Effect of Pre-commercial Thinning on the Coarse Root-Shoot Allometry of *Pinus pinea* L.

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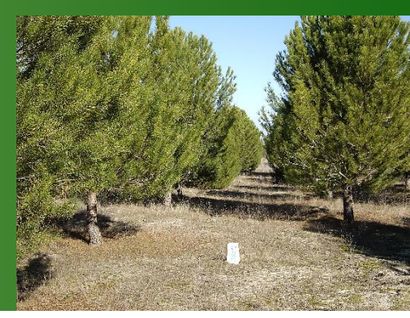


Introduction

The growth distribution pattern (allocation) between above and belowground plant components has not been deeply studied. Its knowledge could have a great impact in environments with limited water or nutrient scarce resources such as Mediterranean areas. Forest management may help plants to minimize these negative limitation effects as per using competition control by thinning as a drought adaptation tool.

This matter could have significant consequences for some species as *Pinus pinea* L., e.g. in fructification processes due to the high value of its pine cones. Thinning at early stages reduces competition and the remaining trees obtain more space for crown development and a higher cone yield in following years (Mutke *et al*., 2012; Moreno-Fernández *et al*., 2015).

Material & Methods

- **Study area**

  Olmedo (Valladolid, Center Spain), 41° 17'N – 4° 45' W, 750 m altitude, sandy and poor quality soils.

  Mean temperature 12.7ºC and precipitation of 417 mm.

  Afforestation of *Pinus pinea* with 1222 tree ha^{-1} in 1996.

  Pre-commercial thinning experiment established in 2006.

  2 treatments: Unthinned and thinned (~600 tree ha^{-1}).

- **Data**

  38 sampled trees in 2013: 18 trees from unthinned plots and 20 from thinned plots.

  Wood disks collected for growth ring studies from breast height and vertical root → Annual growth ring width series.

- **Analysis**

  Growth trend series root:stem diameter → slope value comparison through mixed model analysis.

  Thinning influence in the yearly root:stem diameter growth allometric coefficient values.

$$\alpha = \frac{\ln(^{y_{i+1}}/_{y_i})}{\ln(^{x_{i+1}}/_{x_i})} \quad (Pretzsch, 2010)$$

  Lloret *et al*. (2011) indexes were used to identify different growth responses in dry years (2009 and 2012).

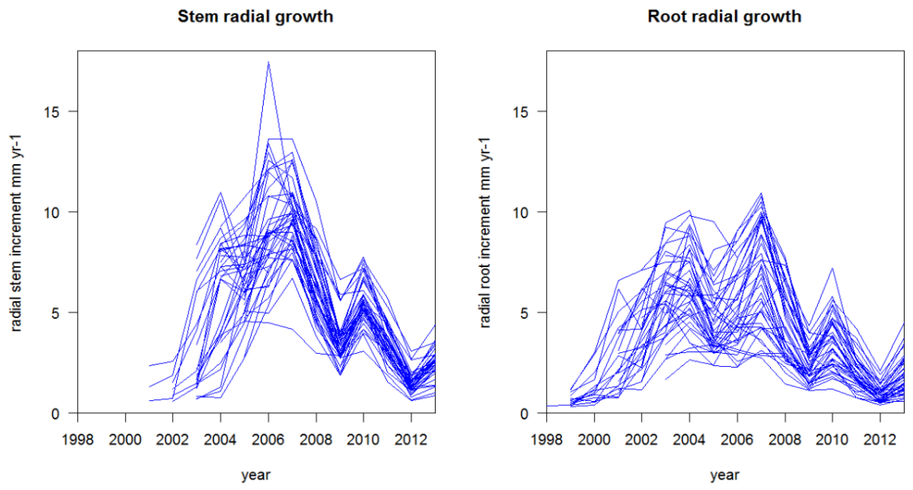
$$\text{Resistance} = \frac{Growth\ dry\ year}{Growth\ previous\ year}$$

$$\text{Recovery} = \frac{Growth\ post\ dry\ year}{Growth\ dry\ year}$$

Drought impact in root & stem diameter growth

Year	Indices	Growth	Unthinned	Thinned
2009	Resistance	Stem	0.59	0.62
		Root	0.53	0.57
	Recovery	Stem	**2.18 a**	**1.80 b**
		Root	1.00	0.86
2012	Resistance	Stem	0.54	0.56
		Root	0.43	0.49
	Recovery	Stem	2.75	2.52
		Root	**2.18 a**	**1.78 b**

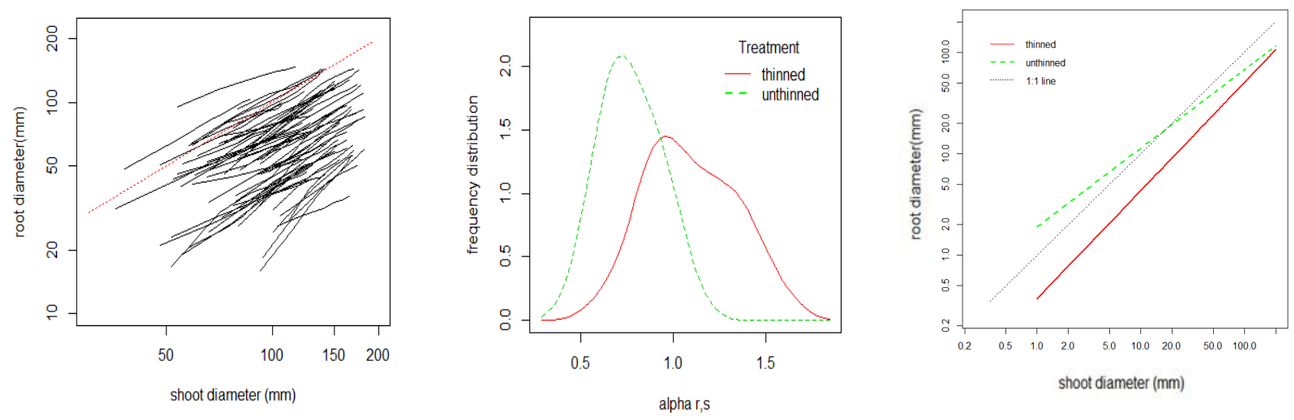
- The analysis of the resistance values showed higher resistance values in thinned trees for the two studied dry periods compared with unthinned trees, although the differences were not significant.
- Stem growth in unthinned stands recovered faster after the drought of 2009 than thinned trees (statistically different), but differences were not shown in 2012.
- Root growth recovery was always higher in unthinned trees than thinned trees, showing differences only for the dry year of 2012.



Results & Discussion

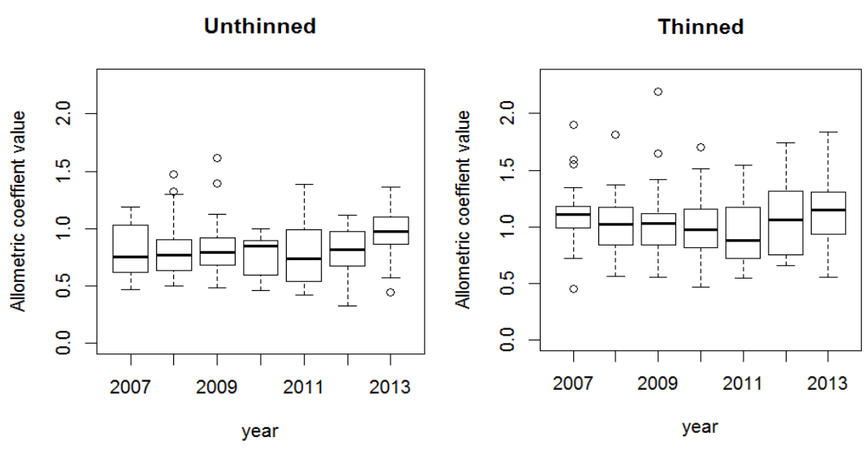
Pattern of the relationship between root and stem diameter growth

- Root:stem diameter growth relationship were showing slope values that vary between 0.55-1.59 (mean value 0.94). This relationship was different between thinned and unthinned trees having unthinned trees a mean value of 0.77 and thinned trees 1.06.



Thinning influence in allometric coefficient

- Statistically different allometric coefficient values were found between unthinned and thinned trees for each year, except 2013 where no differences were found.
- Thinned trees showed larger values than unthinned trees, being higher than 1.0 (isometric growth), except for the year 2011. For the unthinned trees values were always lower than 1.0.



CONCLUSIONS

- We observed higher growth investment in root diameter than stem diameter growth in thinned trees. The opposite tendency was found in unthinned trees.
- Value of the yearly allometric coefficient is different between unthinned and thinned trees, showing the latter a general patter of higher investment in root diameter growth in all studied years.
- Resistance and recovery indexes did not vary strongly between unthinned and thinned trees. Low plantation densities could limit the competition between trees showing no different growth patterns.

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