$\delta^{13}C$ of leaf and cellulose reveal post-photosynthetic fractionation

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1. Introduction and aim

- **Background:** The ^{13}C isotope composition ($\delta^{13}C$) of leaf integrates signatures of ^{13}C discrimination occurring during and after photosynthesis (post-photosynthetic fractionation, Δ_{post}), complicating the interpretation of physiological responses.
- **Knowledge gap:** While photosynthetic discrimination is well studied, the downstream Δ_{post} processes are less known.
- **Aim:** Quantify the effect of Δ_{post} on $\delta^{13}C$ of mature leaves by a mass balance model.

2. Methods and Modeling

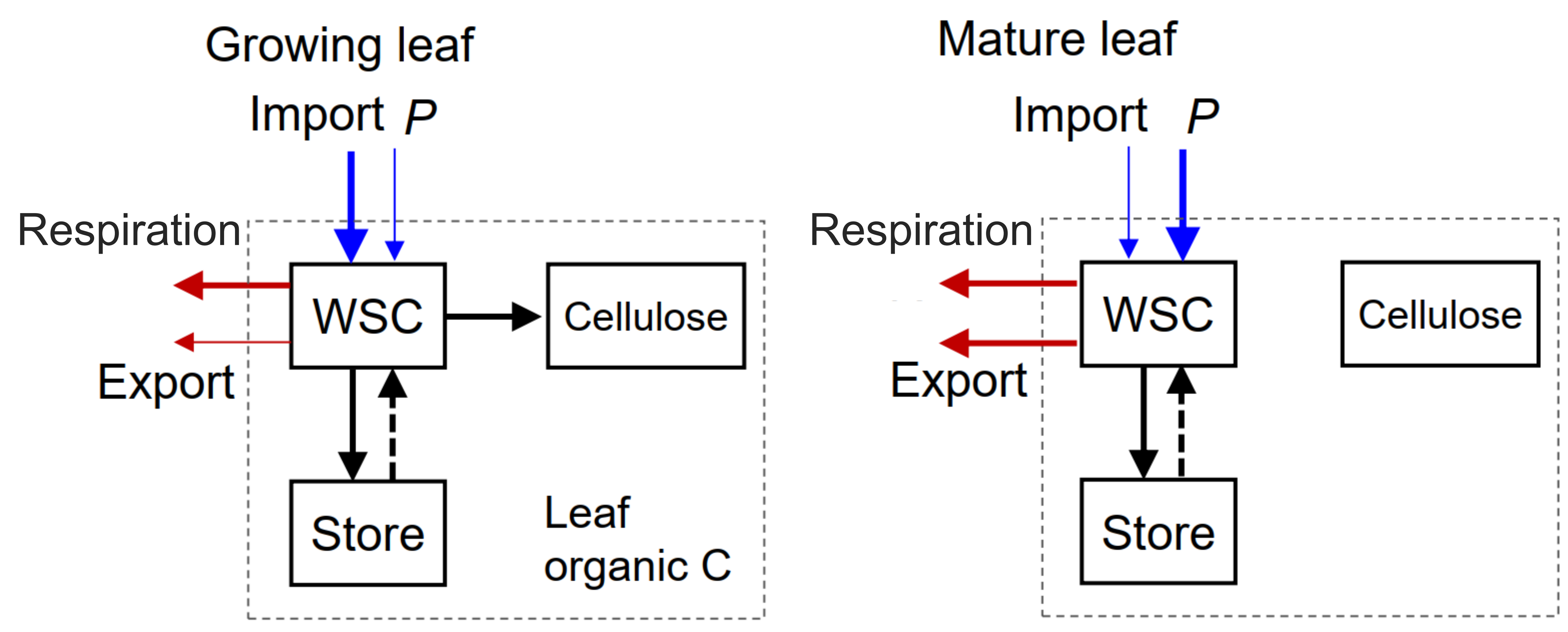

Fig. 1 The processes influencing $\delta^{13}C$ of leaf

$$\delta_{DM} = \delta_{Imp}\frac{\int Imp}{C_{mass}} + e_{resp}\frac{\int Resp}{C_{mass}} + e_{exp}\frac{\int Exp}{C_{mass}}$$

Carbon import — Respiration — Carbon export

Treatments: vapour pressure deficit (low VPD1, high VPD2) and nitrogen supply (low N1, high N2)

Measurements: ^{13}C fractionation of leaf dry matter (Δ_{DM}) and that of cellulose (Δ_{cel}) along leaf age category

3. How does Δ_{post} affect Δ_{DM} and Δ_{cel}?

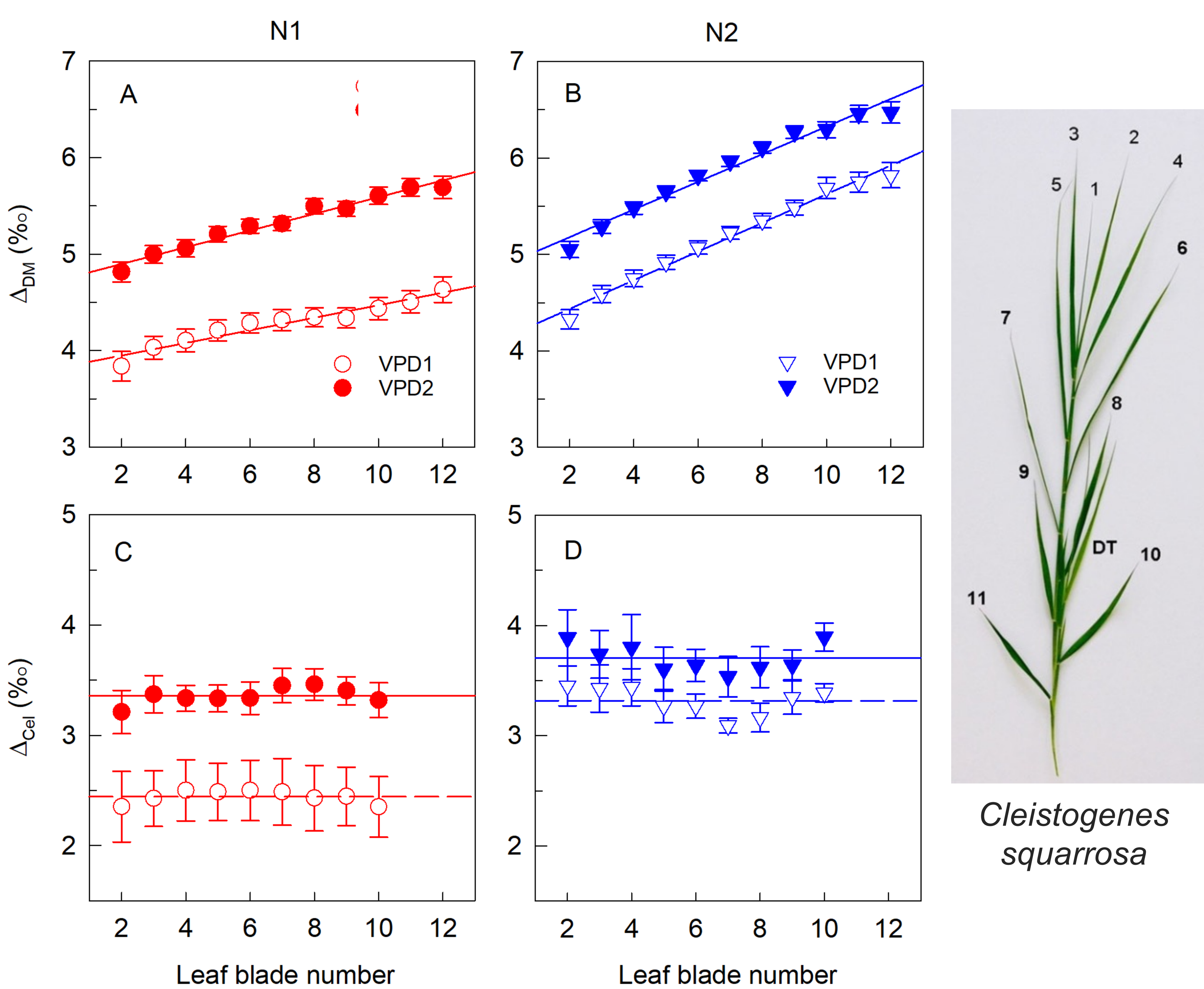

Fig. 2 The divergence between Δ_{DM} and Δ_{cel} increased with leaf age class, indicating the accumulation of Δ_{post}.

4. Can we quantify Δ_{post}?

Table 1 Mean fractionation of respiration (e_{resp}) and carbon export (e_{exp}) (‰)

	e_{resp}	e_{exp}
N1VPD1	–1.09 ± 0.83	–0.57 ± 0.06
N1VPD2	–0.75 ± 0.34	–0.50 ± 0.06
N2VPD1	–0.74 ± 0.51	–0.96 ± 0.04
N2VPD2	–1.03 ± 0.21	–0.68 ± 0.04

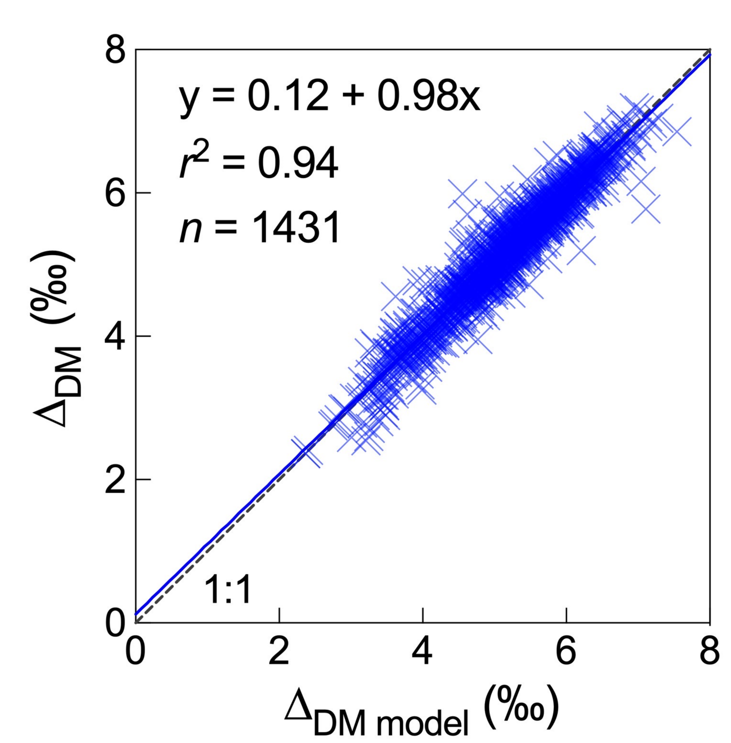

Fig. 3 The mass balance model was sufficient to estimate leaf Δ_{DM}.

5. Take home message

- Leaf became increasingly ^{13}C-depleted during ontogeny, while $\Delta^{13}C$ of cellulose remained constant.
- Respiration and carbon export are the driving mechanisms of Δ_{post}.
- Care must be taken when using Δ_{DM} to assess photosynthetic performance. Δ_{DM} of young leaves and Δ_{cel} are more reliable proxies for predicting physiological parameters.

- **Reference**: Yu YZ, Liu HT, Yang F, Li L, Schäufele R, Tcherkez G, Schnyder H, Gong XY. 2024. $\delta^{13}C$ of bulk organic matter and cellulose reveal post-photosynthetic fractionation during ontogeny in C_4 grass leaves. *Journal of Experimental Botany* 75(5): 1451-1464.

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