

Seedling nutrient loading to improve planting success. A Mediterranean perspective

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Introduction

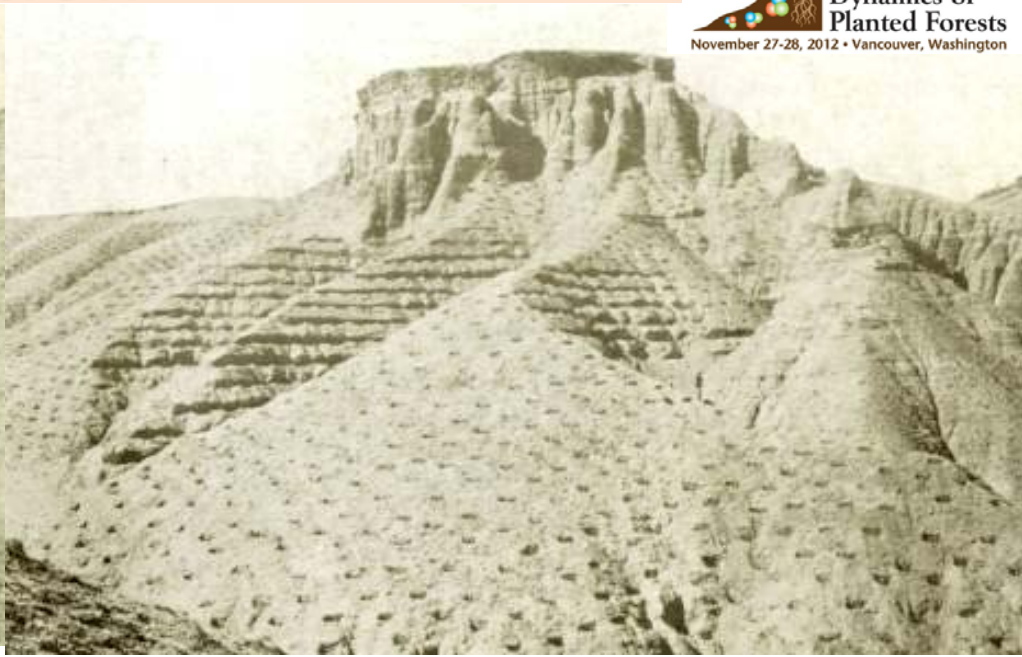
Introduction

- Afforestation in Spain from the 1940s to the 1980s led to more than 3 M of ha transformed to forests
- Many highly degraded areas were afforested on harsh dry sites
- Low nursery technologies and low seedling quality requirements
- Soil erosion control and forest production improvement were main objectives



1892

Introduction

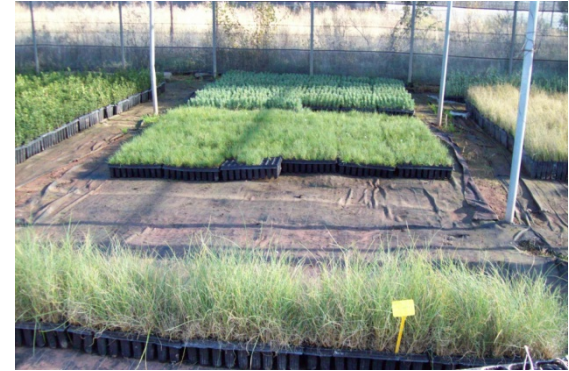


- Keystone aspects of the establishment success?:
 - ✓ Mostly pines were used
 - ✓ High planting densities guaranteed stand establishment
 - ✓ Low labor costs permitted fails replacement from year to year



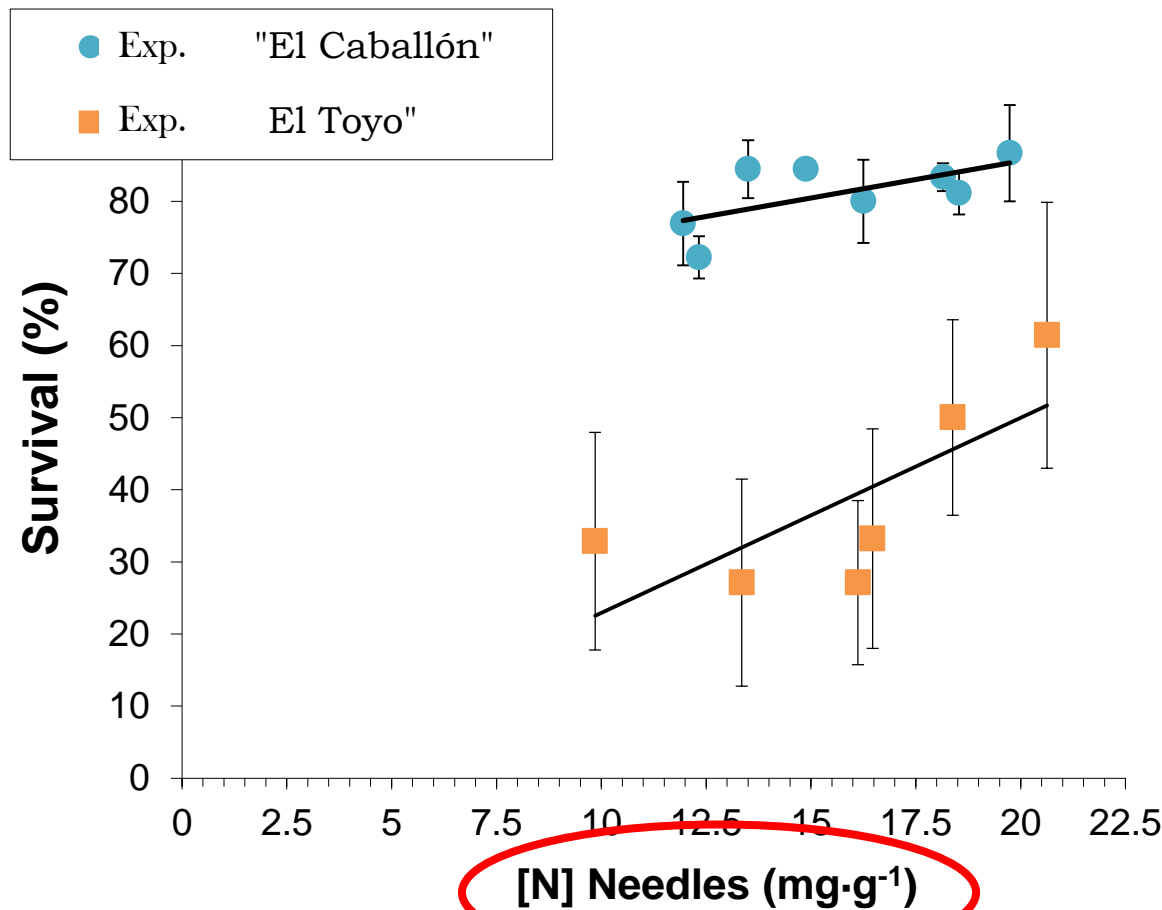
➤ Changes from the 1980s to present:

- From soil erosion control to forests and other ecosystems restoration
- Much higher forestation costs
- Plant production in larger and centralized nurseries
- Needs to widen the pool of species
- Global change is the “dressing of every salads”, even more important in Mediterranean areas



The necessity to improve seedling quality clearly emerges ...

...and there is room for improvements:



Even for pines species



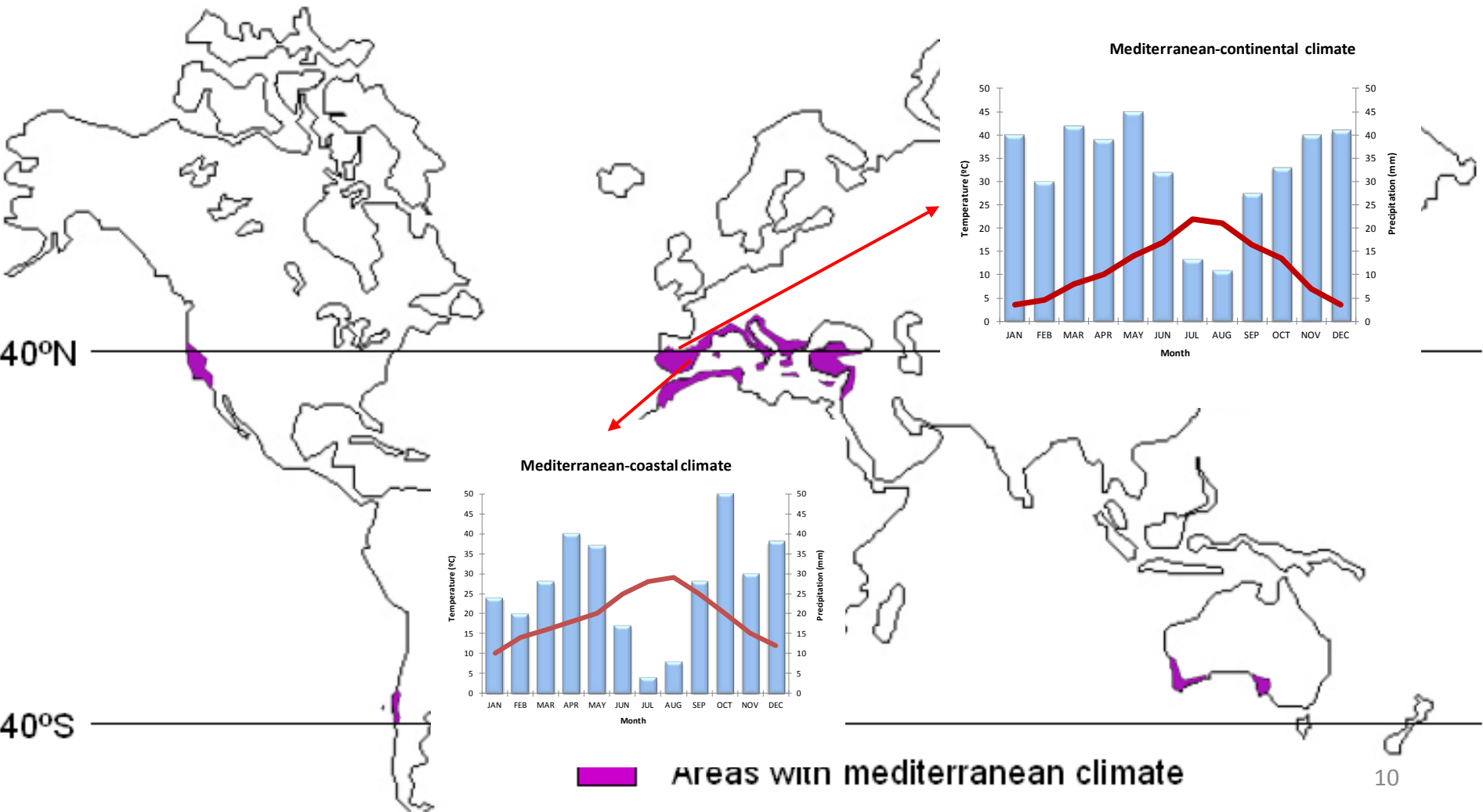
Pinus halepensis.
(Oliet et al., 1997, 2009)

A Mediterranean perspective? *Specificities about artificial regeneration in the Mediterranean*



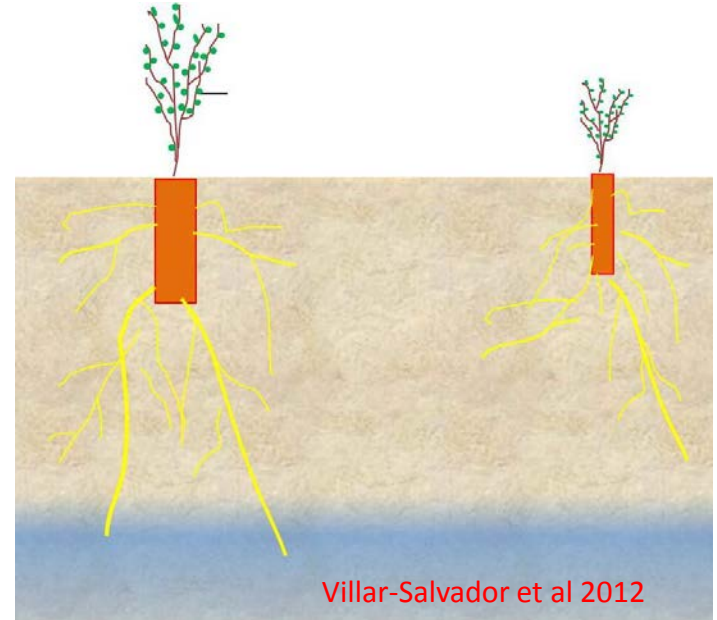
Specificities about Mediterranean artificial regeneration

- Mediterranean climate
 - Strong summer drought preceded by unpredictable springs



- **Field constraints and facts:** planting window. We must plant *asap*, from early fall rains to February

➤ Seedlings must emit new roots in depth as soon as possible to avoid subsequent summer drought



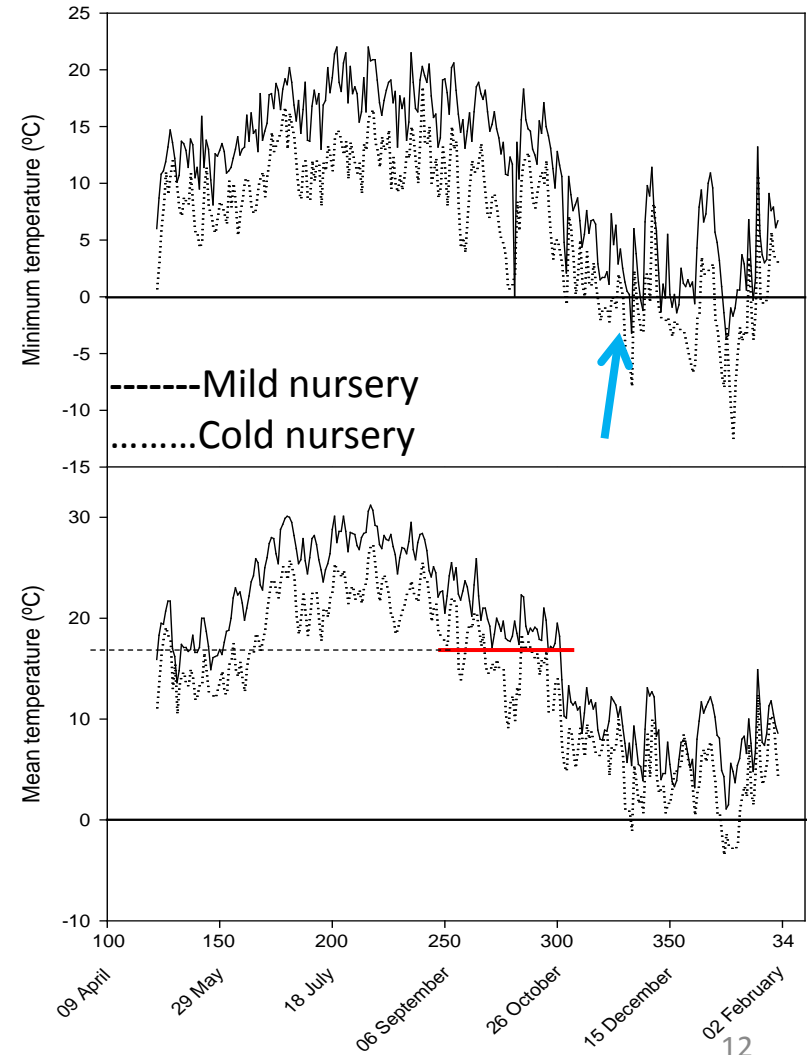
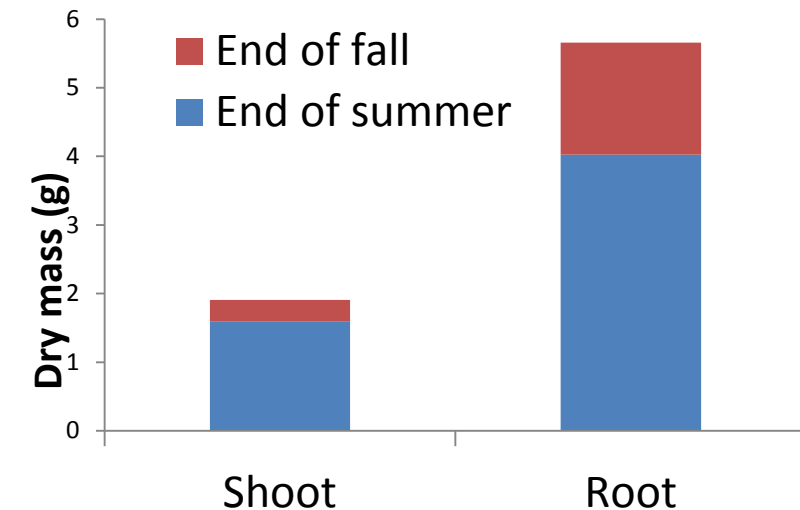
➤ Early frost after planting in fall can damage the seedlings




- **Nursery production facts.**

Raising seedlings outdoors:

- **Frosts** occur during fall in inland (continental) nurseries (*hidden death* of seedlings prior to plantation)
- **Late growth** occurs during fall in mild (coastal) nurseries:

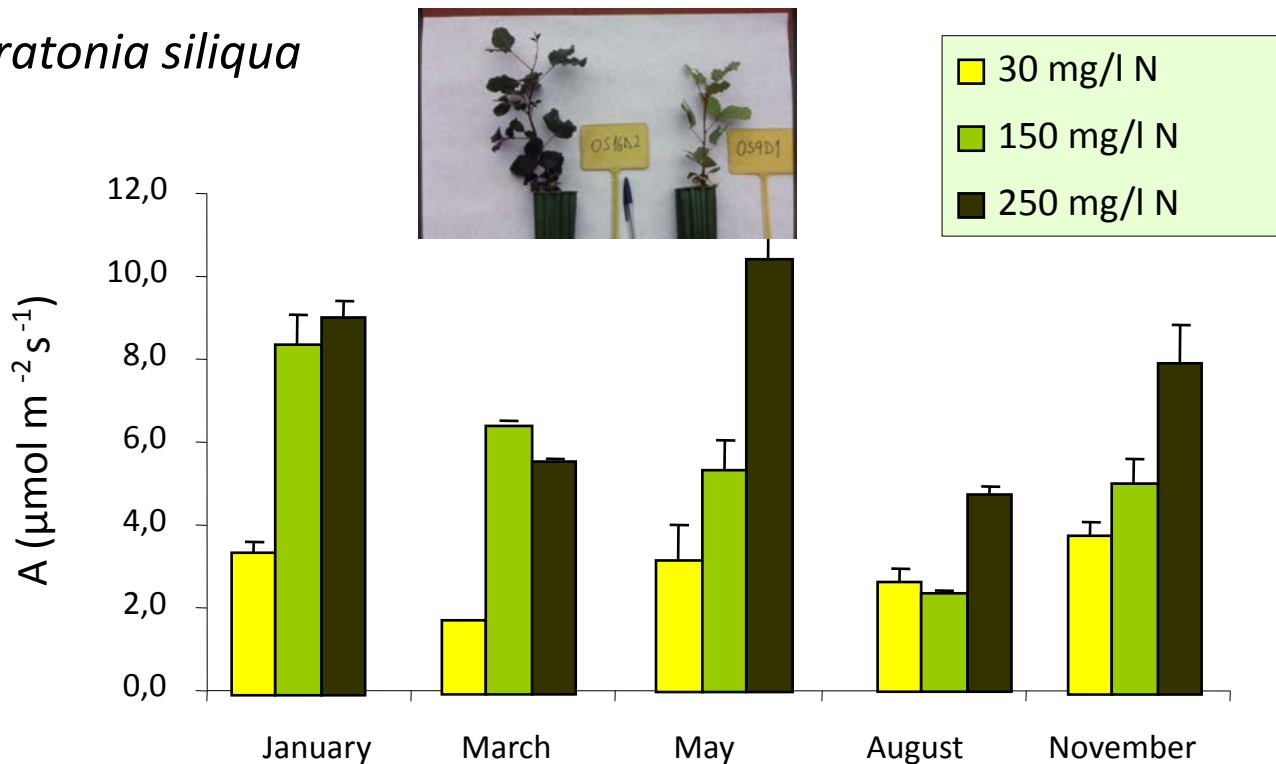




Importance of seedling nutrient status at planting in Mediterranean zones: why loading?

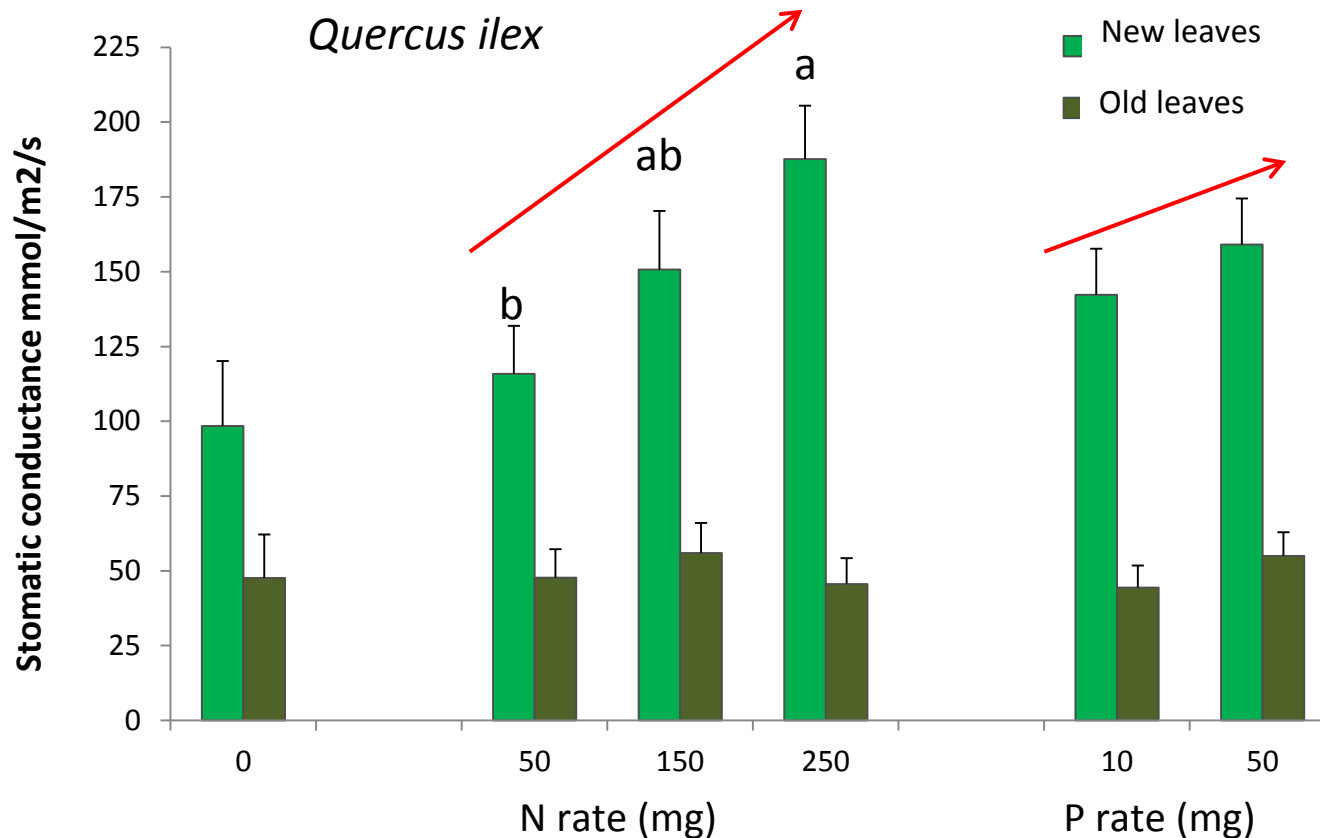
- Photosynthesis activation to resume growth after planting is strongly related to nutrient (mostly N) status

Ceratonia siliqua



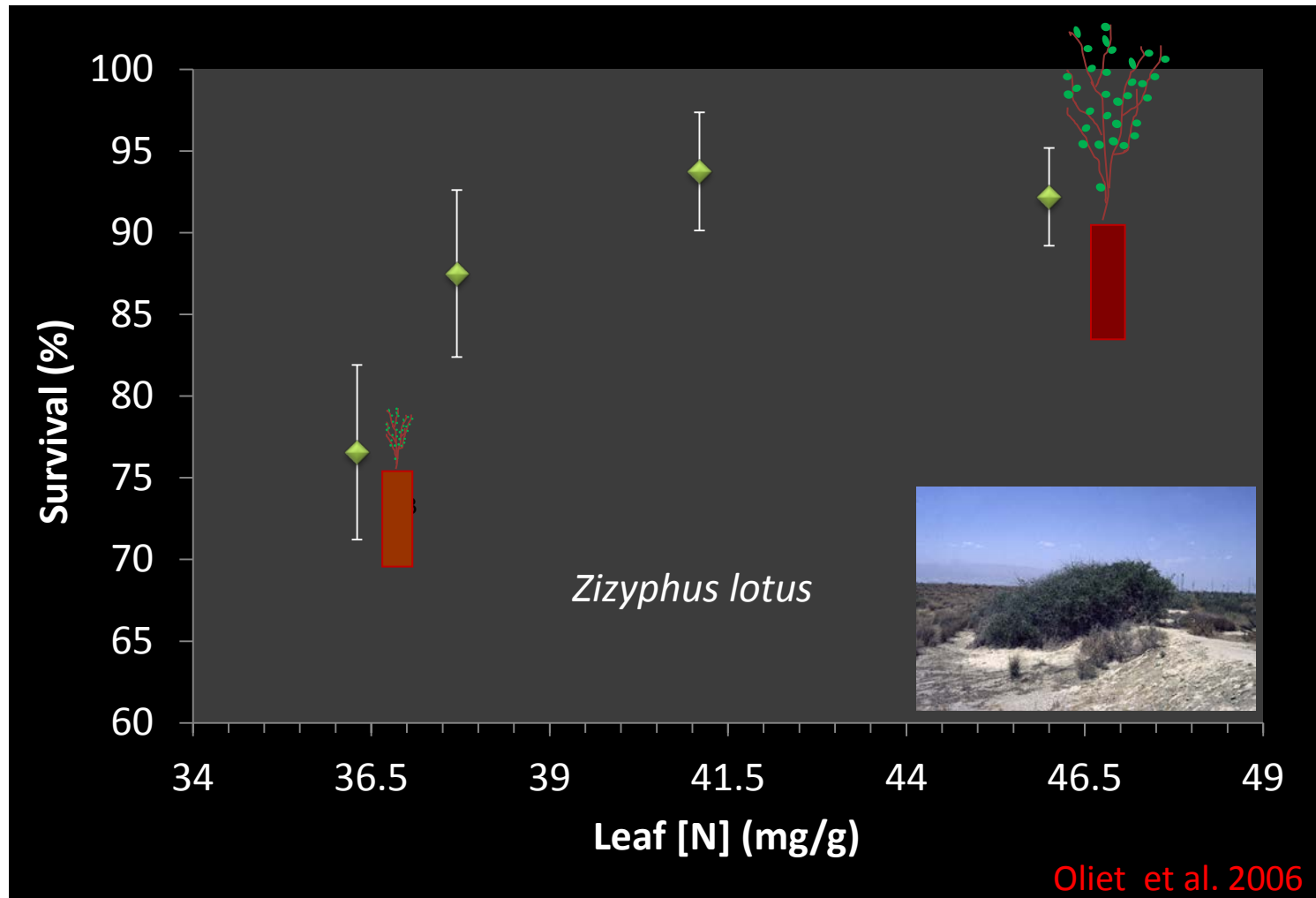
(Planelles 2004)

- Nitrogen loaded seedlings of sclerophyllous species increase stomatic conductance after planting

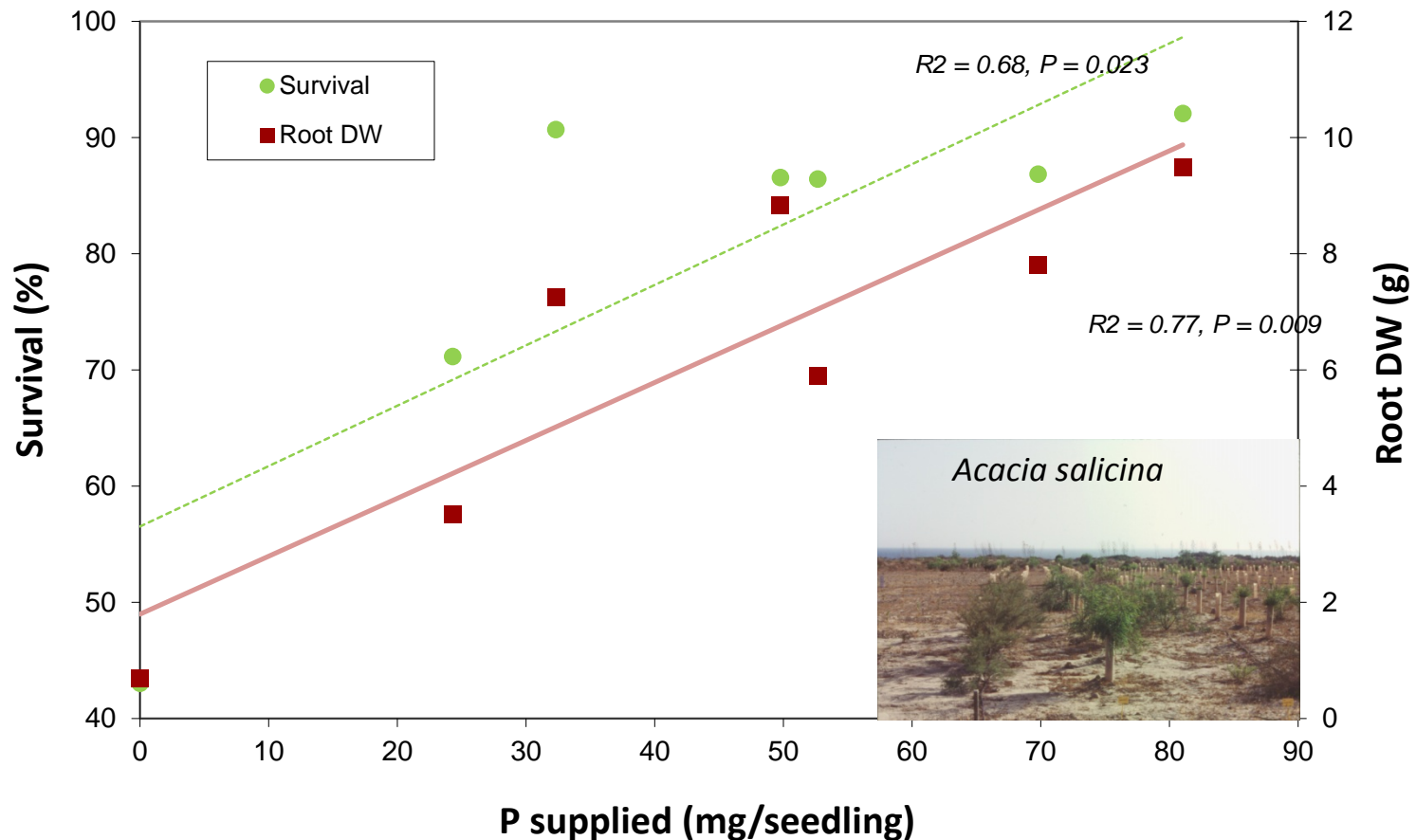


Why loading in Mediterranean zones?

- A large body of evidence shows how nitrogen loaded seedlings survive better under very dry conditions

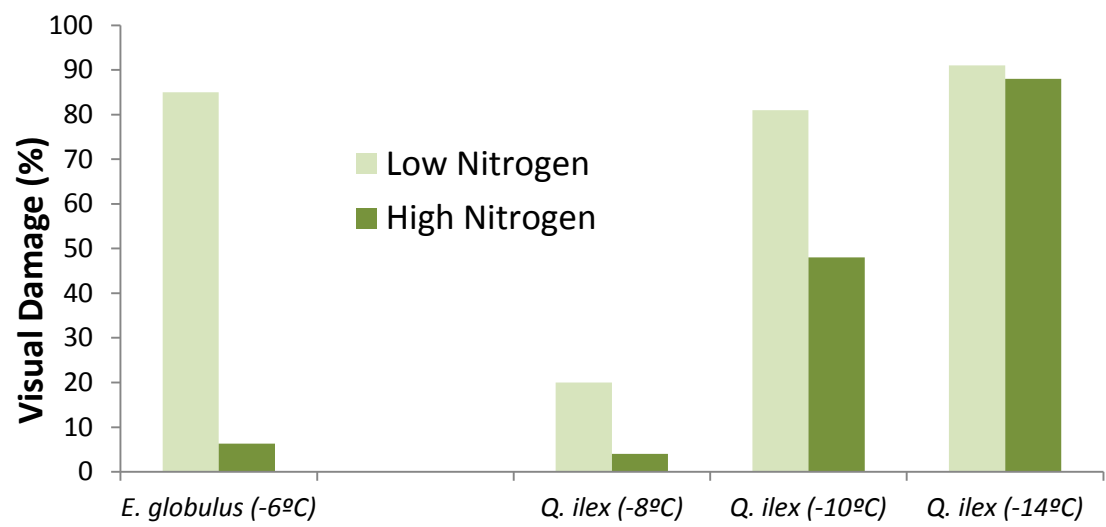


- Is only nitrogen? **Phosphorus** loaded seedlings also show a superior response after planting

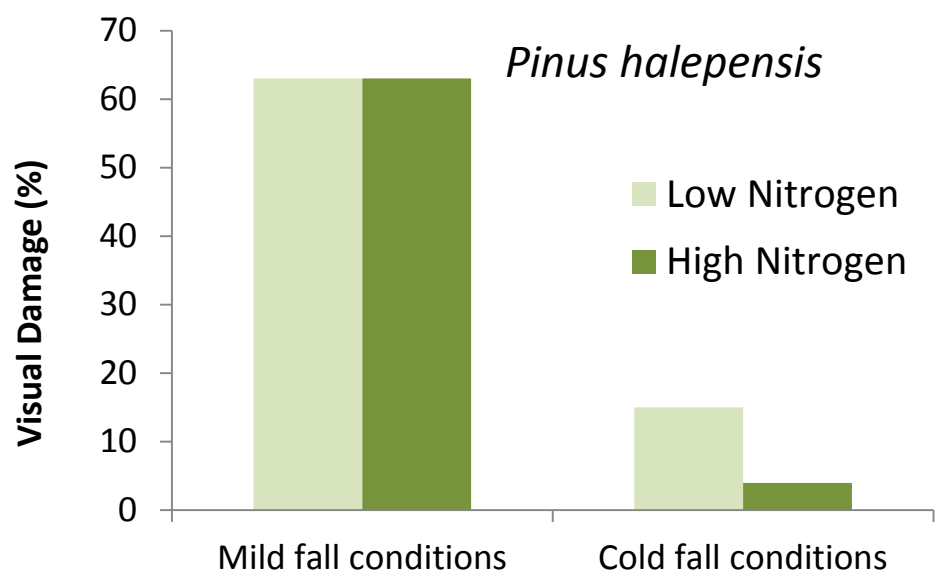


Why loading in Mediterranean zones?

- **Cold resistance** of seedlings in both nursery and plantations can be critical Cold resistance is closely related to nutrient (mostly N) status



Fernández et al. 2007
Andivia et al., 2011



Interaction N × environment on frost resistance

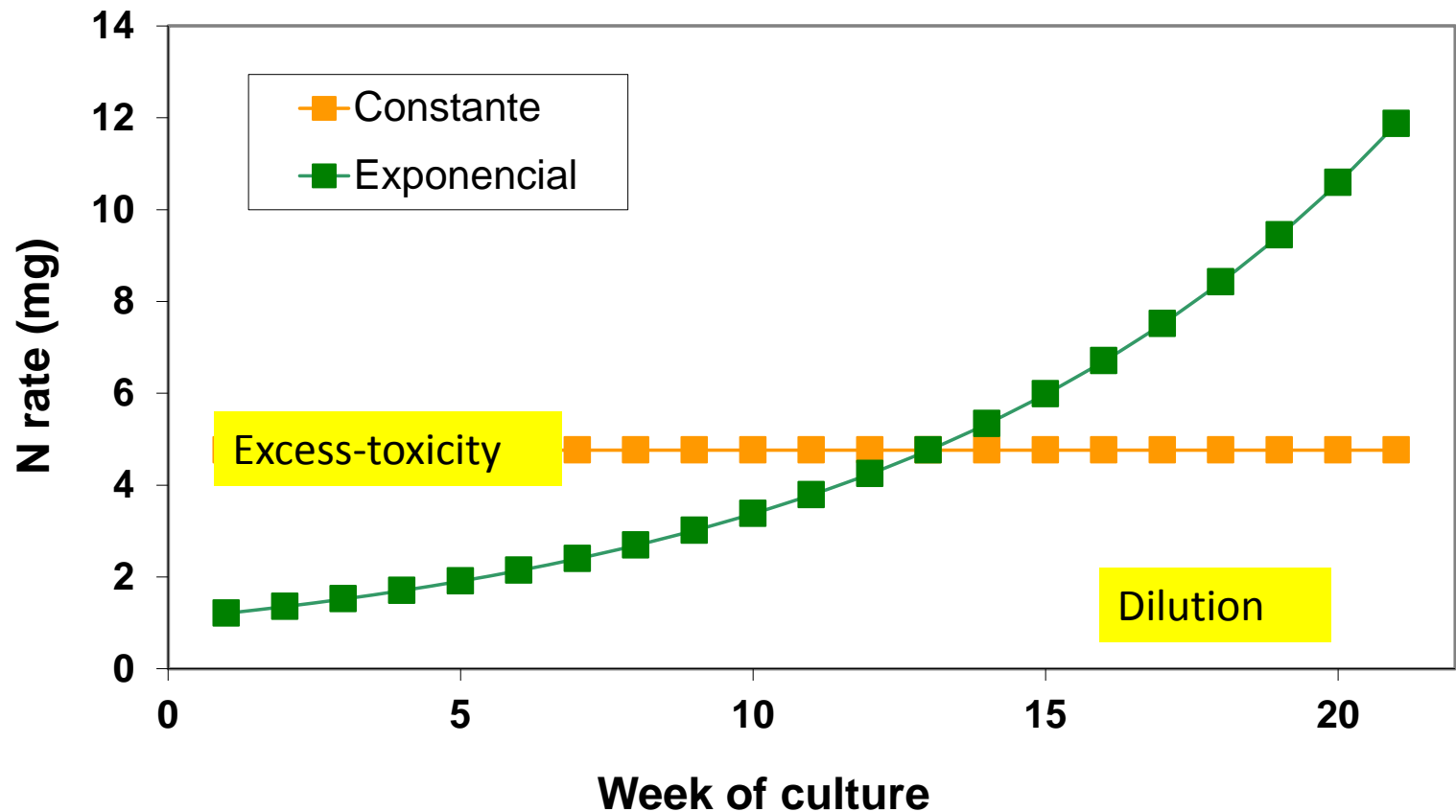
Puértolas et al. 2005



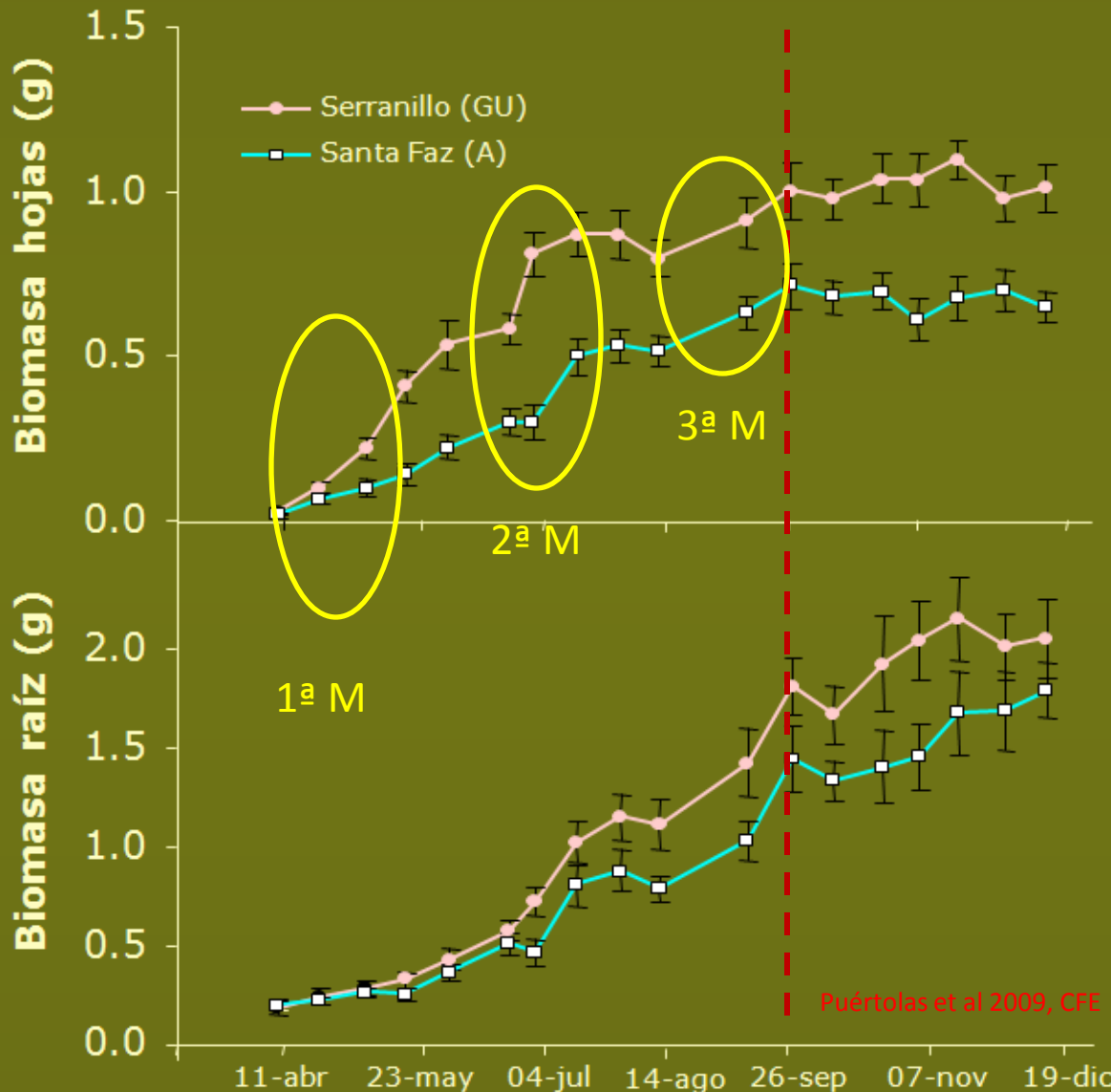
How can we nutrient load our seedlings in Mediterranean nurseries?

15.03.2007

- Is exponential regime effective in nutrient loading every species?



- Oak species like *Quercus ilex* exhibits a rhythmic growth pattern in the nursery:

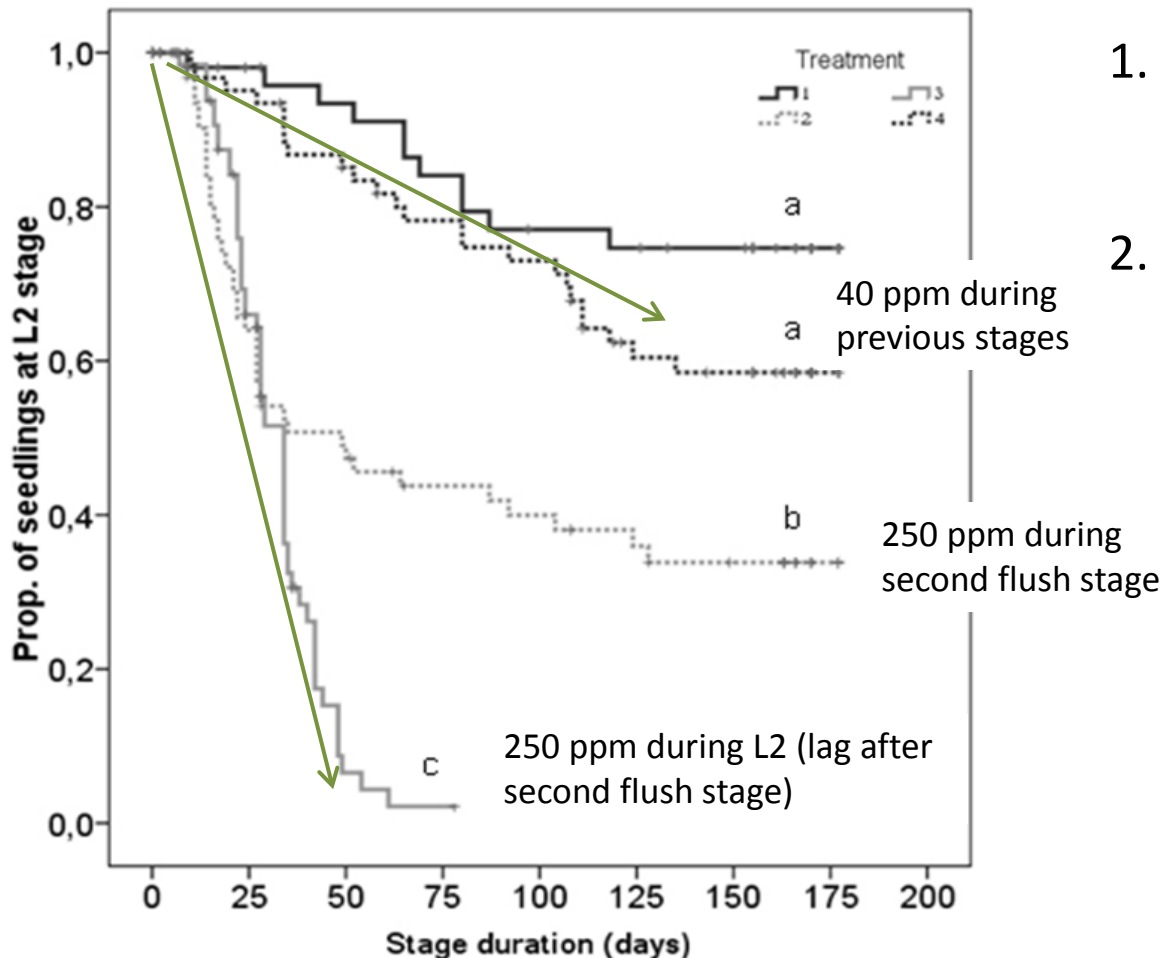


Several active growth periods are followed by lag stages
Those intervals are not synchronized

Roots still growth during late fall

Puértolas et al 2009, CFE

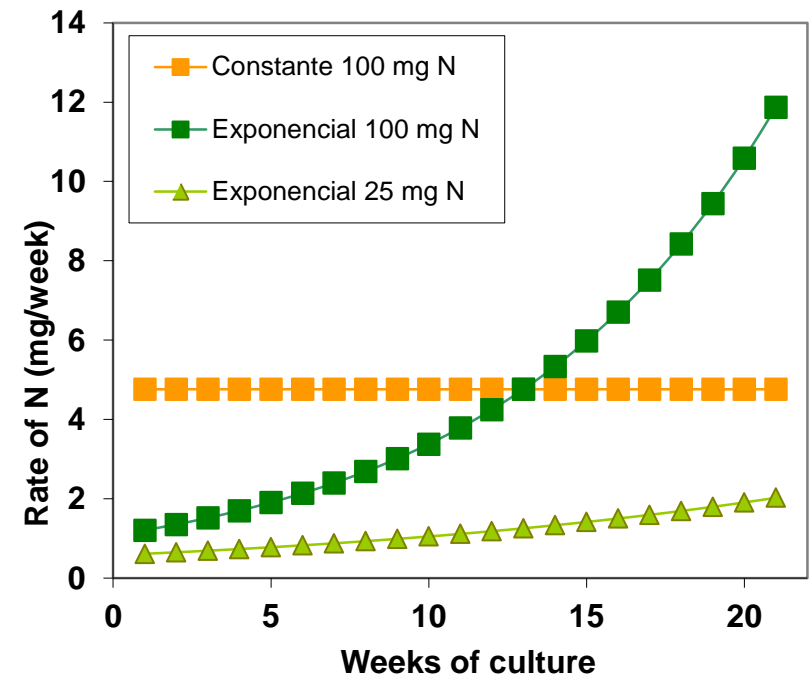
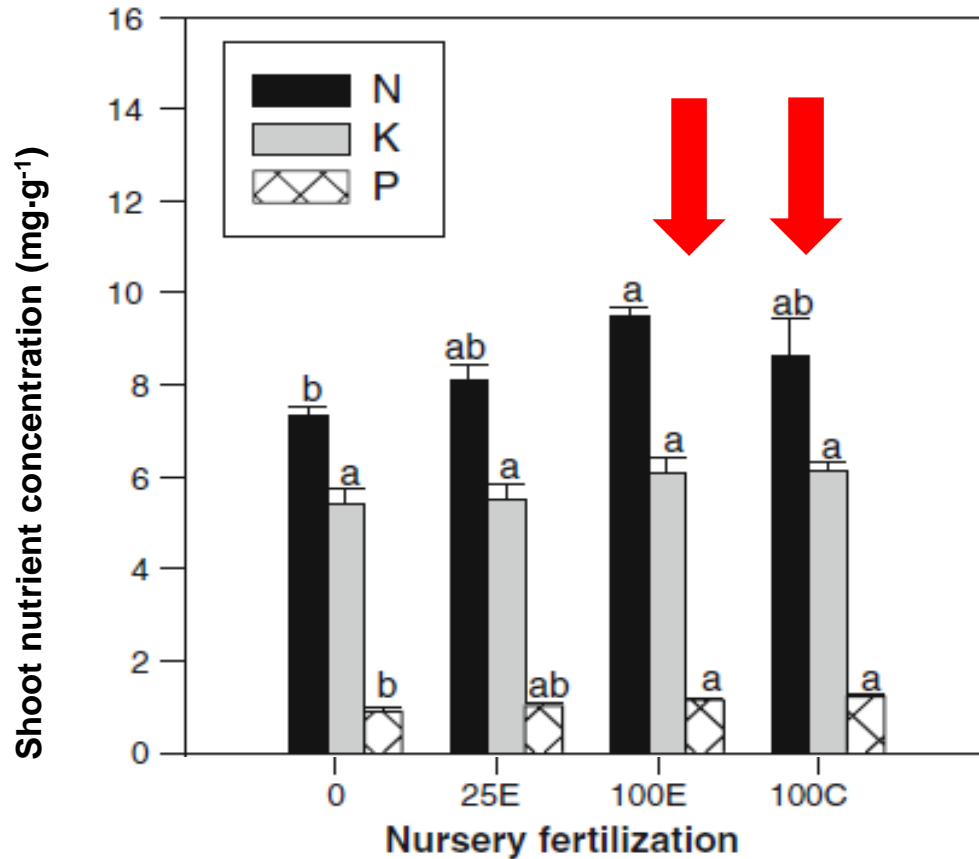
- How nutrient availability during growth affects ontogeny of species with rhythmic growing pattern (*Quercus ilex*):



- Higher synchronicity for highly fertilized seedlings during second lag
- More seedlings reaching advanced stages in ontogeny

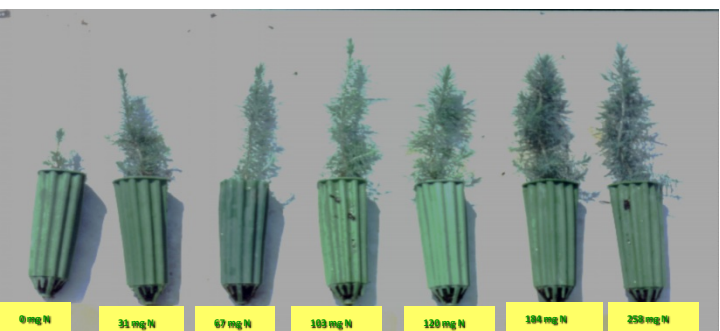
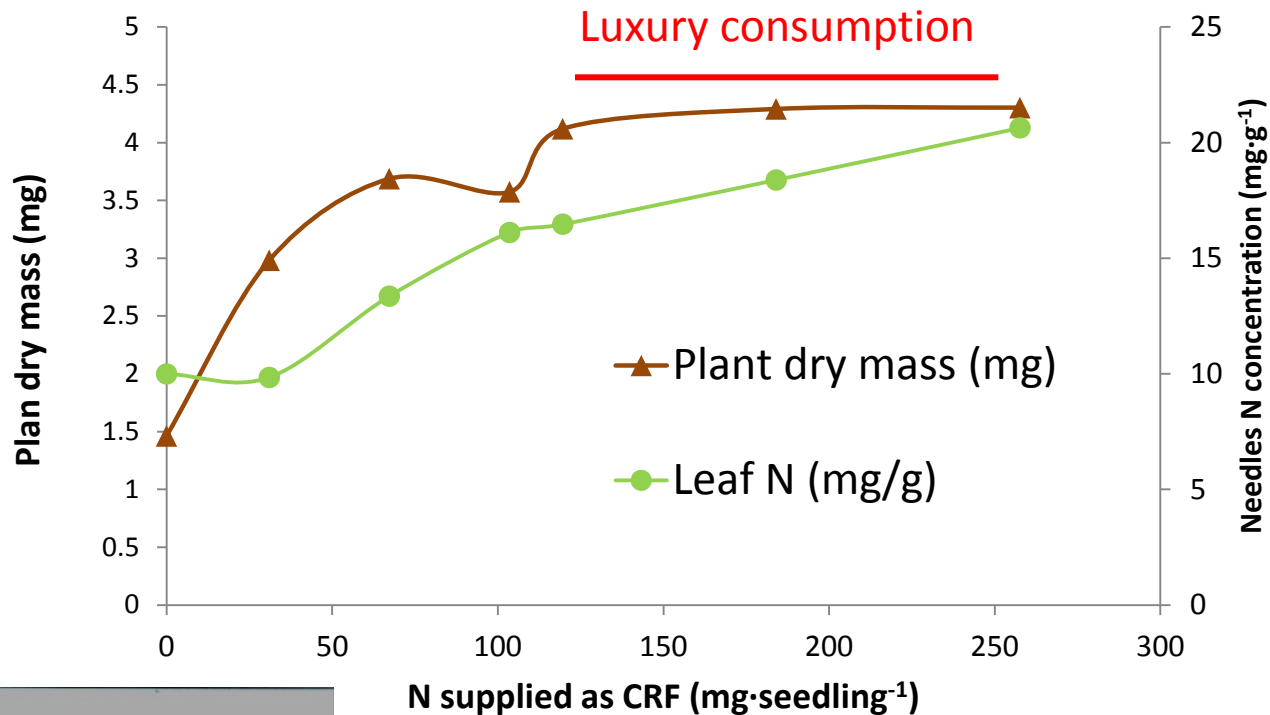


- Potential ability of exponential regime to nutrient load species with growth patterns at intervals is very low



Quercus ilex (Oliet et al. 2009)

- **Controlled release fertilizers** are a good alternative to nutrient load seedlings by using high rates with high fertilizer recovery

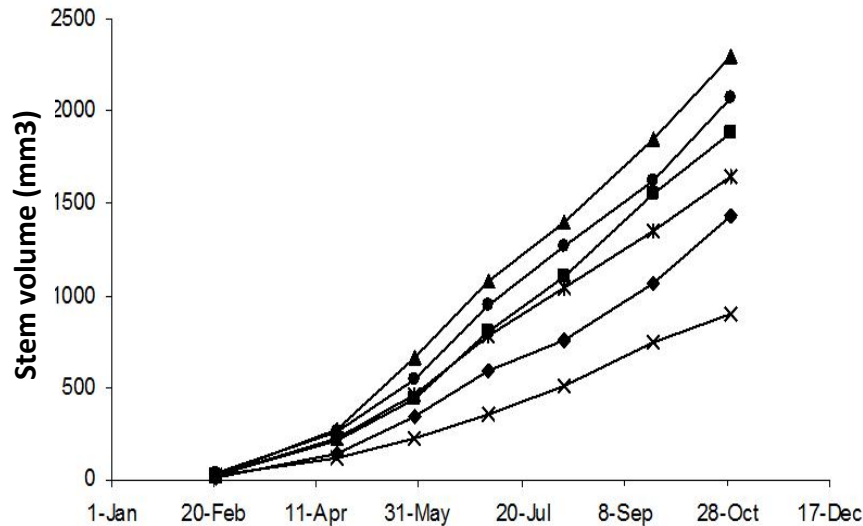
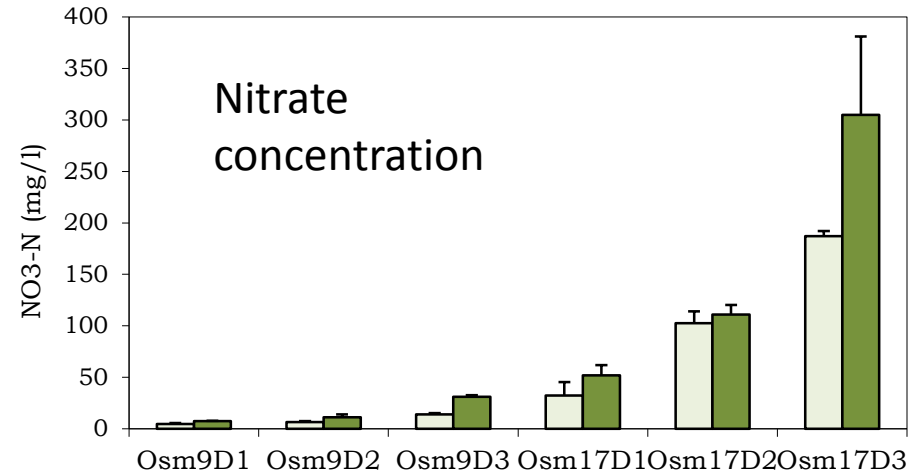
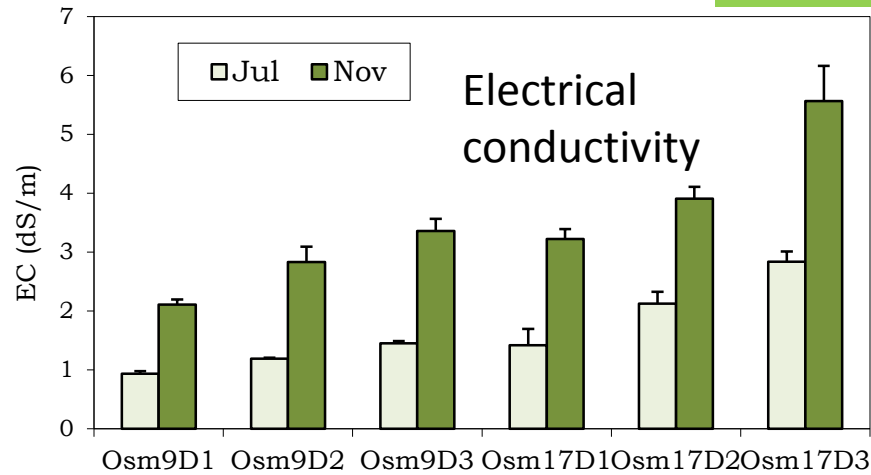


Pinus halepensis

Oliet et al 1999

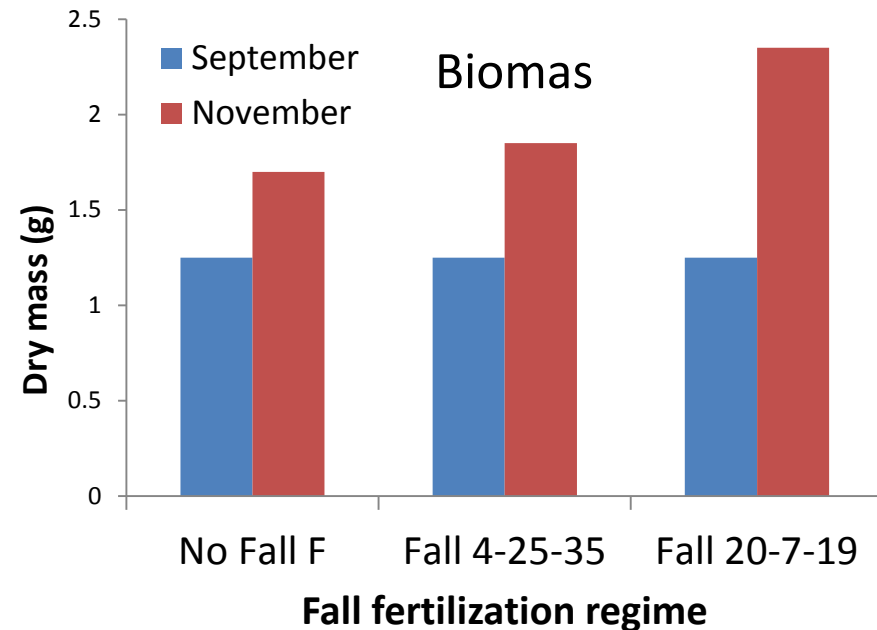
- **CRF** provide nutrients till late fall to avoid nutrient dilution

Saturation extract

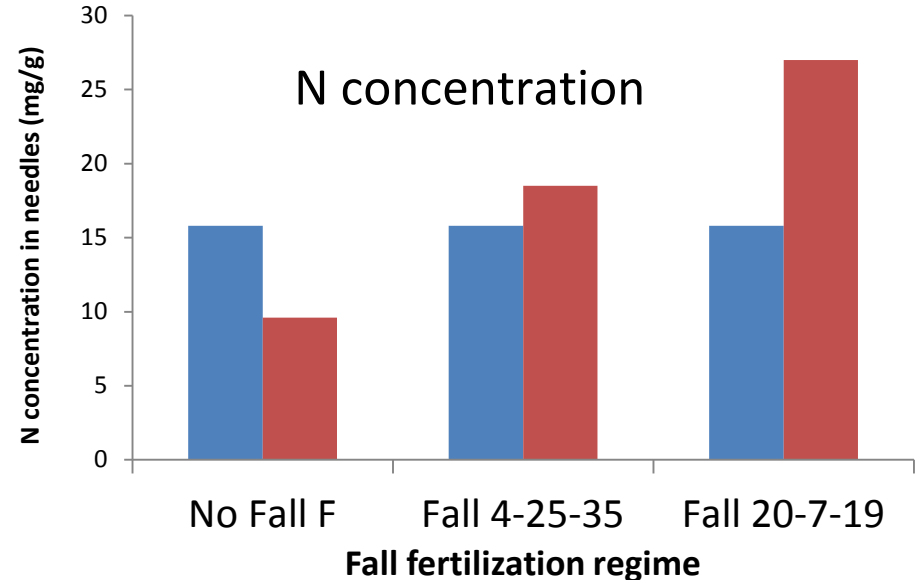


- Nutrient dilution during fall occurs precluding nutrient loading. Is fall fertilization a solution?

Fall fertilization promotes growth ...

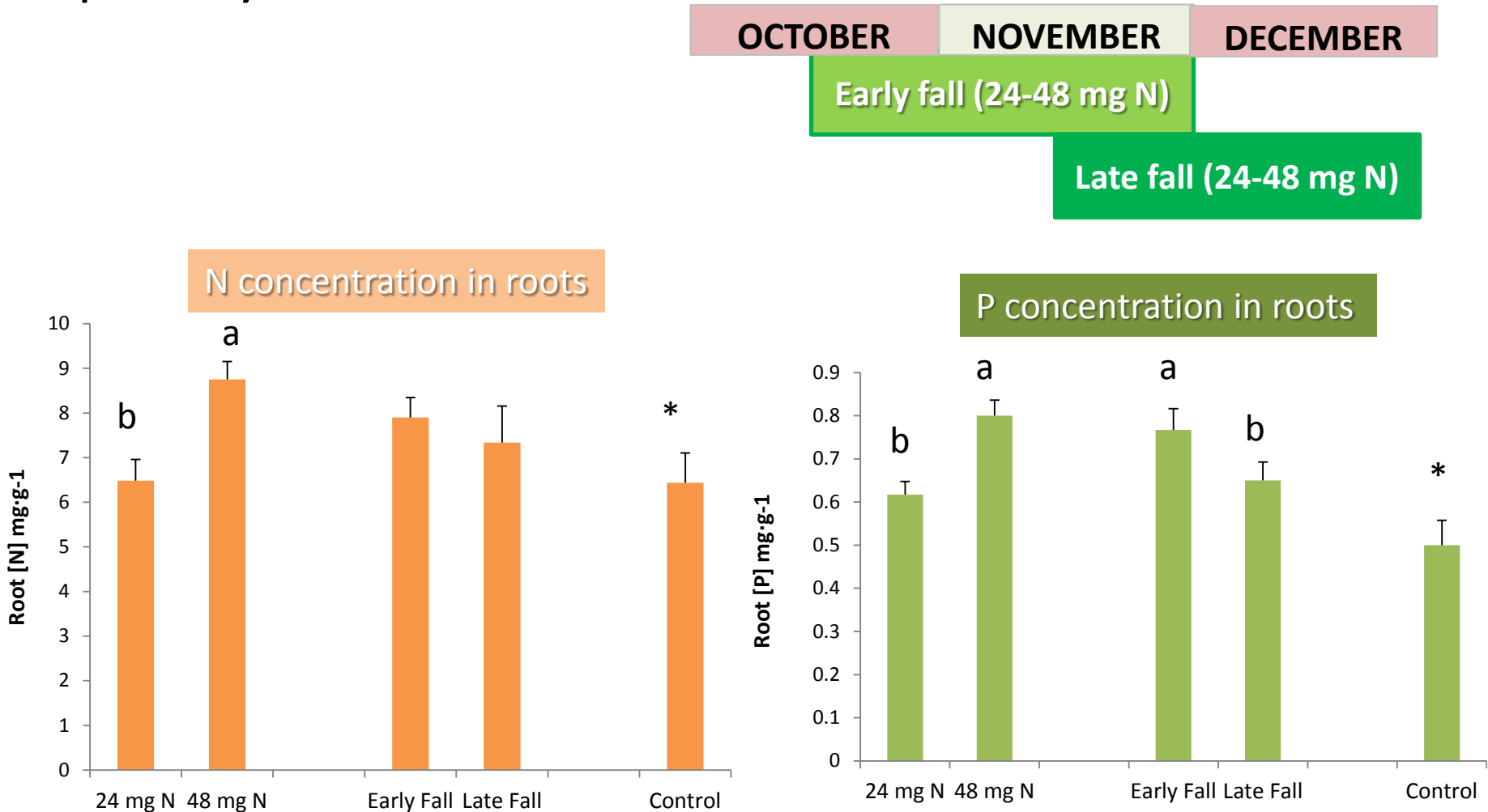


... but also nutrient loading

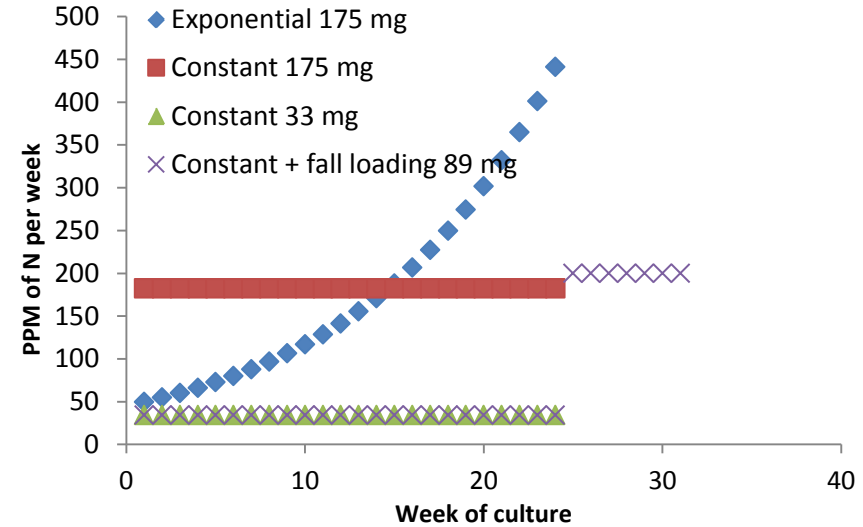
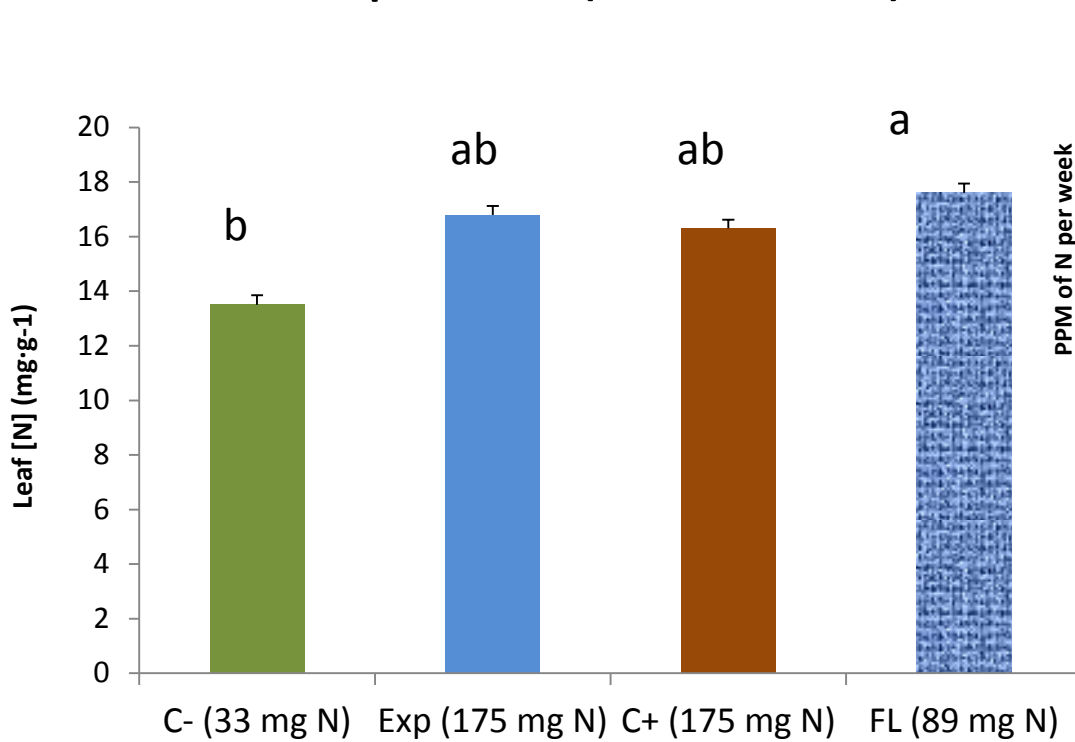


Pinus halepensis

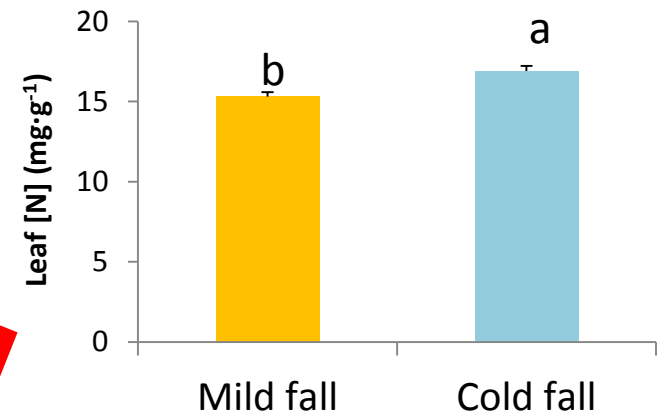
- **Early** fall fertilization is more effective to load Holm oak, specially with P



- Fall fertilization is an adequate strategy to nutrient load these species (Holm oak)



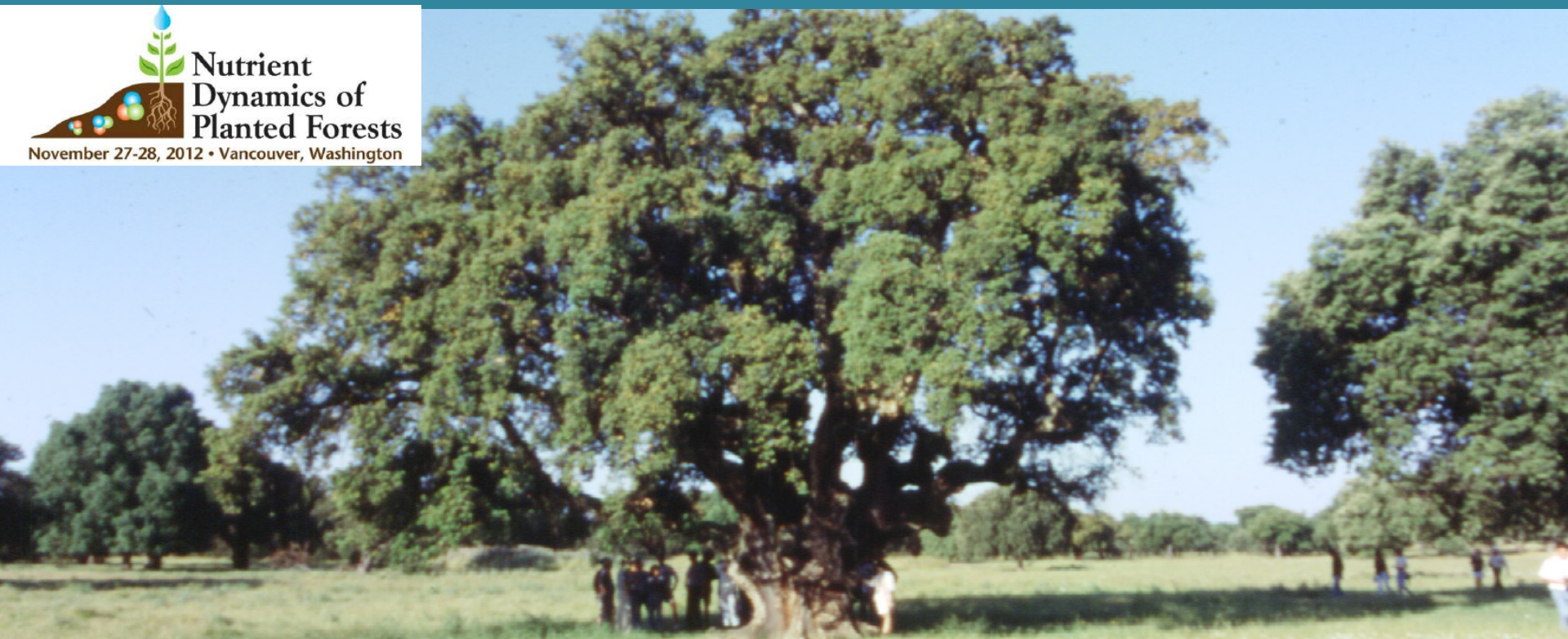
Fall fertilization seems more effective in cold fall nurseries



Heredia et al (in prep)

- Developing fertilization programs for Mediterranean species of interest to reach effective nutrient loading:
 - Improve the knowledge of specific growing patterns in the nursery
 - Understand nutrient dynamics during hardening and fall (uptake and remobilization) to improve efficiency of late season fertilization
 - Improve knowledge of interactive relationships between cold acclimation, nutrient uptake and environment during hardening. Cold resistance of roots deserves special attention.

Thank you very much! ¡Muchas gracias!



Special thanks to people from:

