Leaf and foliage characteristics associated with high yield in *Salix* plantation

Ebe Merilo

Institute of Botany and Ecology,
Tartu University

Experimental plantation

- Saare plantation, established in 1993 with 7 different clones
- 4 treatments were studied:

  Salix viminalis (78183) and *Salix dasyclados* (81090)

  control and fertilized plots
- Experiment was done during the 2., 3. and 4. year of the second rotation in 1999-2001

What was measured:

- Leaf area index (LAI) – allometrically
- Effective extinction coefficient (k_{eff}) – $-\ln a_d/LAI$

  a_d from fisheye photographs
- Clumping index (Ω) – k_{eff}/k_{the}

  k_{the} from the measurements of leaf angle distribution
- Seasonal radiation interception – Lambert-Beer formula
- Light use efficiency (LUE) – the slope of the linear regression between standing alive above-ground biomass and accumulated intercepted solar radiation

What was measured (2):

- Leaf nitrogen concentration (N)
- Light saturated photosynthetic rate (A_{max}) – LI6400
- Maximal carboxylation rate (v_{cmax})
- Leaf nitrogen partitioning between photosynthetic and non-photosynthetic pools – Niinemets & Tenhunen 1997:

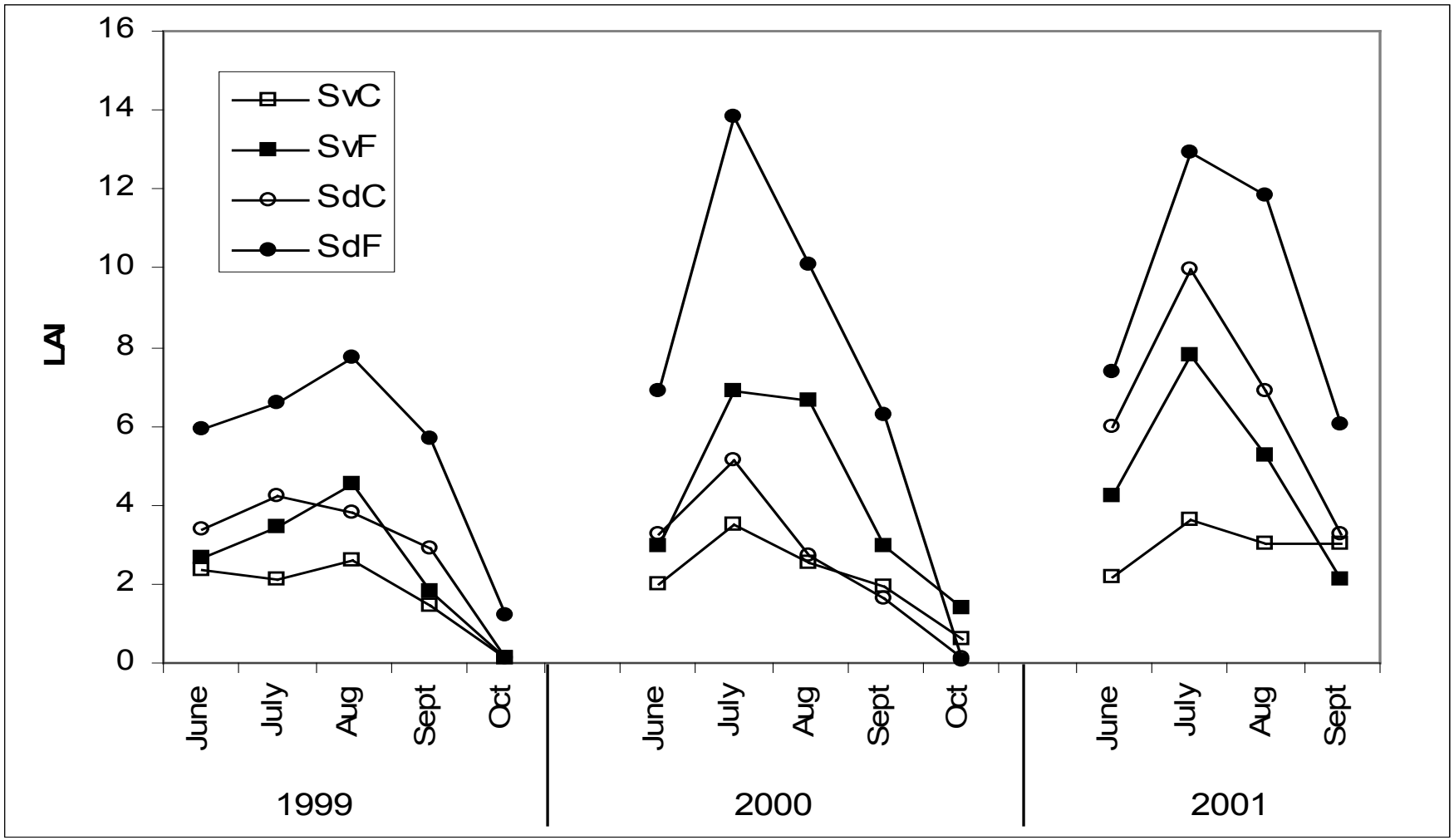
  $v_{cmax} \rightarrow P_R$

  $J_{max} \rightarrow P_B$

  $[Chl] \rightarrow P_L$

  $P_{non} \rightarrow 1\text{-}P_R\text{-}P_B\text{-}P_L$

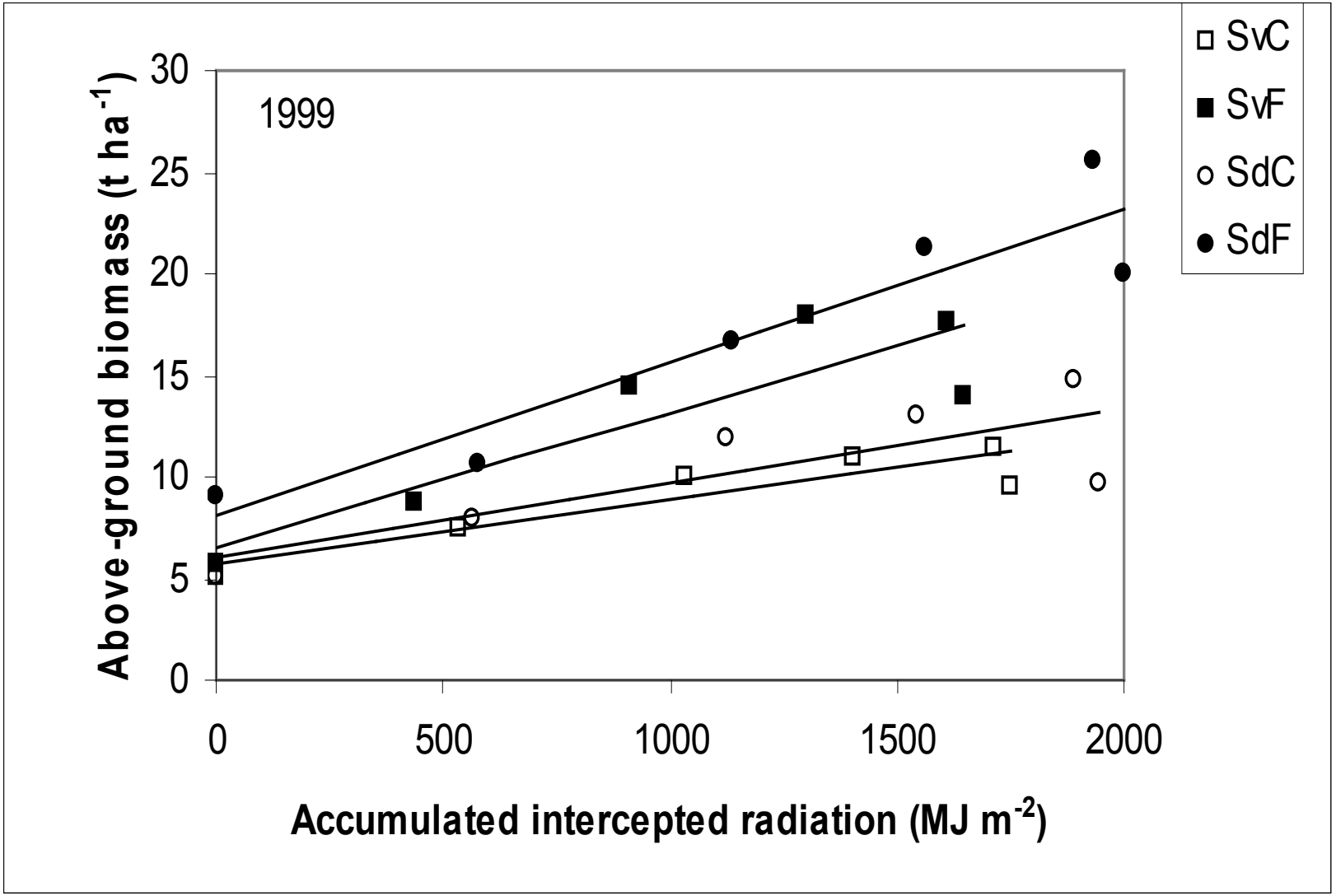
Seasonal average LAI was 1.5-3 times higher in fertilized than in corresponding control plots.



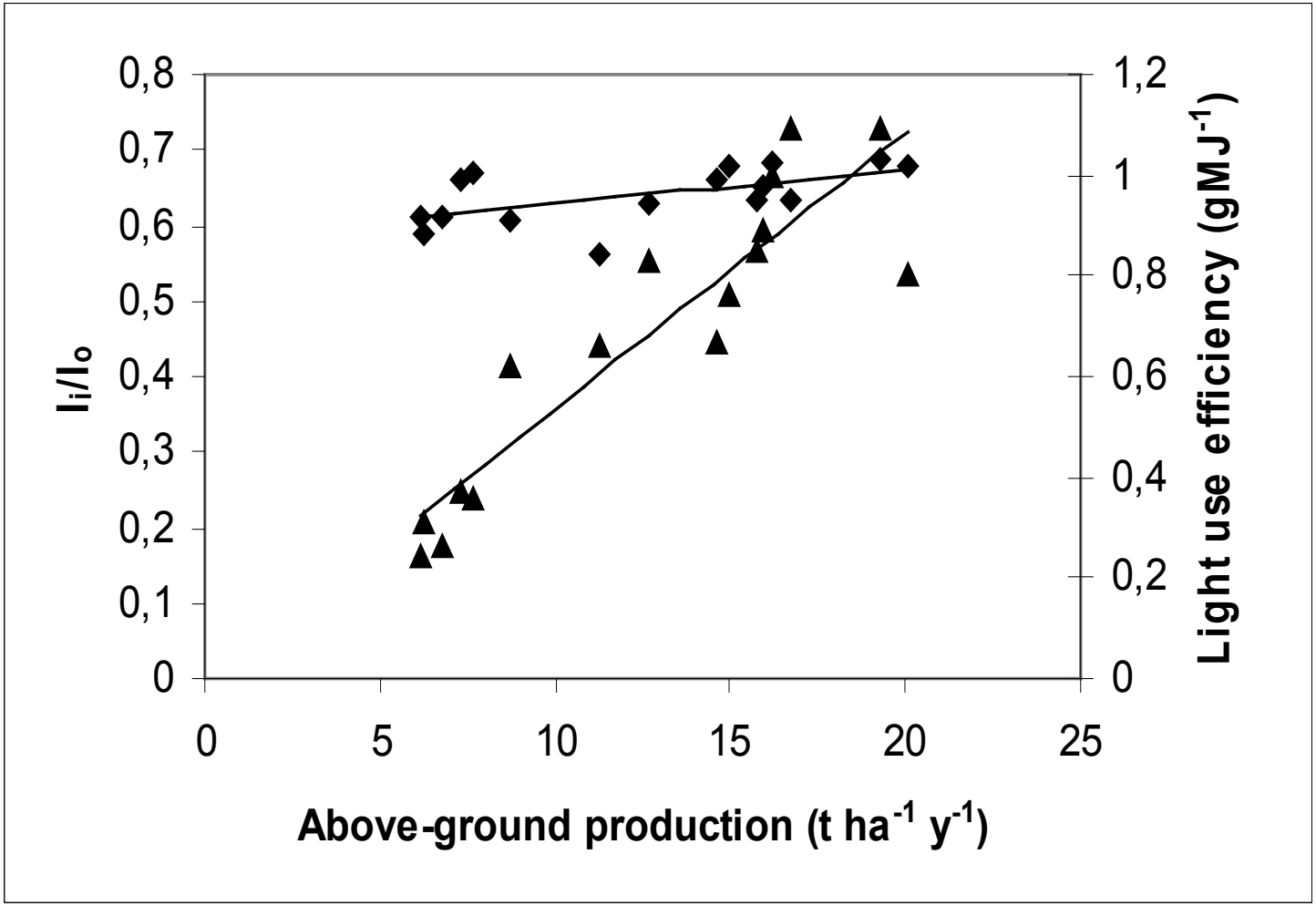
The effect of fertilization on studied characteristics, 3 years pooled (GLM Manova)

	Range	Fertilization effect, how fertilization affected
LAI	0-14	0.0014, +
a_d	0.15-0.30	<0.0001, -
k_{ef}	0.14-0.84	0.0003, -
O	0.16-0.60	<0.0001, -
Prod.	6.2-20.0, t ha^{-1} y^{-1}	0.0005, +
I_i/I_0	0.59-0.68	ns, ~
LUE	0.24-1.05, g MJ^{-1}	0.0086, +

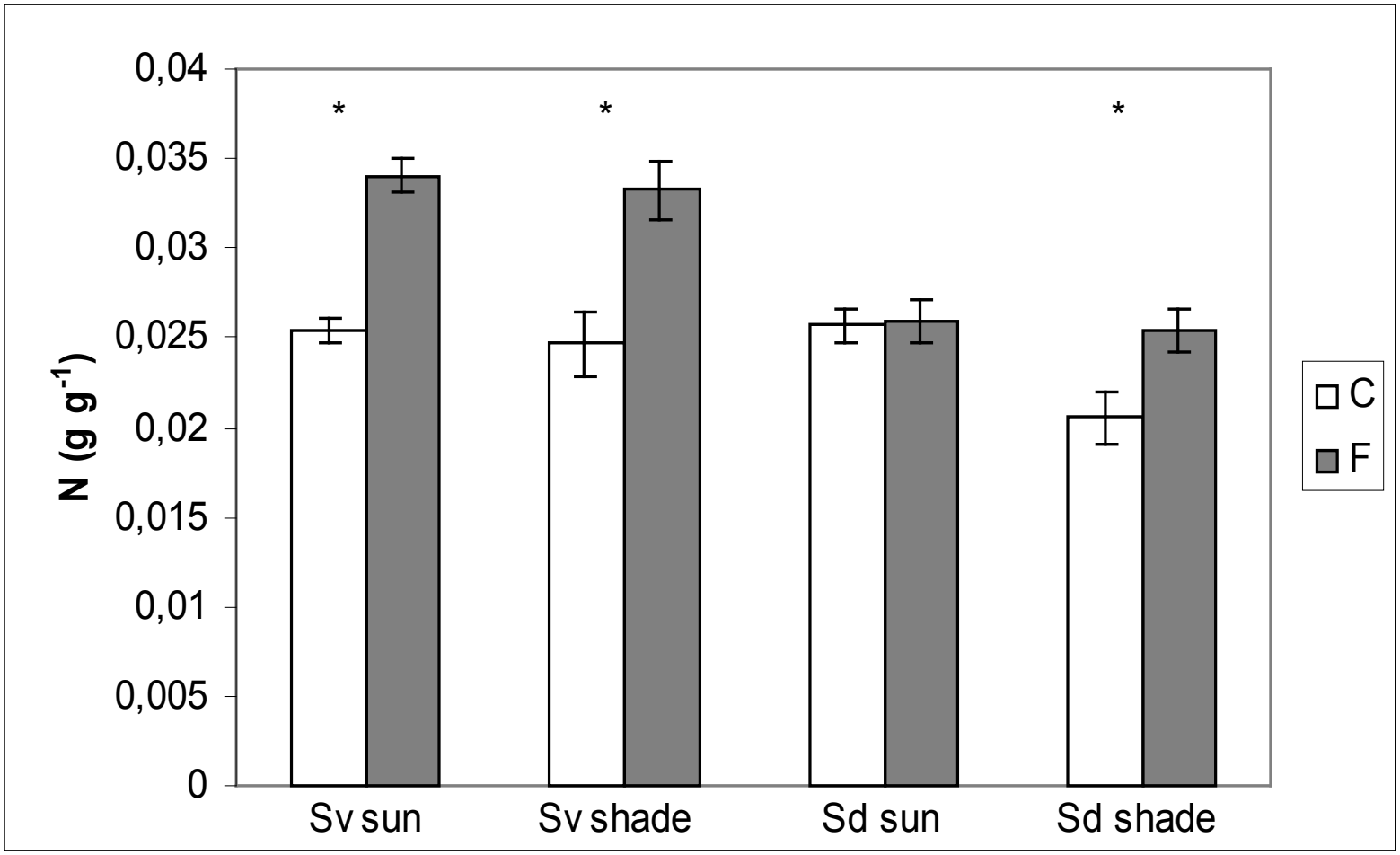
LUE is the slope of the linear regression



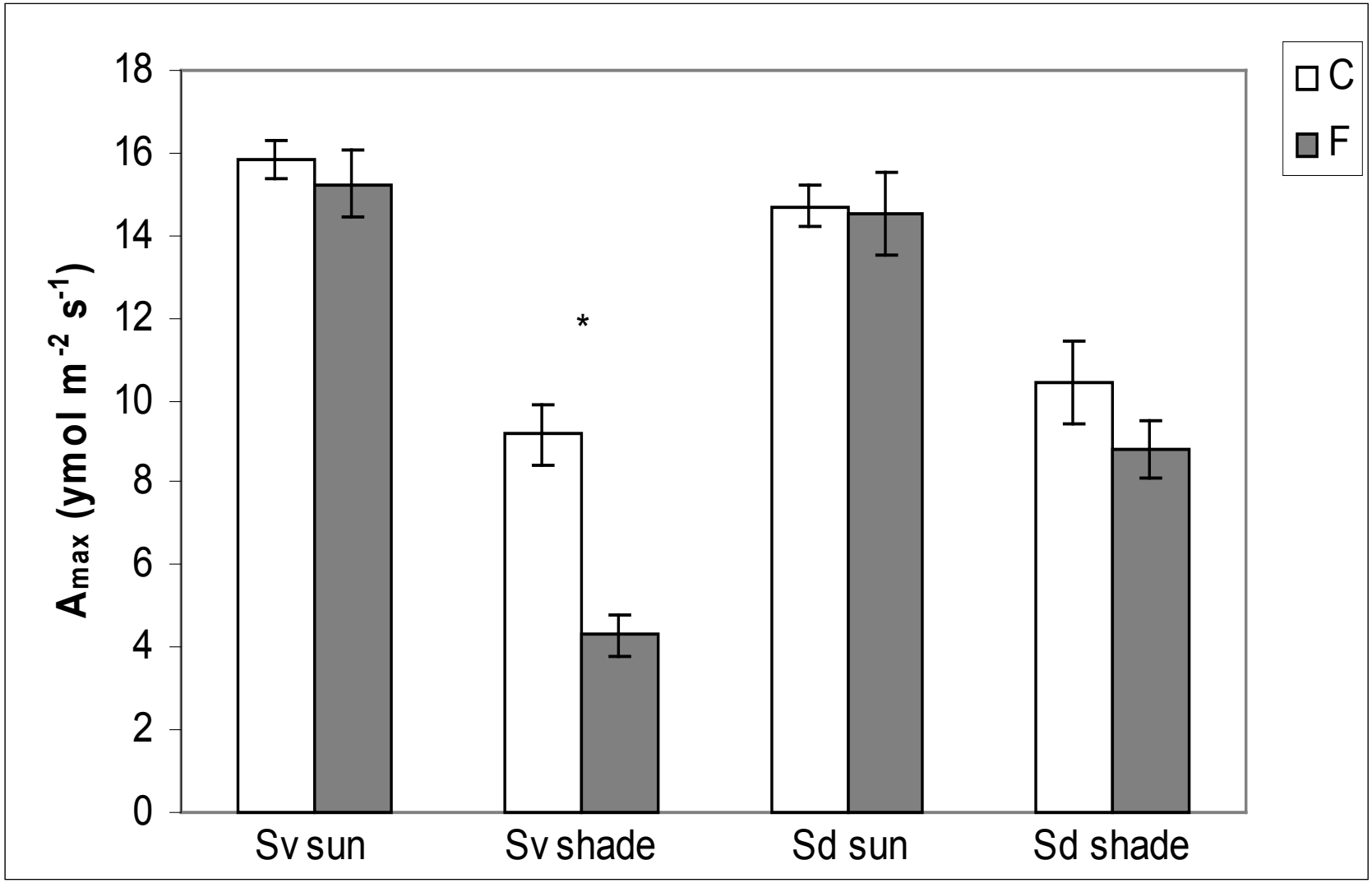
Annual above-ground production was closely related to LUE (triangles< R^2=0.83, P<0.0001), but only marginally to seasonally intercepted radiation (diamonds, R^2=0.34, P=0.0511)



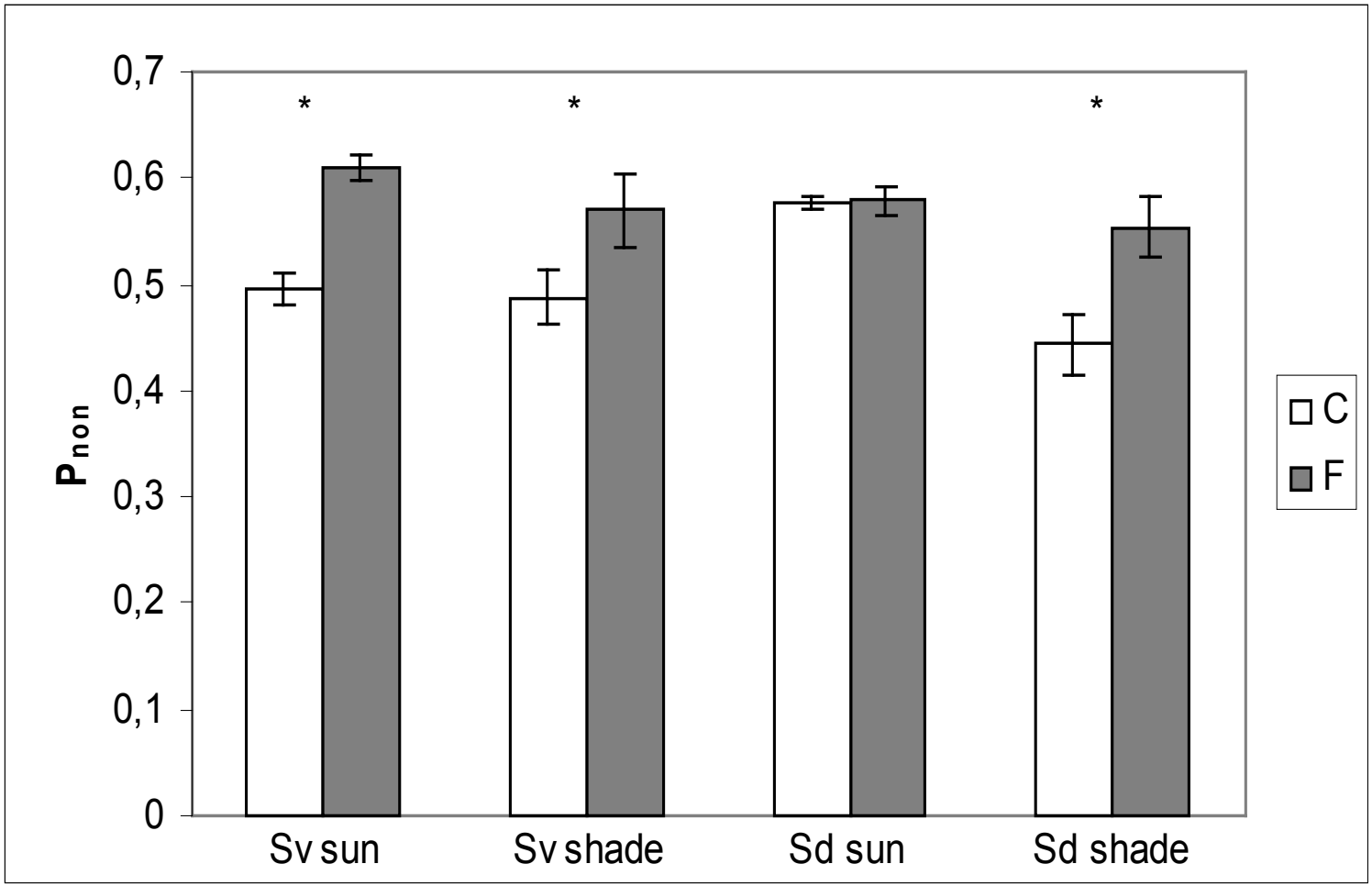
Fertilization had a positive effect on leaf N concentration.



Fertilization had no positive effect on A_{max} and v_{cmax}.



The fraction of non-photosynthetic nitrogen was higher in the leaves of fertilized plants.



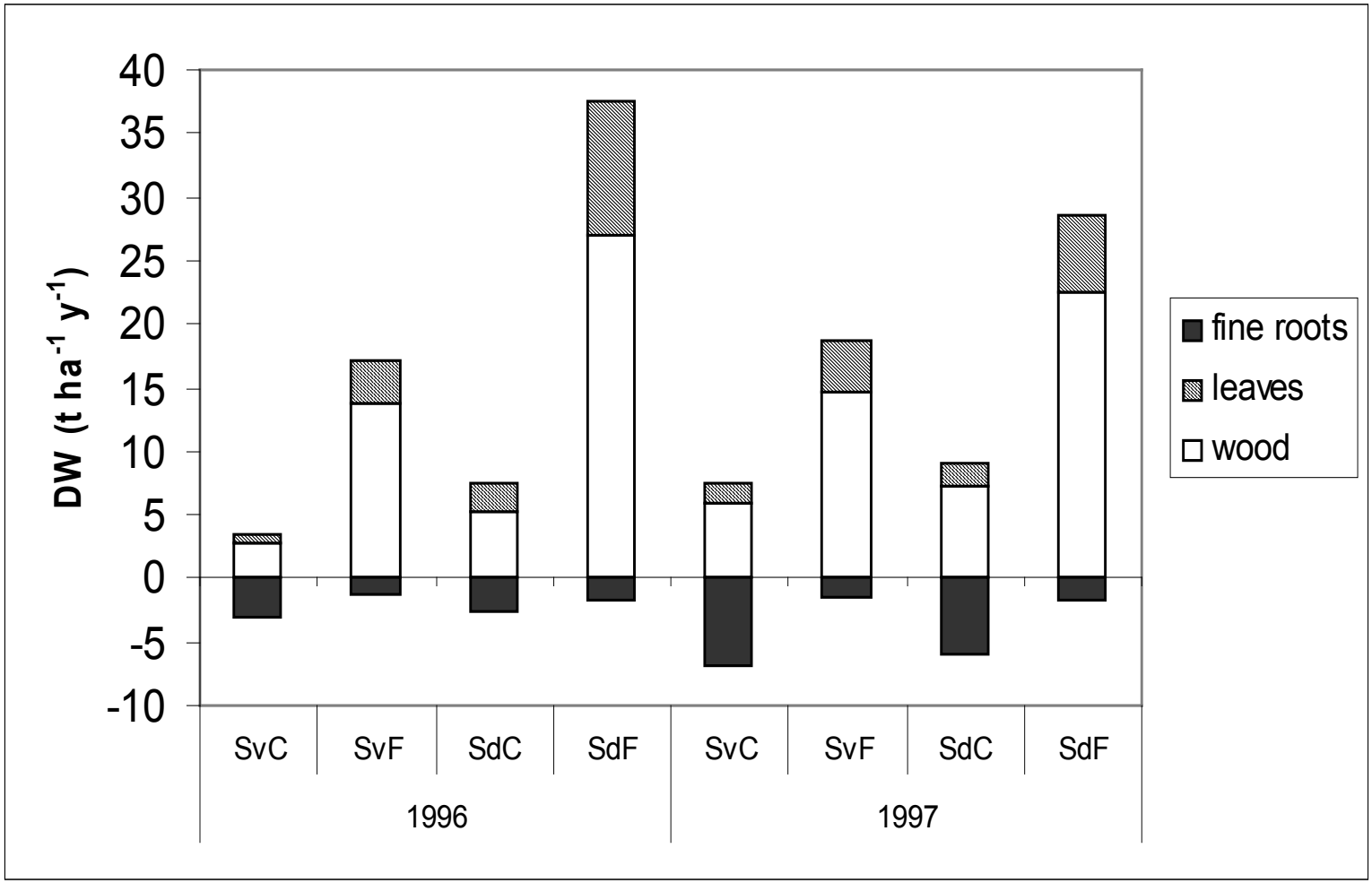
The issue of non-photosynthetic nitrogen

- Evans (1989) analysed the partitioning of leaf N between various components in his often cited paper.
- The fraction of non-photosynthetic nitrogen consists of non-photosynthetic proteins, leaf structural components, nucleic and amino acids and secondary compounds.
- Onoda, Hikosaka & Hirose (2004) found that the fraction of leaf N allocated to cell walls may reach 10%.

The issue of non-photosynthetic nitrogen (2)

- Group of Estonian scientists (Eichelmann, Oja, Laisk & Kull, PCE 2005) found that the fraction of non-photosynthetic N was as high as 54% in the sun leaves of *Betula pendula*.
- Secondary compounds in *Salicacea* are mainly carbon-based phenolic glycosides (salicin, salicortin, tannins, tremulacin).

Higher below-ground allocation was detected in studied plantation during the first rotation, and is one reason for the higher above-ground production in fertilized plots.



Conclusions

- LAI was significantly higher in fertilized than in control plots.
- Lower k_{ef} and Ω values were detected in fertilized plots, indicating higher degree of foliage clumping and self-shading.
- Higher foliage clumping in fertilized plots offset the effect of higher LAI in terms of light capture.
- Annual above-ground production was closely related to LUE, but only marginally to seasonally intercepted light.

Conclusions (2)

- Fertilization increased leaf N, but had no positive effect on studied photosynthetic characteristics (A_{max}, v_{cmax}).
- The fraction of non-photosynthetic nitrogen tended to be higher due to fertilization.
- It is still possible that higher leaf N was associated with higher photosynthetic rate earlier during the season.
- Higher below-ground allocation in control plots is probably one reason for the lower above-ground production and LUE.