



Optimization of wood production in bioenergy plantations: 1. through the use of adequate plant material in terms of resource use efficiencies

Julien Toillon, Bénédicte Rollin, Erwin Dallé, Jean-Charles Bastien, Franck F. Brignolas, Nicolas Marron

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Optimization of wood production in bioenergy plantations

Through the use of adequate plant material
in terms of resource use efficiencies

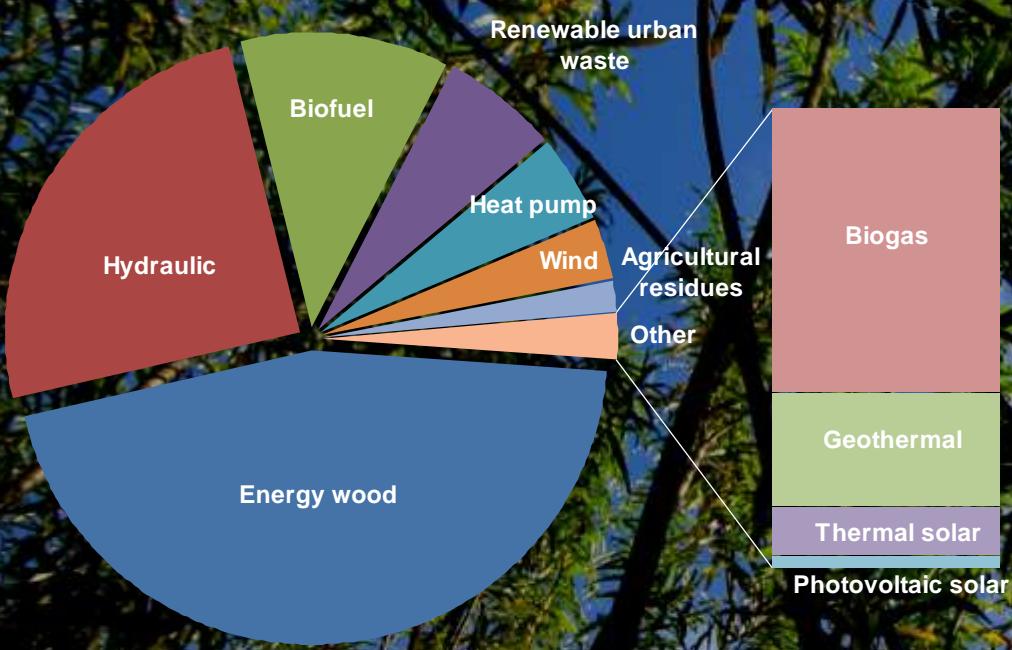
Julien TOILLON, Bénédicte ROLLIN, Erwin DALLÉ
Jean-Charles BASTIEN, Franck BRIGNOLAS & Nicolas MARRON

Why?

How?

Where?

What?



European directive : 20% of produced energy have to be renewable

- 7.9% in France in 2009
- 45% from wood (forest and SRC)
- Need of 8 to 10 millions hectares to reach the objectives...
- ... avoiding concurrence with food agriculture

Why?

How?

Where?

What?



European directive : 20% of produced energy have to be renewable

- 7.9% in France in 2009
- 45% from wood (forest and SRC)
- Need of 8 to 10 millions hectares to reach the objectives...
- ... avoiding concurrence with food agriculture
- Use of suboptimal lands
- Optimization of wood production while reducing inputs
- Use of plant material using efficiently water and nitrogen

Why?

How?

Where?

What?



Most frequently used tree species in Europe:

- Poplar
- Willow
- Eucalyptus
- Black locust (*Robinia*)

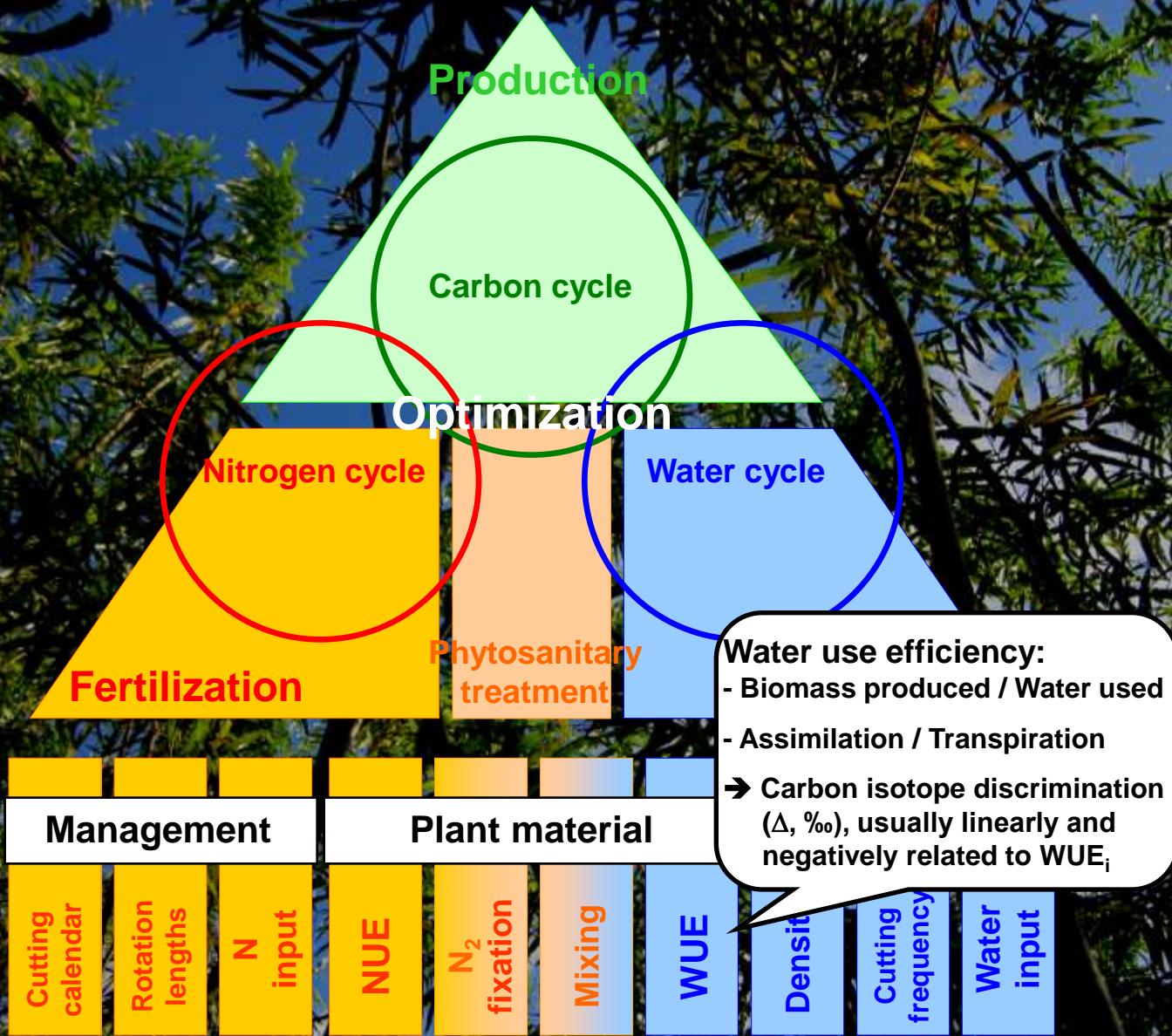
→ 1500 to 12 000 trees / ha
→ 2 to 8 year rotations

Why?

How?

Where?

What?



Why?

How?

Where?

What?

Management			Plant material			Management		
Cutting calendar	Rotation lengths	N input	NUE	N ₂ fixation	Mixing	WUE	Density	Cutting frequency

Why?

How?

Where?

What?



- ERA-Net Bioenergy
- Franco-German cooperation
- “Cost optimisation of adapted plant material”
- “New concepts of sustainable energy crops with woody species”
- www.creff.eu

Cutting calendar
on months
out

ix
ANR
Research Agency
“Intensification
of Congo / Brazil
forest ecosystems”

N₂ fixation
Mixing
nrad.fr

Management

See poster

Plant material

Management

See poster

X

X

X

N₂ fixation

X

Mixing

WUE

X

X

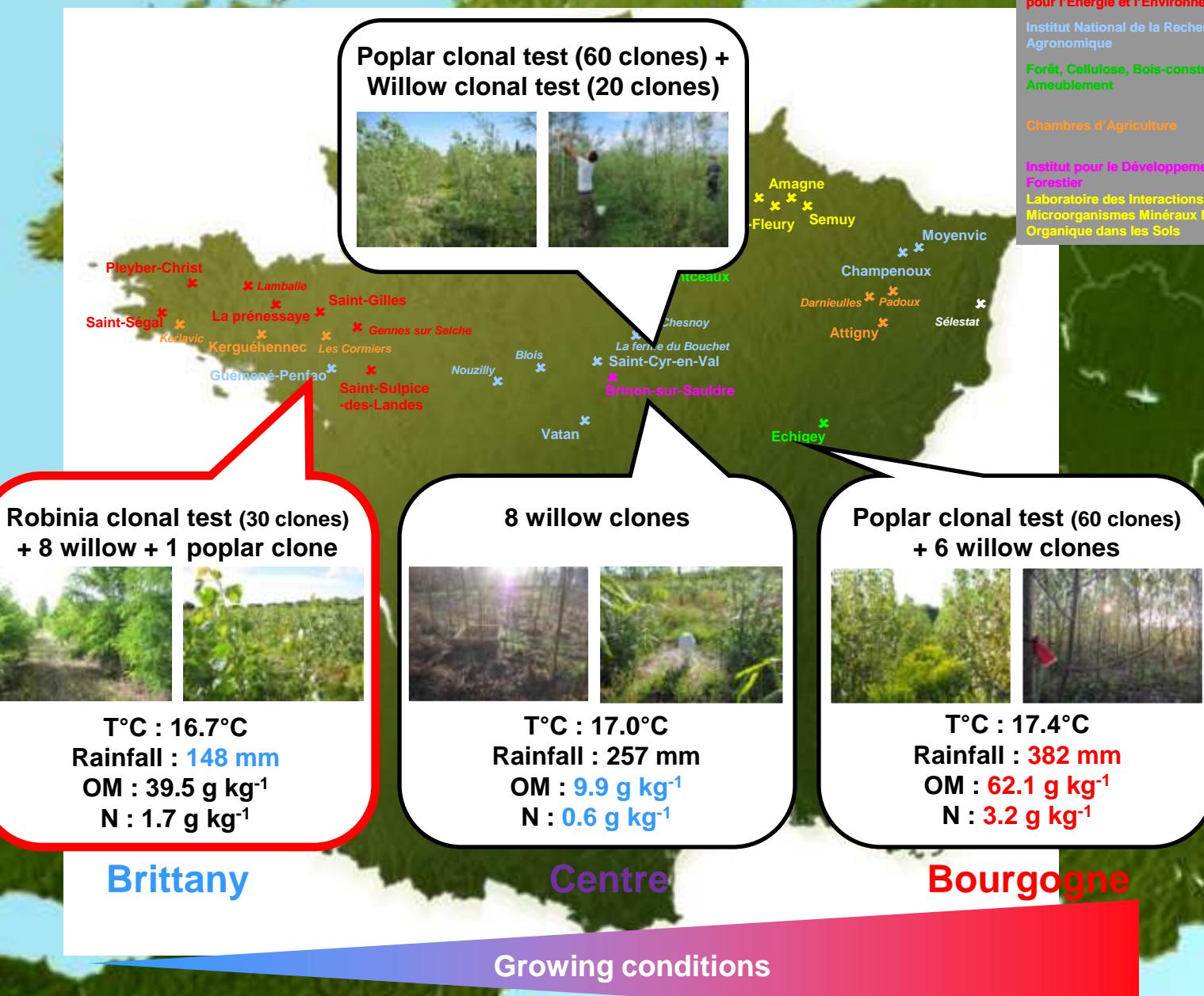
Density

X

Cutting frequency

X

Water input



Why?

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What?



Poplar
'Dorskamp'



Robinia
2 provenances



Willow
8 clones

The 3 species at the same site

Close Δ / WUE values for leaves and wood

Close Δ / WUE values for poplar and willow...

... but inferior for black locust

→ Black locust more efficient to use water than poplar / willow?

→ Or due to extreme conditions at this site in 2010?

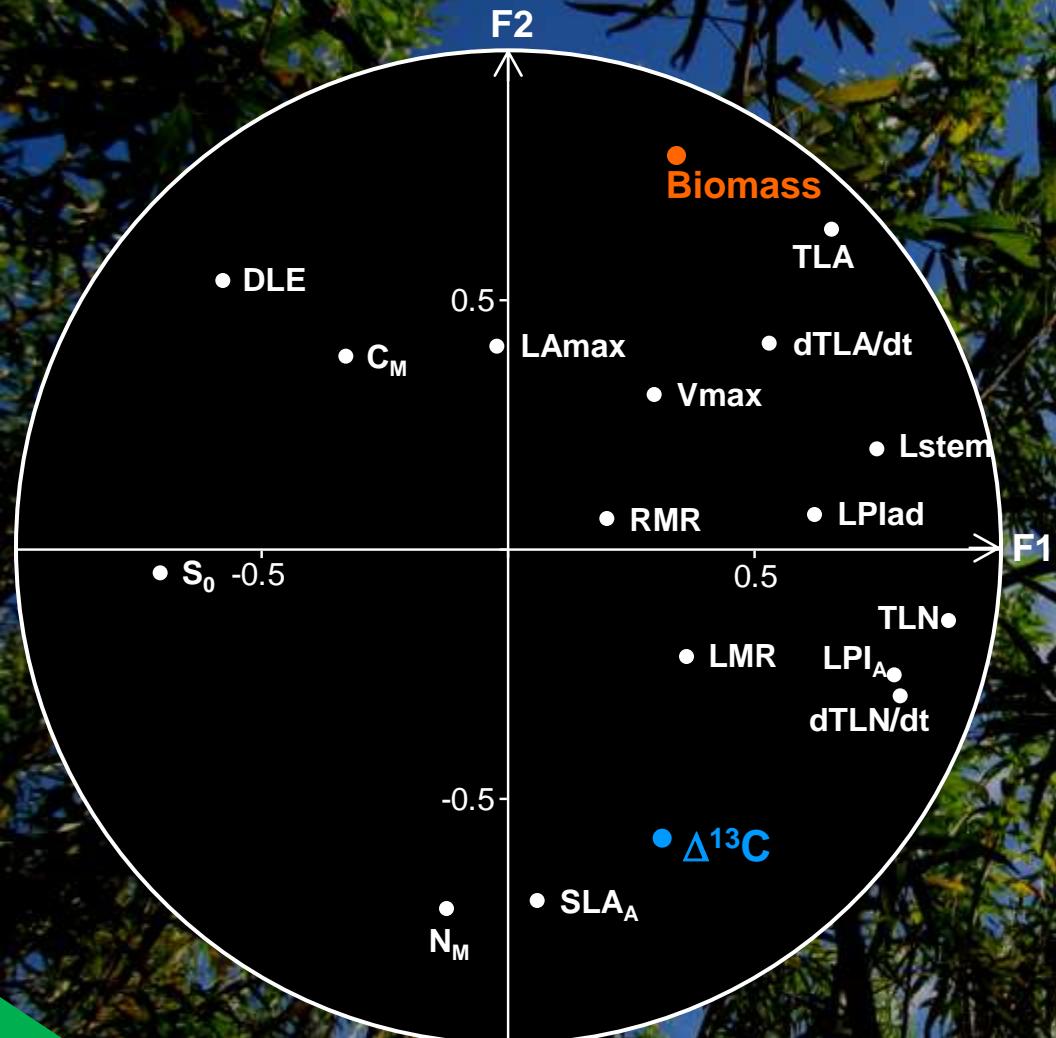
More precisely
for each
species...

Robinia clonal test (30 clones)
+ 8 willow + 1 poplar clone



T°C : 10.7°C
Rainfall : 148 mm
OM : 35.5 g kg⁻¹
N : 1.7 g kg⁻¹

European poplar clones (Italy / Netherland / Belgium / France / Hungary)



Marron et al. 2005

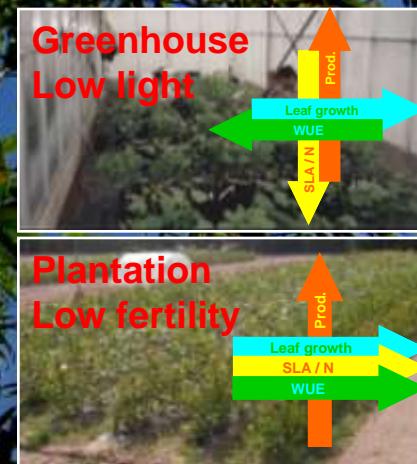
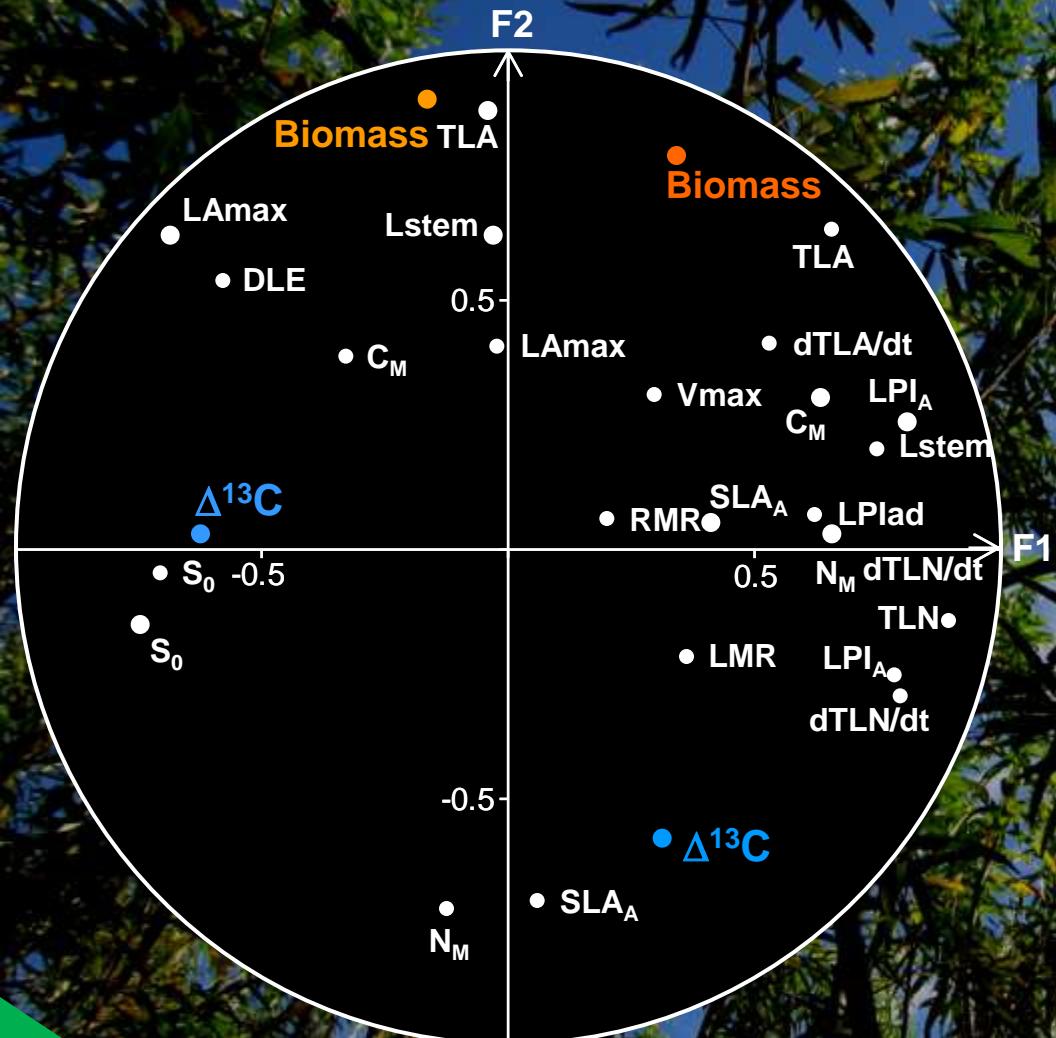
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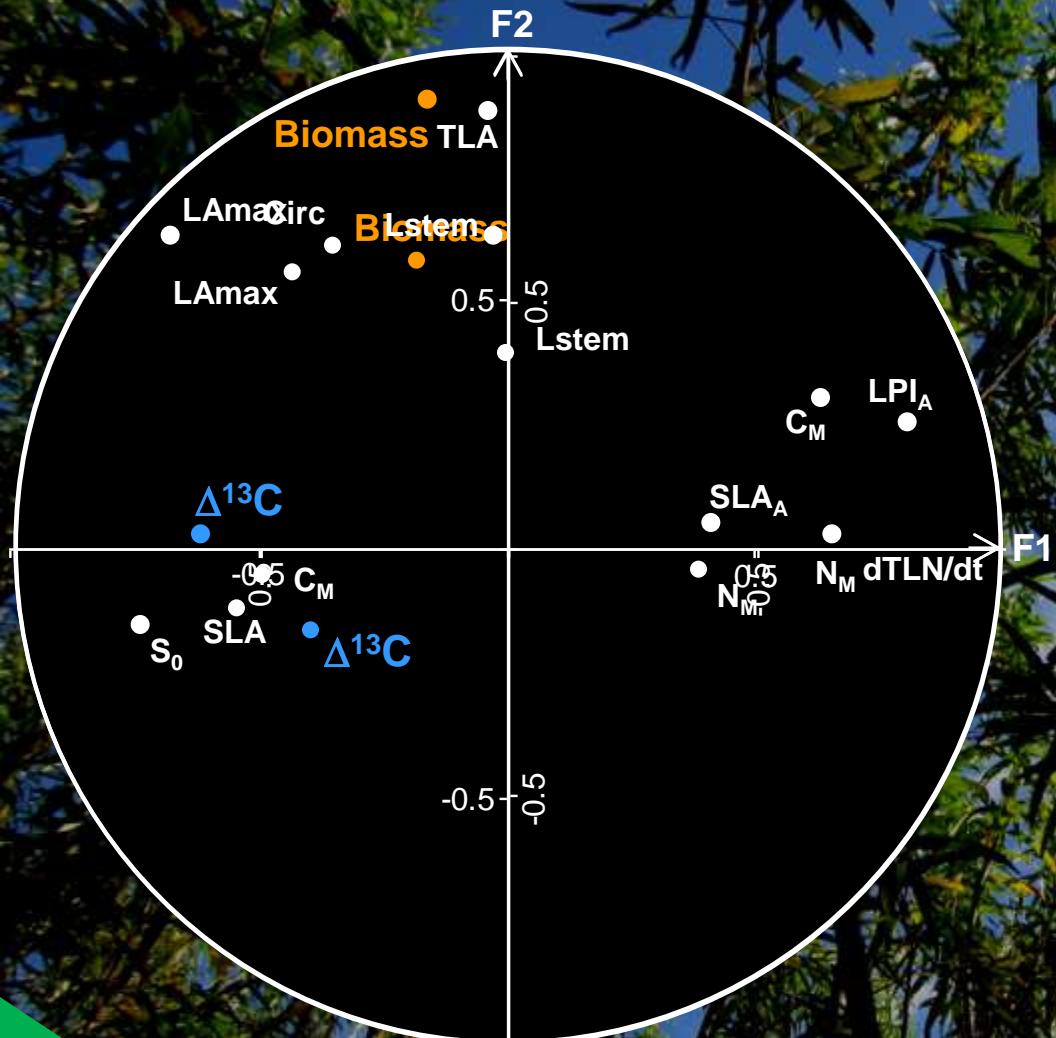
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European poplar clones (Italy / Netherland / Belgium / France / Hungary)



European poplar clones (Italy / Netherland / Belgium / France / Hungary)



Marron et al. 2005

Monclús et al. 2005

Monclús et al. 2006

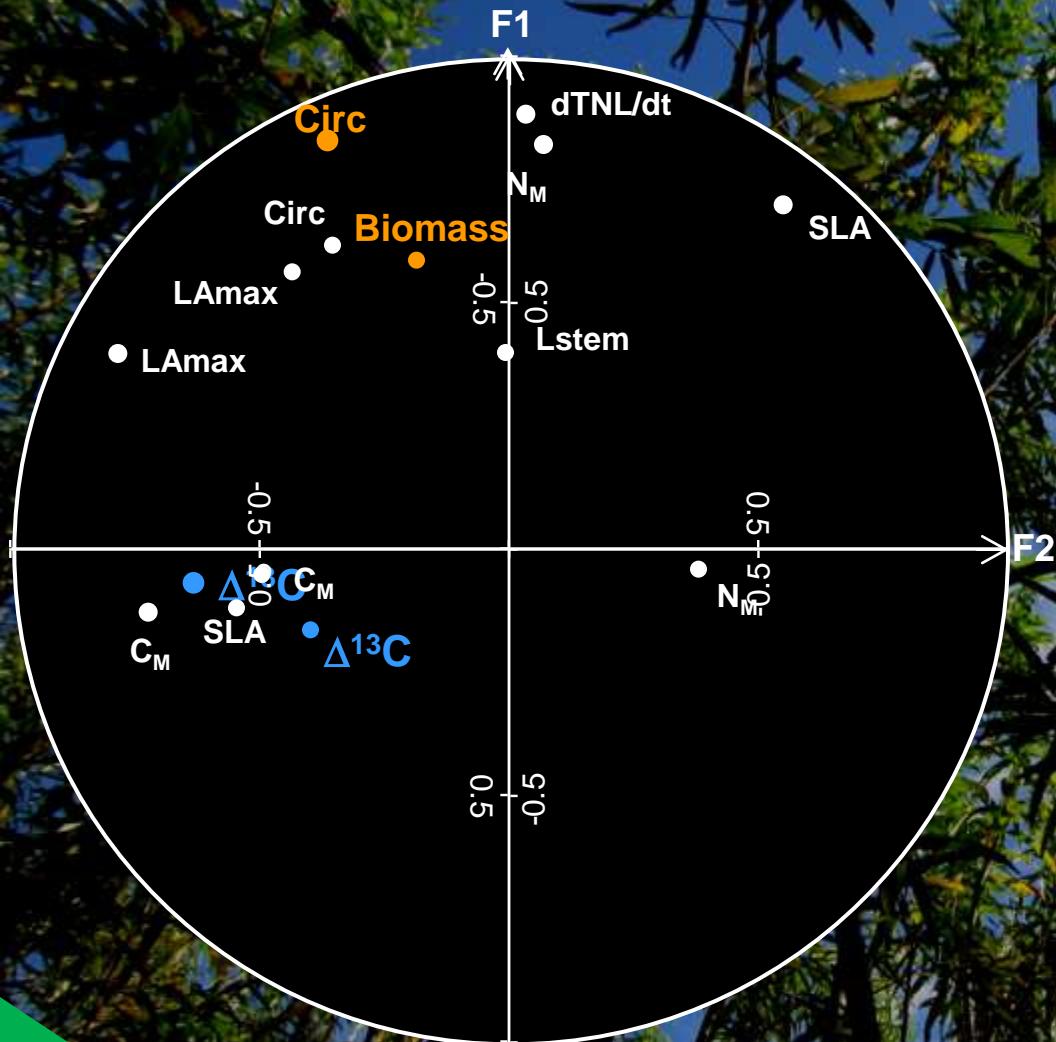
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European poplar clones (Belgian F1)



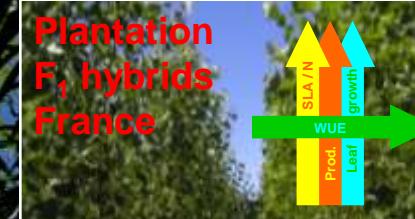
Marron et al. 2005



Monclús et al. 2005



Monclús et al. 2006



Marron and Ceulemans 2006

Dillen et al. 2011

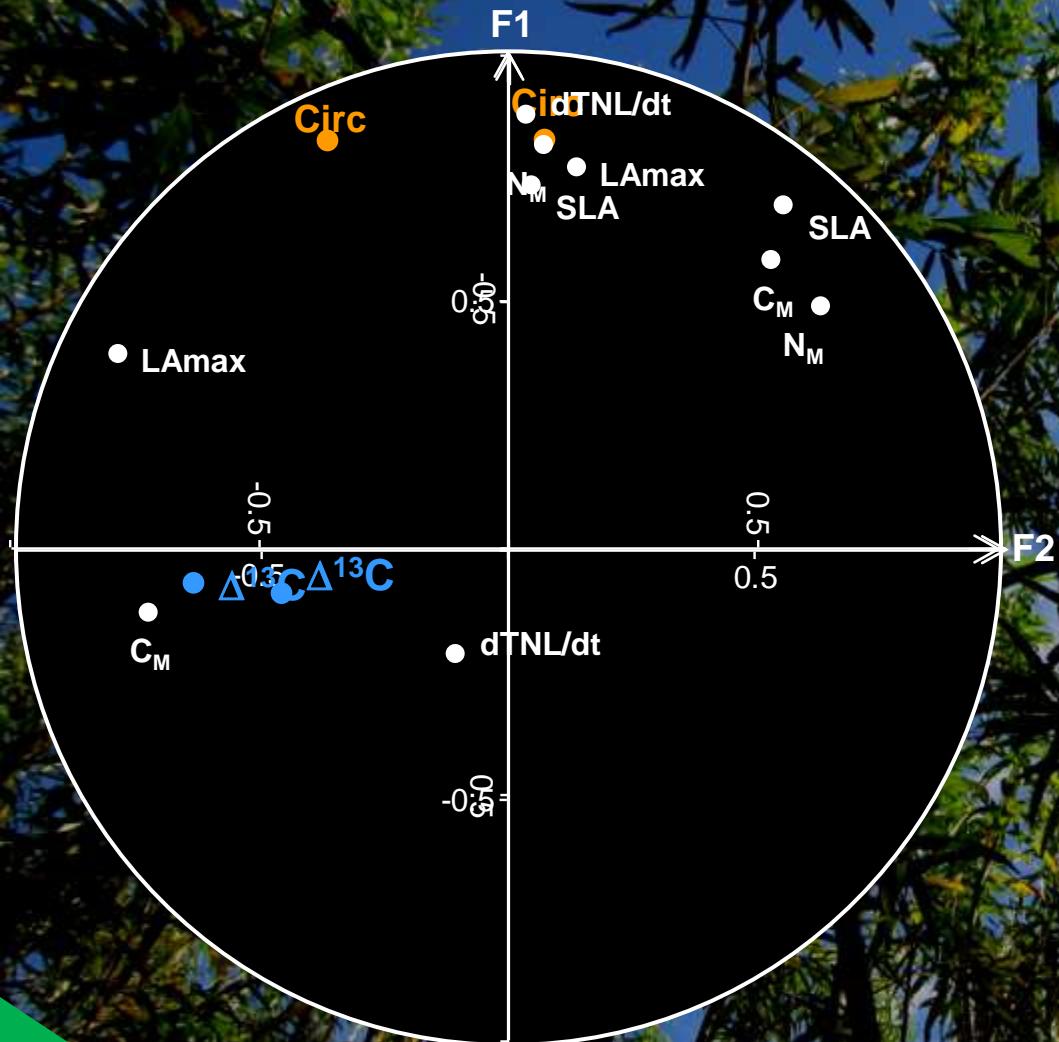
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Marron et al. 2005



Monclús et al. 2005



Monclús et al. 2006



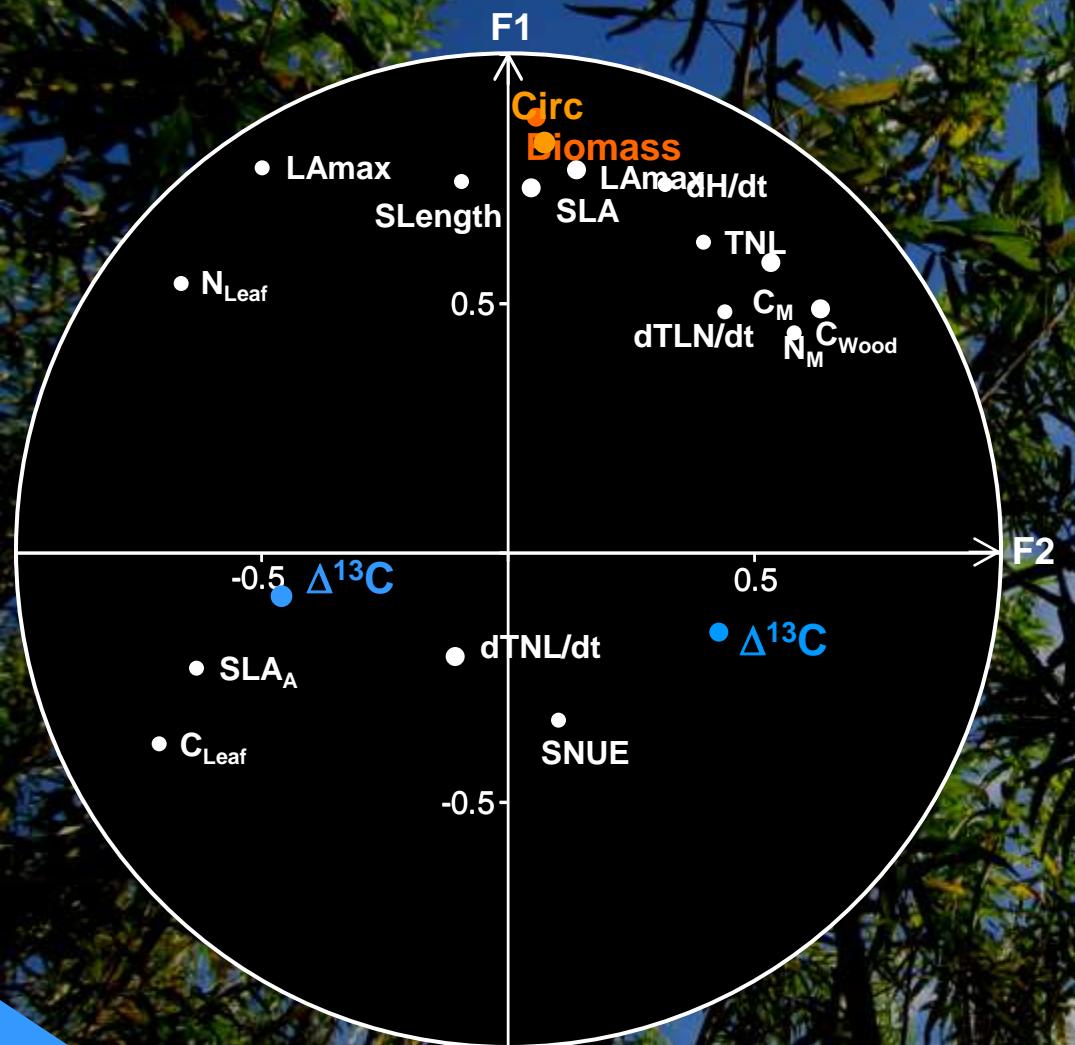
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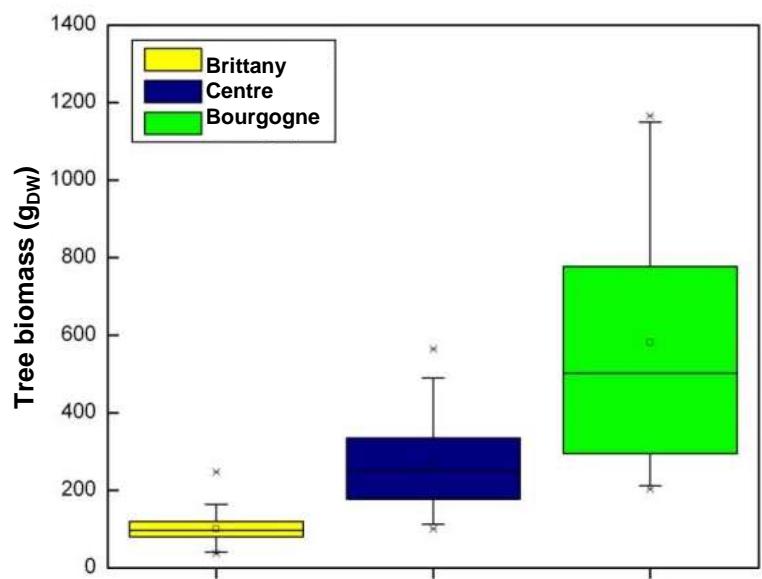
Marron et al. 2007
Dillen et al. 2011

European willow clones (Sweden / Ireland)



Willow

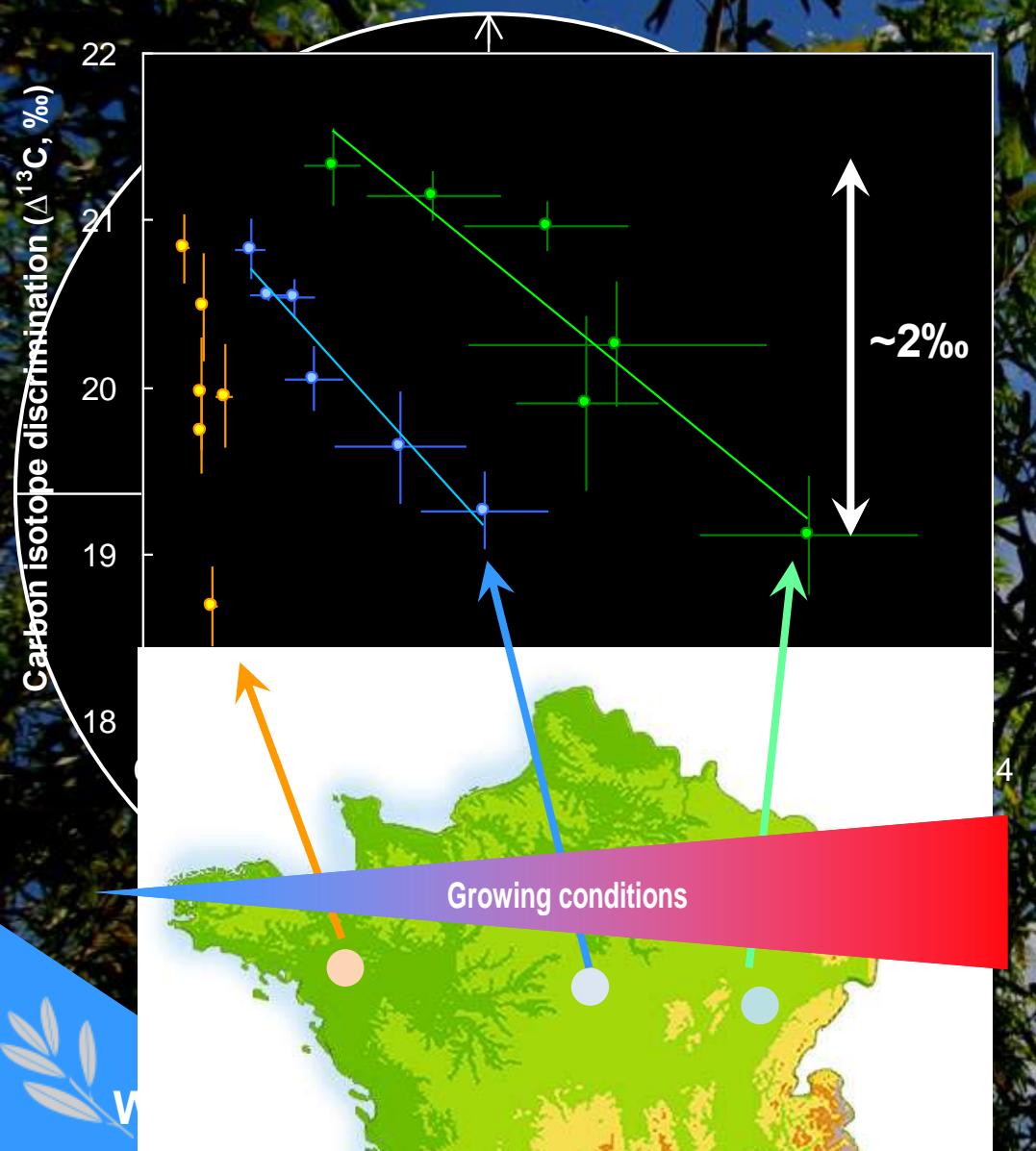
Six willow clones at 3 contrasting sites



For willow as well, it seems that there is no relationship between productivity and Δ / WUE

But...

European willow clones (Sweden / Ireland)



... when studied site by site...

Around 30% variation in Δ among willow clones

Clone ranking stable among sites

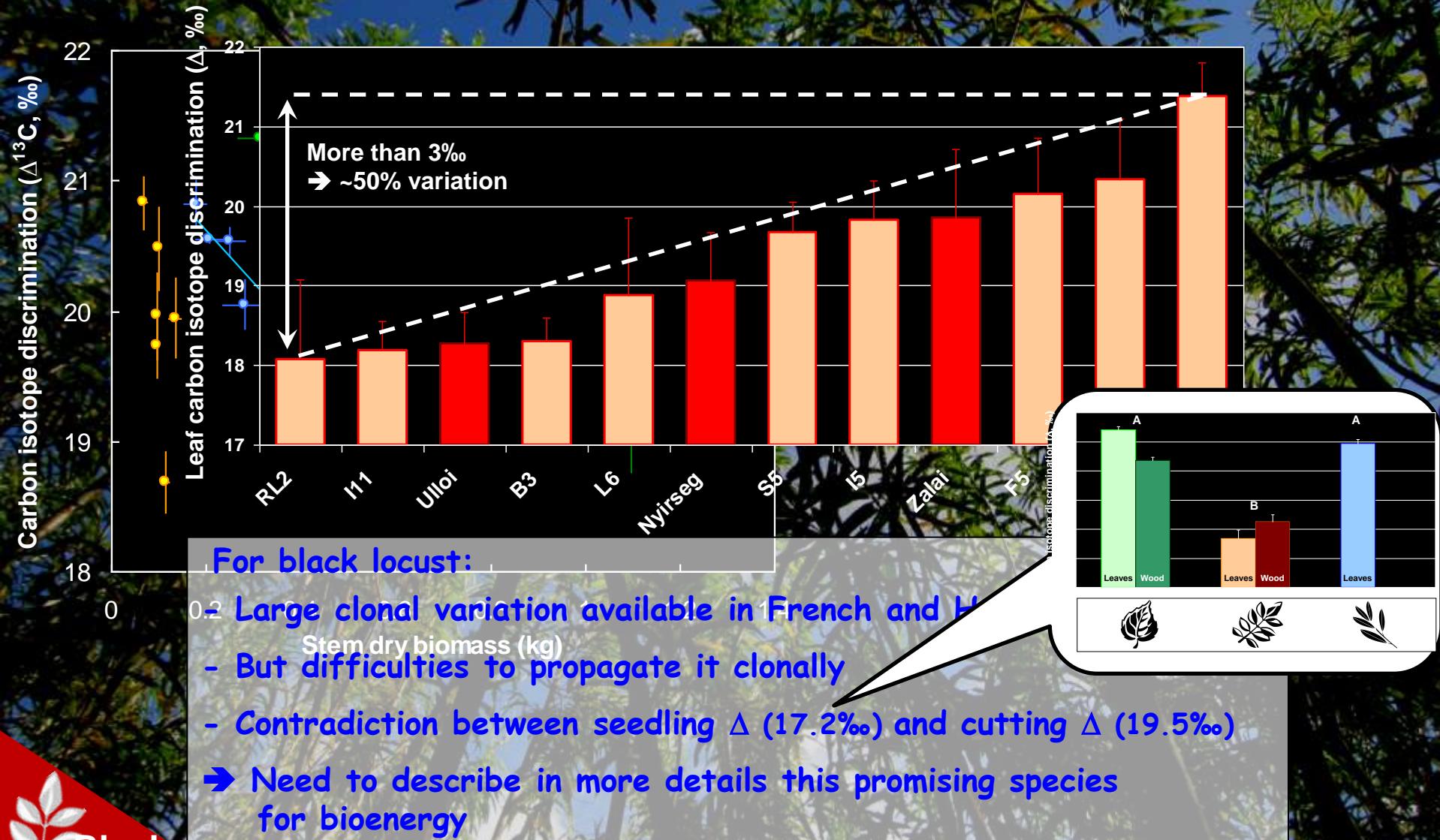
→ Quite wide variation enabling selection

Relation Δ / biomass stronger when conditions are favorable

→ Δ driven by assimilation at the "good" sites

→ Δ driven by stomatal conductance at the "bad" site

European black locust clones (Hungary / France)





In summary:

Variation

- Large Δ / WUE variation for the three species...
... but highly dependant on growth conditions

Clonal rankings usually stable whatever conditions

Relation with productivity

Poplar / Robinia: no link between Δ and production has been shown

Willow: negative link Δ / production (positive WUE / prod.)

→ In any case, possibility to select for both traits together

→ To be completed...



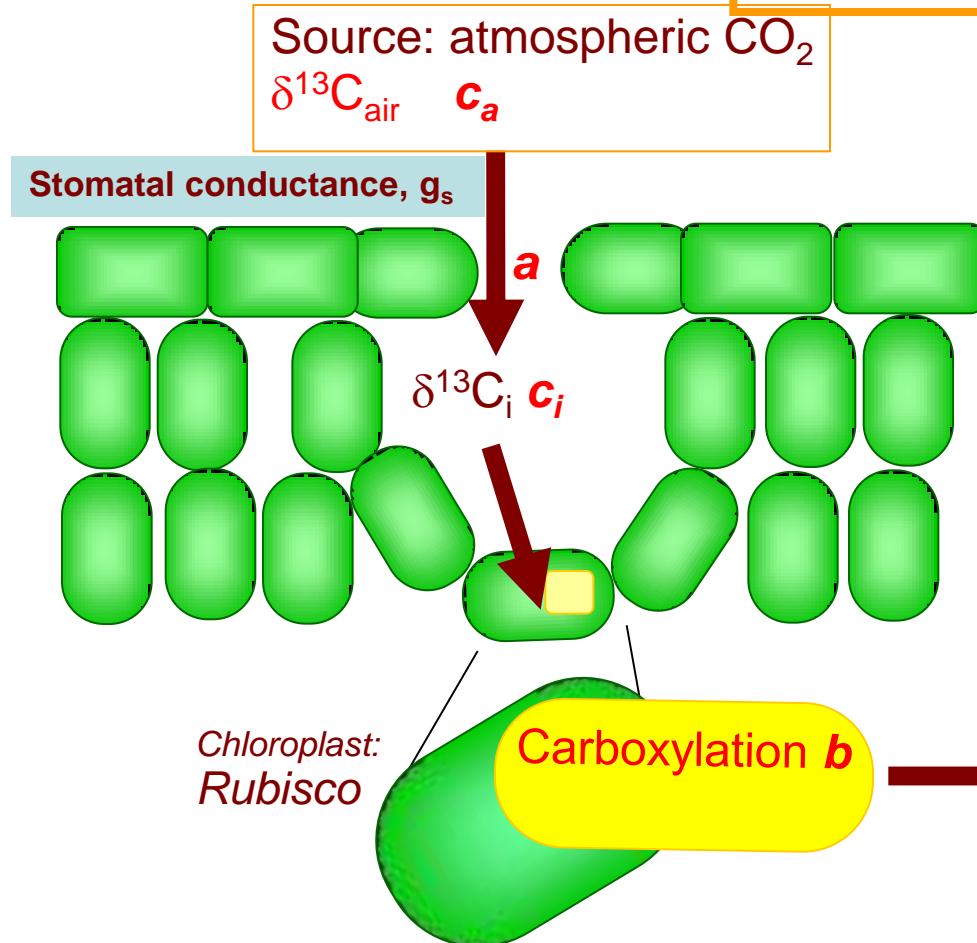
Thank you...
... and to the people
contributing to these projects

Carbon isotope discrimination during photosynthesis and W_i : simple model

$$\Delta^{13}C \approx \delta^{13}C_{air} - \delta^{13}C_p$$

$$W_i = \frac{c_a}{1.6} \left(\frac{b - \Delta^{13}C}{b - a} \right)$$

Farquhar *et al.* 1984



C_a : atmospheric CO₂ concentration

C_i : intercellular CO₂ concentration

C_c : chloroplastic CO₂ concentration

Discrimination factors:

a : 4.4‰

b : 27‰

$\delta^{13}C_{air}$: carbon isotope composition of atmospheric CO₂ (≈-8‰)

$\delta^{13}C_p$: carbon isotope composition of photosynthates