

Nutritional status of *Pinus sylvestris* and *Quercus pyrenaica* is improved in heterospecific neighbourhoods

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Background

Increasing tree diversity may enhance the capacity of forest ecosystems to provide ecosystem services.

A decline and imbalance in the mineral nutrition of trees in European forest stands have been observed as a consequence of global change (Jonard et al., 2024).

Investigating the beneficial impact of tree diversity on mineral nutrition is therefore valuable.

Objective: To assess the nutritional status of *Pinus sylvestris* and *Quercus pyrenaica* trees in mixed and monospecific stands.

Hypothesis: The nutritional condition of trees is enhanced when they are situated within mixed stands.

Methods

The study was conducted in the Sierra de Guadarrama National Park, situated in the centre of the peninsula and characterised by mountainous terrain and a Continental Mediterranean climate. Five sites were identified, each comprising a mixed stand and a monospecific stand of each species: *P. sylvestris* and *Q. pyrenaica*. In monospecific stands, five individuals were selected, while in mixed stands, five individuals of each species were chosen. A branch was excised from the upper third of the tree and subsequently dried. The leaves were then ground and sent to the Nutrilab laboratory, where the concentrations of carbon, nitrogen and phosphorus were determined. For each tree sampled, we determined the identity and size of individuals in a basal area of a 7 m radius. The results were analysed in three distinct ways: to identify any differences in nutrient concentration between species, to determine whether stand type had an impact on the nutrient concentration, and to ascertain whether there was an effect of the neighbourhood on the concentration of nutrients in mixed stands

Complementarity between *Pinus sylvestris* and *Quercus pyrenaica* in a nutritional context:

Mixed leaf characteristics in the litterfall

Broadleaf litterfall is more nutritious.

Conifer litterfall is more recalcitrant → forest floor humus

Nutrient requirements

Conifers have lower nutrient requirements than broadleaf.

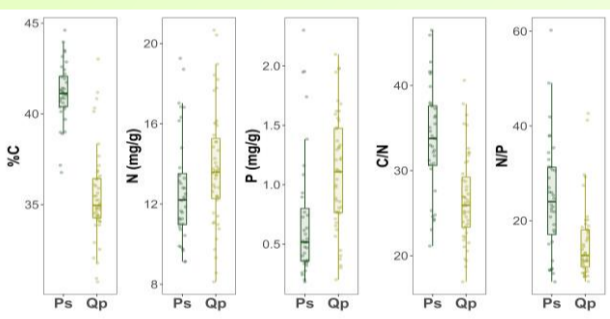
Morphologies

Heights: better light interception.

Root system: water and nutrients through the soil levels allotment.

Results

1. Differences in nutrient concentrations between species



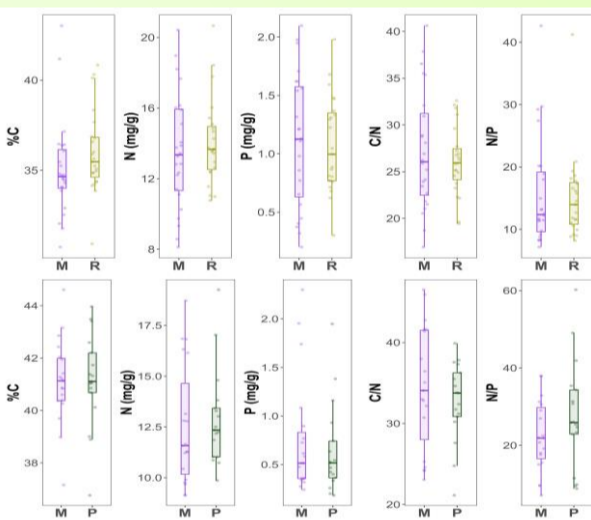
F. 1: foliar nutrient concentrations in *P. sylvestris* and *Q. pyrenaica* and C:N and N:P ratios

Carbon proportion and C:N and N:P ratios are higher in the pines.

- Reduced leaf area and chlorophyll concentration in pine needles results in more efficient photosynthesis and less carbon loss through respiration.
- A higher stabilisation factor in pine stands (Tomé, 2022) and, as a result, a lower amount of organic matter that the soil can assimilate, results in a lower nutrient recycling capacity.

Different nutrient requirements

2. Effect of forest composition on nutrient concentration



F. 2: box and whisker plots of foliar nutrient concentrations and C:N and N:P ratios in pines (brown) and oaks (green) mixed (M) and monospecific (P) forest stands

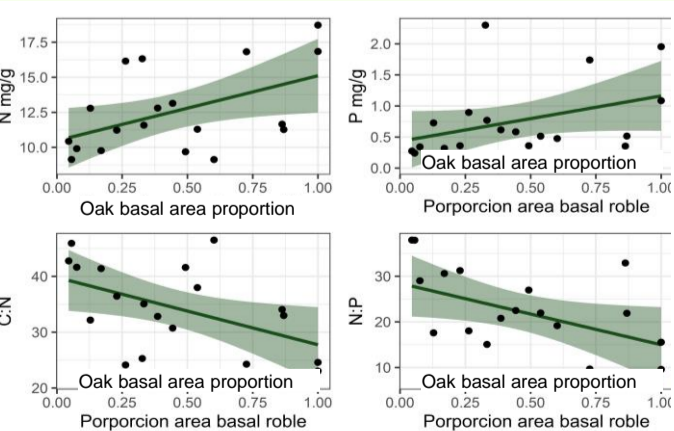
No significant differences were found between mixed and monospecific stands.

Factors that may affect nutrient availability: interaction with other nutrients, pH, microclimatic conditions and rainfall.



F. 5: different root extensions between oaks (left) and pines (right) (Martín-Gómez et al, 2017)

3. Effect of neighbourhood on nutrient concentration

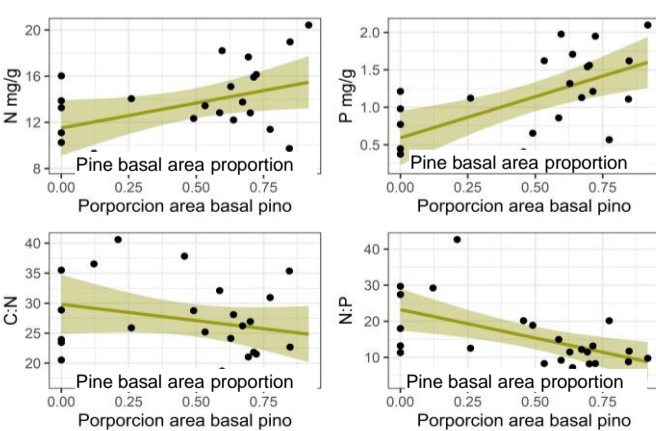


F. 3: Effect of the basal area ratio of oak in the vicinity of pine individuals in mixed stands on nutrient concentrations and leaf C:N and N:P ratios

C:N and N:P balances decrease at the local level, but not at the stand level.

→ They are not related to increased availability, but they may be to increased efficiency or reduced competition

Complementarity between *Pinus sylvestris* and *Quercus pyrenaica*



F. 4: Effect of the basal area ratio of pine in the vicinity of oak individuals in mixed stands on nutrient concentrations and leaf C:N and N:P ratios.

Conclusions

1. Tree diversity improves the nutritional status of individuals in pine-oak mixtures.
2. The positive effects of mixing are noticeable at a local scale, but not at the stand scale
3. Complementarity could be due to reduced competition.

Applications to forest management and restoration:

THE DIVERSIFICATION OF MONOSPECIFIC MASSES ON AN INDIVIDUAL SCALE COULD IMPROVE THEIR NUTRITIONAL STATUS AND PRODUCTIVITY

References

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- Martín-Gómez, P., Aguilera, M., Pemán, J., Gil-Pelegrín, E., & Ferrio, J. P. (2017). Contrasting ecophysiological strategies related to drought: the case of a mixed stand of Scots pine (*Pinus sylvestris*) and a submediterranean oak (*Quercus subpyrenaica*). *Tree Physiology*, 37(11), 1478-1492.
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