Does tree species richness attenuate the effect of experimental irrigation and drought on decomposition rate in young plantation forests?

This presentation participates in OSPP

Outstanding Student Poster & PICO Contest

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Background & objectives

Soil organic matter (OM) transformations (decomposition and stabilization) is an important ecological process that regulates nutrient cycling and ecosystem C balance. Expected changes in precipitation in Europe due to climate change are likely to affect soil OM transformations. In forests, higher tree species richness might modulate the effects of changed precipitation. We evaluated the effects of tree species richness on OM decomposition and stabilization in combination with reduced precipitation (FORBIO, Belgium) and irrigation treatments (ORPHEE, southern France) in young (6-8 yr.) experimental plantations. The objectives were,

1. to measure OM transformation under drought and irrigation.
2. to assess the effect of tree species richness on OM transformations under drought and irrigated conditions.

Methods

FORBIO(B): Drought Experiment

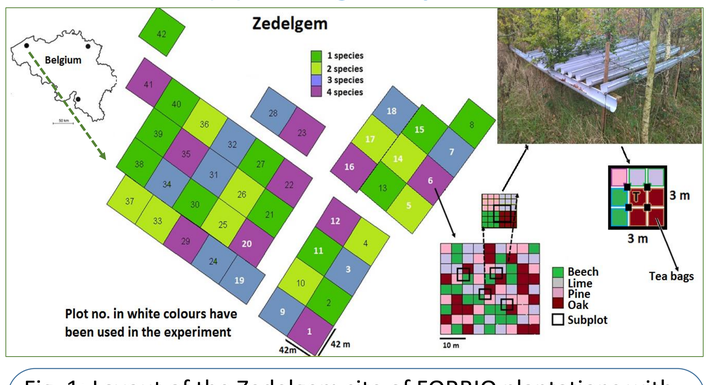

Fig. 1: Layout of the Zedelgem site of FORBIO plantations with detailed plantation design of a 4 species mixed plot. A 3 m × 3 m rainout shelter has been built around beech and oak trees to impose drought. Details about FORBIO see Verheyen et al. (2013).

Overview: FORBIO (Zedelgem)

Target species: Beech and Oak
Species richness: 1 to 4
Species composition: *Betula pendula, Q. robur, Fagus sylvatica, Tilia cordata & Pinus sylvestris*
Subplots size: 3 m × 3 m
Replication: 3
Soil type: dry sandy to wet loamy

ORPHEE (F): Irrigation Experiment

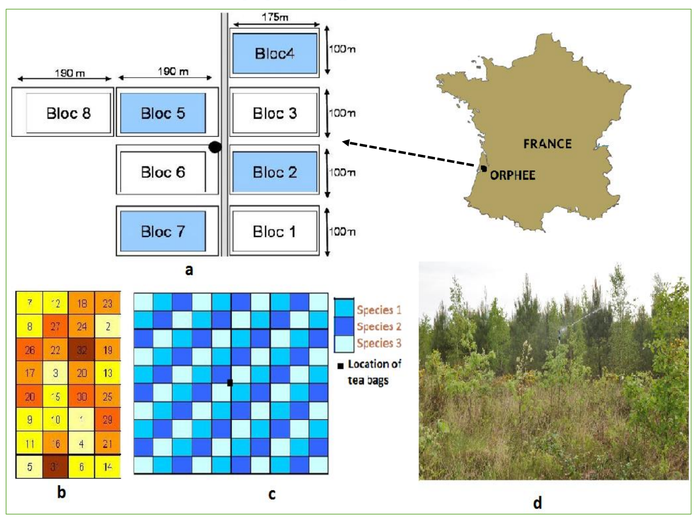

Fig. 2: Layout of the OPRHEE plantations a) out of eight block, 4 has been irrigated (blue), b) plots within a block :1 (light) to 5 (dark) species per plot, c) planting design of a 3 species plot with the location of tea bag, and d) sprinkler irrigation has used to add about 3 mm water in every night during summer. For details about ORPHEE see Castagneyrol et. al. (2013).

Overview: ORPHEE

Target species: none
Species richness: 1 to 5
Species composition: *B. pendula, Q. robur, Q. pyrenaica, Q. ilex & P. pinaster*
Plot size: 10 m × 10 m
Replication: 4
Soil type: sandy podzol

Tea bags used to measure OM transformation

Lipton rooibos and green tea bags were buried (5-7 cm) in soil for about three months. Decomposition rate (*k*) and stabilization factor (S) rates were calculated from mass loss data (Keuskamp et al. 2013). Data were analysed using linear regression and mixed effect modelling. S and *k* were calculated using the following formula-

$$S = 1 - \left(\frac{ag}{Hg}\right)$$

$$\text{ag} = 1 - \frac{\text{final weight (g)}}{\text{initial weight (g)}}$$

$$k = \frac{\log\left(\frac{ar}{(wt - (1 - ar))}\right)}{t}$$

$$ar = Hr \times (1 - S)$$

$$\text{wt} = 1 - \frac{\text{final weight (g)}}{\text{initial weight (g)}}$$

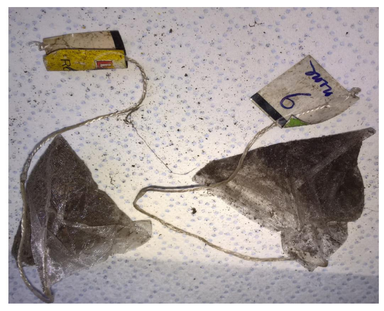

Fig. 3: Tea bags after 3 months of burial

where,
ag= decomposed fraction of green tea,
ar = predicted labile fraction of rooibos tea,
t = incubation time of tea bags (days),
wt= fraction remaining of rooibos tea.
Hg= 0.842 g g $^{-1}$ for green tea; Hr=0.552 g g^{-1} for rooibos tea (Keuskamp et al., 2013)

Results

Soil moisture differences in top soil layer

- ~4% less soil moisture in drought plots than in control plots
- ~7% more soil moisture in irrigated plots than in control plots

Drought affected OM transformations

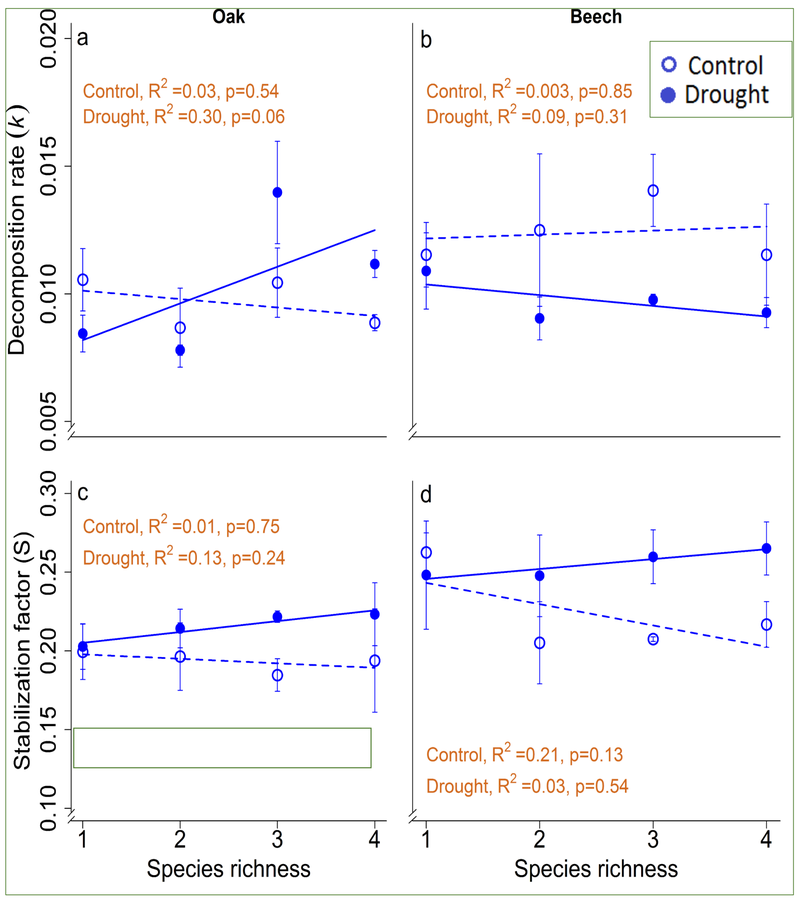

Fig. 4: Changes in decomposition rate (*k*) and stabilization factor (S) due to drought under oak (a & c) and beech (b & d) trees at Zedelgem. n=3, error bars= SEM

- **No species richness effect on both *k* and S.**
- **Drought significantly (p<0.05) decreased *k* and increased S under the beech trees only.**

Irrigation increased both decomposition and stabilization

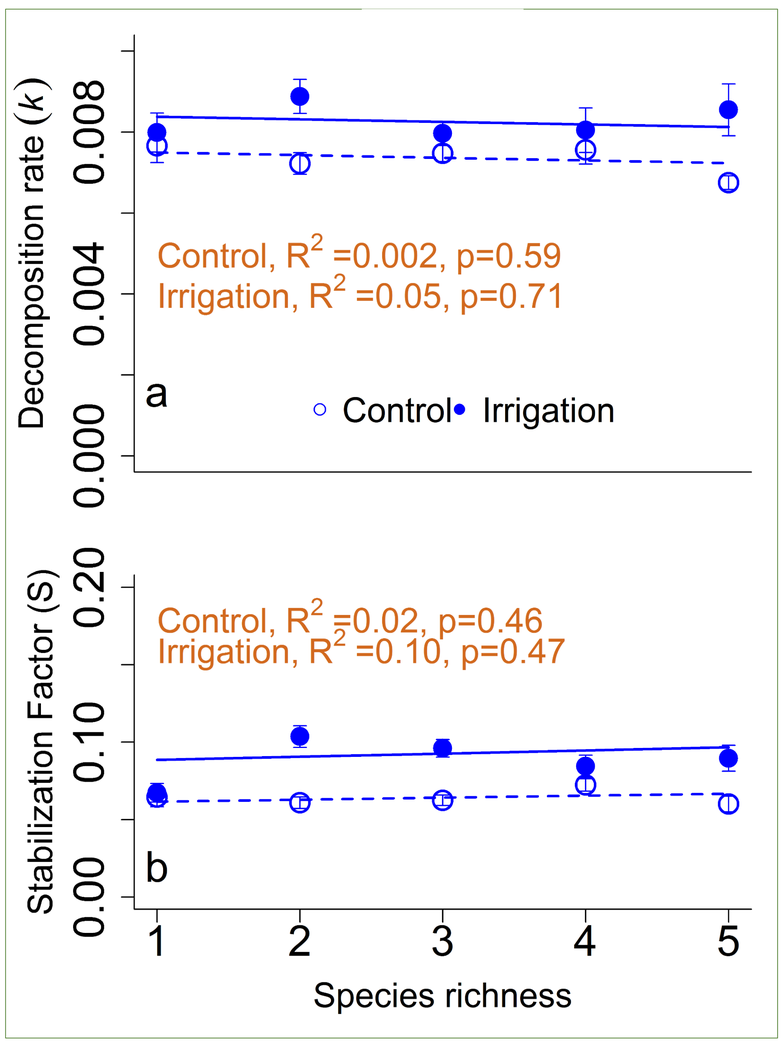

Fig. 5: Changes in (a) decomposition and (b) stabilization rate due to irrigation at ORPHEE.

- **No species richness effect on *k* and S.**
- **Irrigation significantly (p<0.01) increased both *k* and S.**

Higher OM transformations in FORBIO

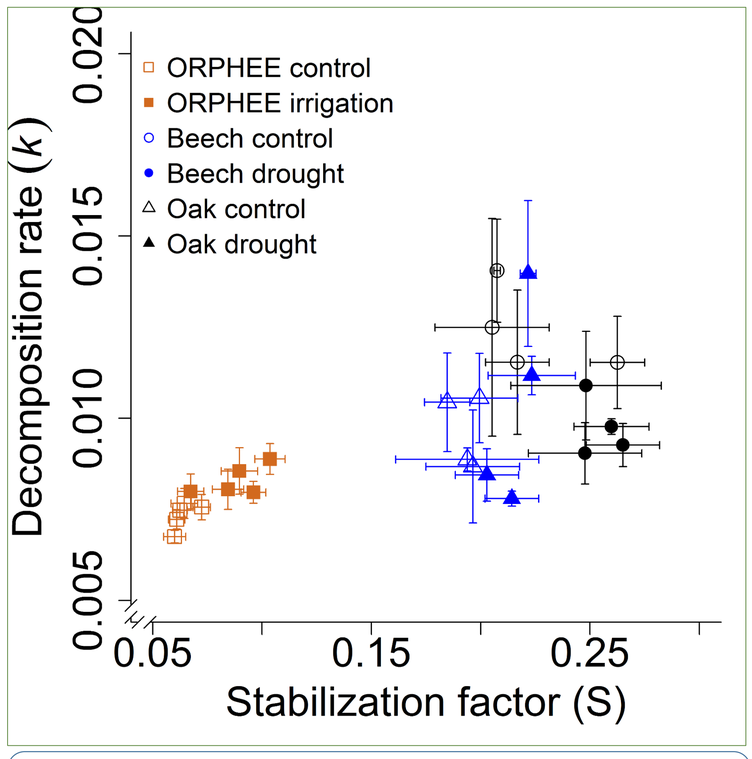

Fig. 6: Changes in decomposition and stabilization rate due to drought and irrigation at both sites.

- **Variation in both *k* and S were higher at FORBIO**

Conclusions

- **Tree species richness did not attenuate the effects of drought and irrigation on OM transformation.**
- **Soil moisture had more influence on OM transformations than tree species richness in young plantations.**

References

Castagneyrol et. al., 2013. J. Ecol. 101:418–429. doi: 10.1111/1365-2745.12055
Keuskamp et al. 2013. Methods Ecol. & Evo. 4(11):1070-1075. doi: 10.1111/2041-210X.12097
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