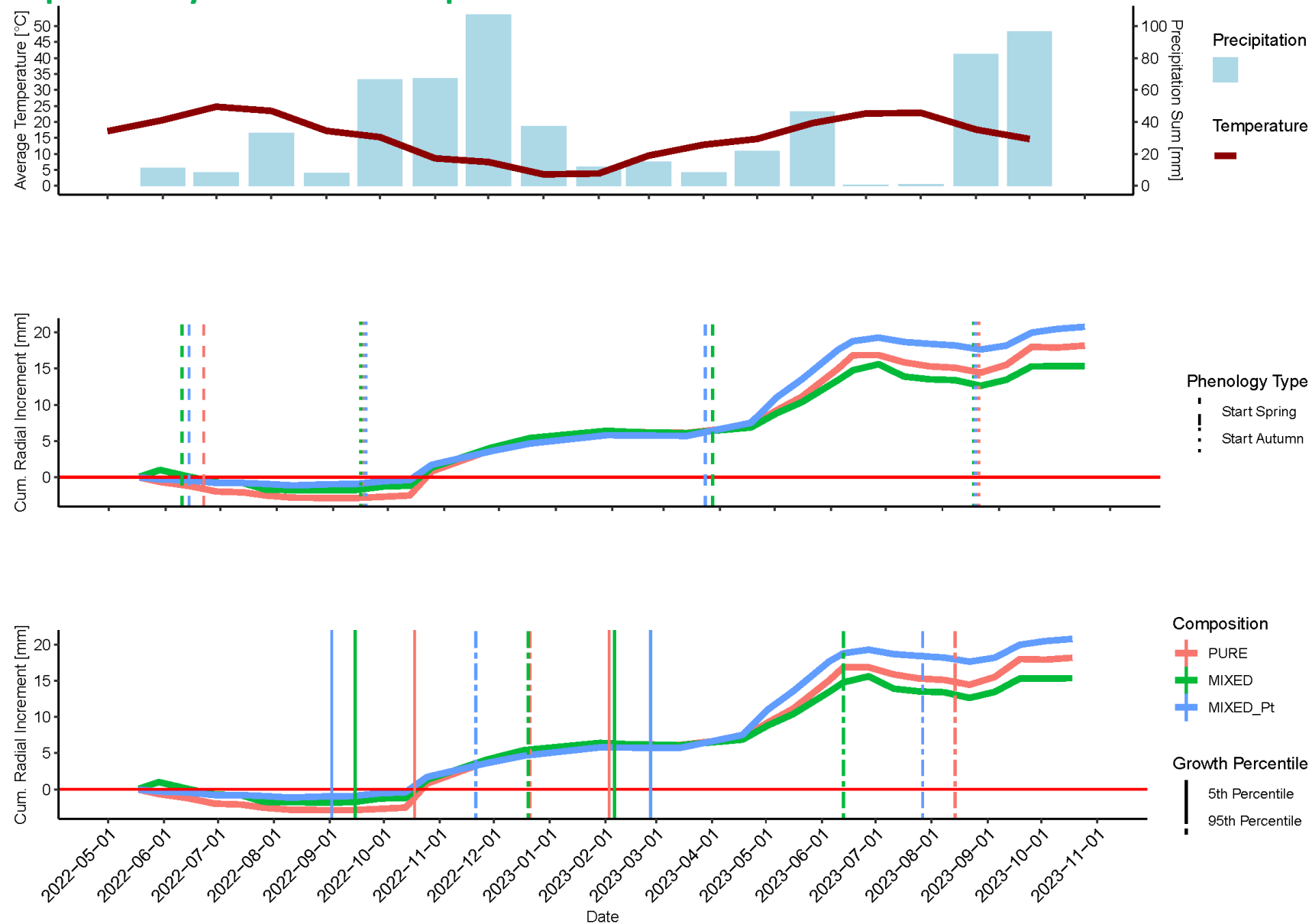


Fig. 6. Phenology and growth pace of Pinus pinea contrasted with climate characteristics during 2022 – 2023.

3.2. Results. Does stand composition have an effect on the seasonal growth of *Pinus pinea*?

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- **Composition** influences the periodical growth only **during summer** (July - August);
- **Mixed-Pt stands:** summer growth suppression alleviated;
- The lowest growth in **mixed stands** during summer.

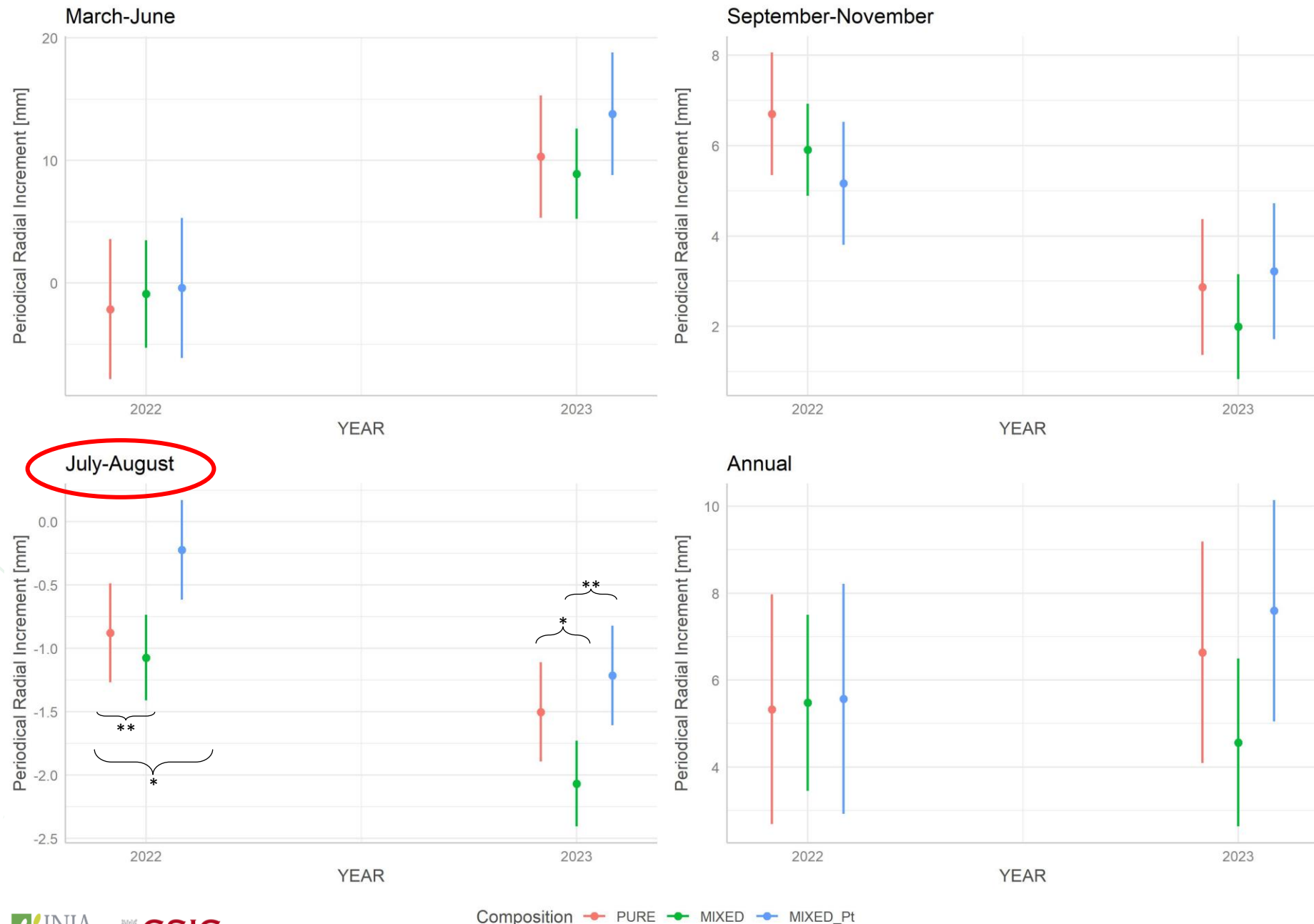


Fig. 7. Estimated marginal means of periodical increments, separately for each composition.

3.3.1. Results. Does the daily growth of *Pinus pinea* respond differently to climate conditions depending on stand composition?

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- Highest daily growth in **mixed-Pt stands**;
- Lowest daily growth in **mixed stands**;
- Intermediate daily growth in **pure stands**;
- The trend becomes stronger during **late spring** (max. growth) and **summer** (min. growth).

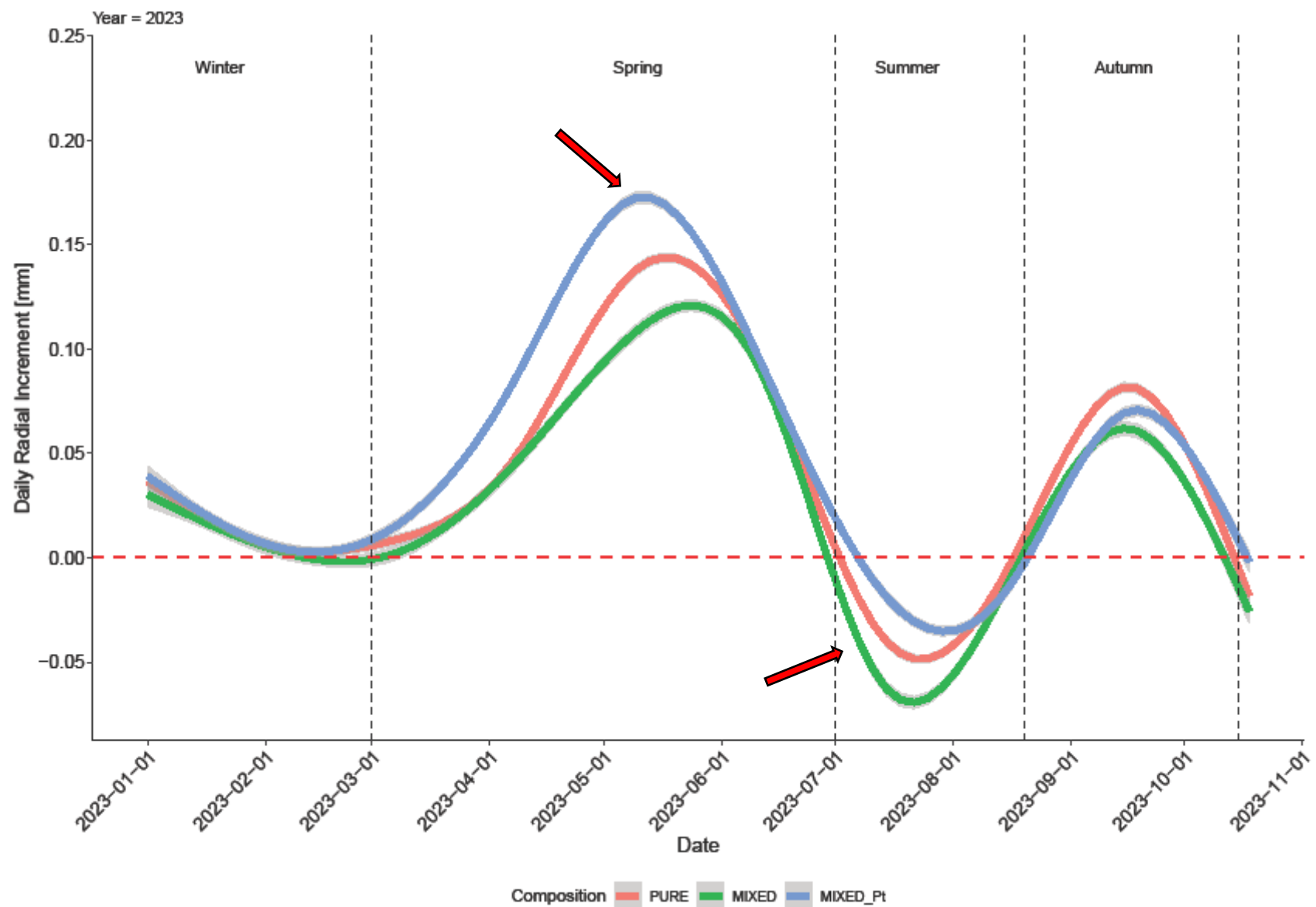
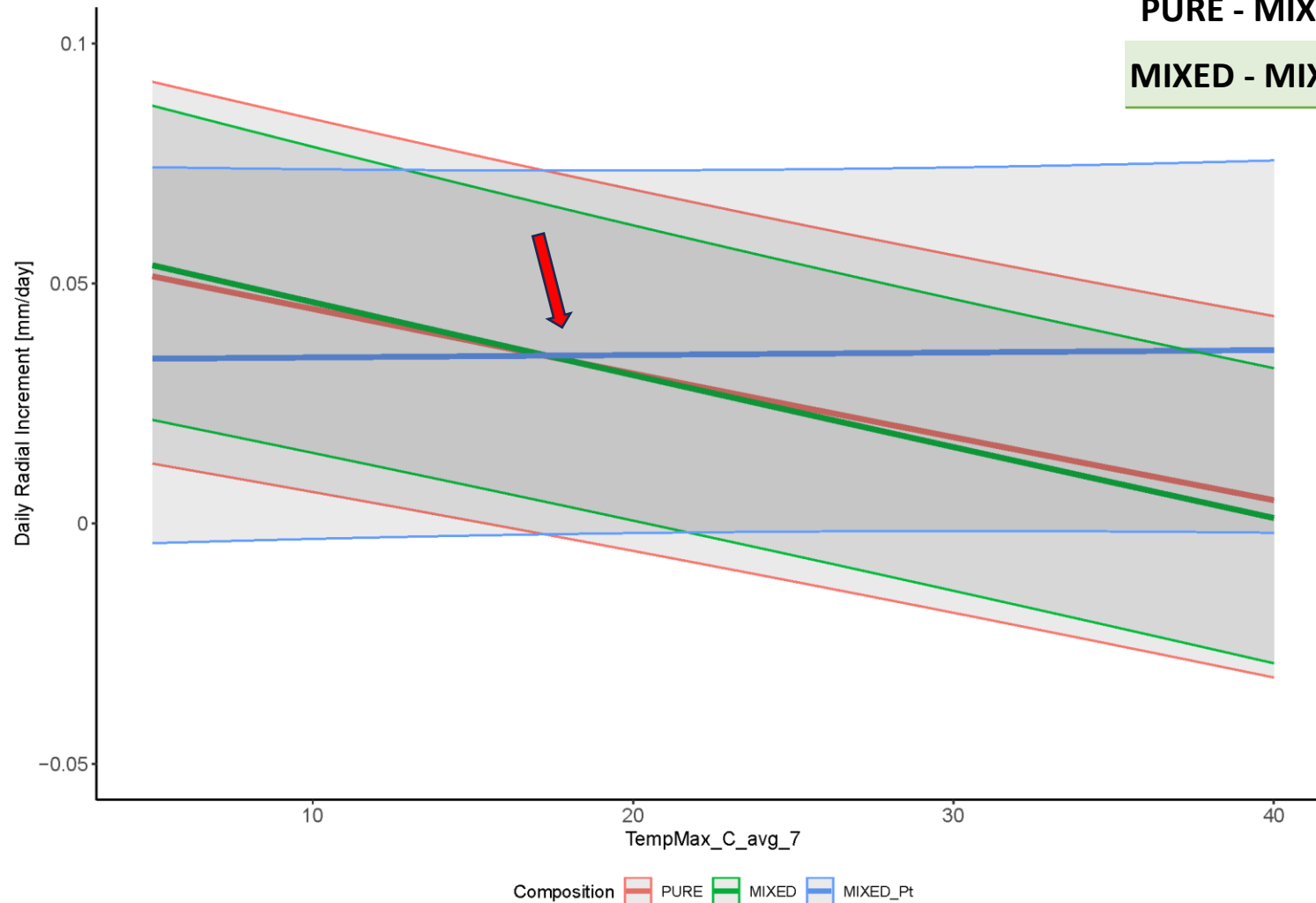


Fig. 8. Predicted Daily Radial Increment Rate in each stand type, during 2023.

3.3.2. Results. Does the daily growth of *Pinus pinea* respond differently to climate conditions depending on stand composition?

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Contrast	A	B	Estimate	P-value
PURE - MIXED	-0.00130	-0.00146	0.00017	0.88608
PURE - MIXED_Pt	-0.00130	0.00005	-0.00135	0.00141
MIXED - MIXED_Pt	-0.00146	0.00005	-0.00151	0.00008



- Stone pine **low sensitiveness** to temperature increase in **mixed-Pt stands**.
- The temperature suppresses DRI in **pure** and **mixed stands** in a similar way;
- Daily growth **with Pt** lower up to $\sim 20^{\circ}\text{C}$ threshold; after, daily growth becomes higher than in **pure** and **mixed stands without Pt**.

Fig. 9. Predicted Daily Radius Increment, conditioned on maximum temperature average 7 days before growth, separately for each composition.



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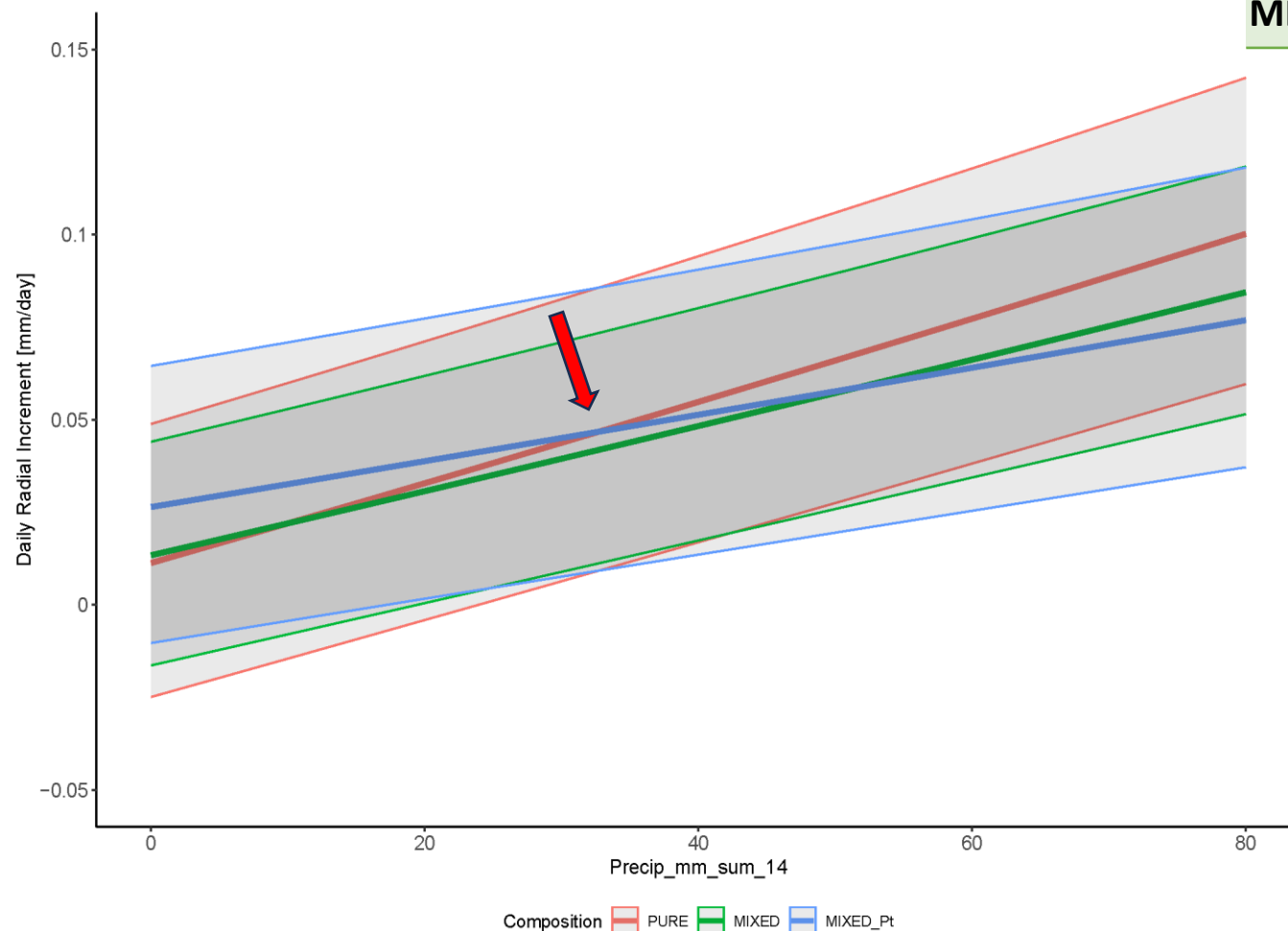


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3.3.3. Results. Does the daily growth of *Pinus pinea* respond differently to climate conditions depending on stand composition?

Contrast	A	B	Estimate	P-value
PURE - MIXED	0.00105	0.00085	0.00021	0.06893
PURE - MIXED_Pt	0.00105	0.00060	0.00045	0.00002
MIXED - MIXED_Pt	0.00085	0.00060	0.00025	0.02204



- No difference in reaction to precipitation between pure and mixed stands.
- While growing in mixed stands with *Pinus pinaster*, the reaction to precipitation is less pronounced than in pure or mixed stands without Pt.
- During low precipitation periods (< 35 mm), daily growth rate higher in mixtures with Pt.

Fig. 9. Predicted Daily Radius Increment, conditioned on precipitation sum 14 days before growth, separately for each composition.

4. Conclusions

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- 1) *Pinus pinea* growth was higher in mixed stands with *Pinus pinaster*, such in terms of cumulative growth, as daily growth.
- 2) Mixing with *Pinus pinaster* enhances the growth mostly during water- limited conditions (summer 2022 – 2023, spring 2023).
- 3) Possible explanation: *Pinus pinaster* competitiveness is suppressed under water stress >>> more resources for *Pinus pinea*.



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