

Supporting Information

Table S1. Summary of the measurements performed within the study. MN = MN0095; E = Eiko; MG = MinnGold.

| Scale | Measurement | Pots | | | Field | | |
|--------------|---|--------|------|-----------|--------|-------|------|
| | | 2015 | 2016 | 2017 | 2015 | 2016 | 2017 |
| Leaf | Leaf area, leaf mass, pigments and nitrogen concentration measurements | | | | MN, MG | E, MG | |
| | Leaf optical properties ($f\text{APPFD}_{\text{LEAF}}$ components) | | | | MN, MG | E, MG | |
| | A/PPFD and A/APPFD curves | MN, MG | | E, MN, MG | MN, MG | | |
| | A/C _i curves | MN, MG | | | MN, MG | | |
| | ΦPSII | MN, MG | | | MN, MG | | |
| | NPQ | | | | MN, MG | | |
| | NPQ relaxation, recovery of CO ₂ fixation rate | | | E, MG | | | |
| Plant/canopy | Surface energy balance | | | | | E, MG | |
| | Canopy optical properties ($f\text{APPFD}_{\text{CANOPY}}$ components) | | | | | E, MG | |
| | CO ₂ fluxes (GPP, NEE, R _i , R _{sc0}) | | | | | E, MG | |
| | Transpiration | | | | | E, MG | |
| | Leaf area index (LAI) and biomass production | | | | | E, MG | |

Table S2. Maximal carboxylation rate (V_{cmax}), maximal electron transport rate (J_{max}), mesophyll conductance to CO_2 (g_m) calculated using the approach of Ethier & Livingston (2004) and photorespiration (R_{PR}) measured on green (MN0095) and Chl-deficient (MinnGold) leaves of pot- and field-grown plants. Mann-Whitney-Wilcoxon test was used to compare the two accessions. Values represent mean \pm standard error.

| | Variable | n. replicates | MN0095 | MinnGold | p-value |
|--------------------|--|----------------------|-------------------|--------------------|----------------|
| Pot-grown plants | V_{cmax} ($\mu\text{mol m}^{-2} \text{s}^{-1}$) | 5 | 83.70 \pm 3.26 | 89.24 \pm 9.49 | 1 |
| | J_{max} ($\mu\text{mol m}^{-2} \text{s}^{-1}$) | 5 | 165.62 \pm 5.64 | 164.26 \pm 10.11 | 1 |
| | g_m ($\text{mol m}^{-2} \text{s}^{-1}$) | 5 | 0.16 \pm 0.01 | 0.20 \pm 0.03 | 0.22 |
| | R_{PR} ($\mu\text{mol m}^{-2} \text{s}^{-1}$) | 5 | 10.28 \pm 1.70 | 7.57 \pm 0.97 | 0.42 |
| Field-grown plants | V_{cmax} ($\mu\text{mol m}^{-2} \text{s}^{-1}$) | 6 | 105.70 \pm 5.92 | 93.68 \pm 7.97 | 0.39 |
| | J_{max} ($\mu\text{mol m}^{-2} \text{s}^{-1}$) | 6 | 170.72 \pm 8.37 | 163.23 \pm 15.10 | 1 |
| | g_m ($\text{mol m}^{-2} \text{s}^{-1}$) | 6 | 0.21 \pm 0.02 | 0.16 \pm 0.01 | 0.17 |
| | R_{PR} ($\mu\text{mol m}^{-2} \text{s}^{-1}$) | 3 | 7.91 \pm 2.78 | 10.27 \pm 2.38 | 0.40 |

Table S3. Coefficients of the double exponential model ($NPQ = A^{B^{time}} + C$) fitted to dark relaxation of NPQ measured in the laboratory conditions on pot-grown green (Eiko) and Chl-deficient (MinnGold) leaves. NPQ was normalized to the maximum before fitting (Kromdijk *et al.*, 2016). Values are means \pm standard error (n=4). Mann-Whitney-Wilcoxon test was used to compare the two accessions: * p-value<0.05; ** p-value<0.01 ***p-value<0.001.

| Leaf | Variety | A | B | C | R² |
|-------------|----------------|--------------------|--------------------|--------------------|----------------------|
| Unifoliate | Eiko | 0.585 \pm 0.011 | 1.037 \pm 0.002 | 0.230 \pm 0.016 | 0.93 \pm 0.003 |
| | MinnGold | 0.425 \pm 0.052* | 1.009 \pm 0.005* | 0.447 \pm 0.119* | 0.91 \pm 0.02 |
| Trifoliate | Eiko | 0.630 \pm 0.033 | 1.023 \pm 0.011 | 0.173 \pm 0.029 | 0.94 \pm 0.01 |
| | MinnGold | 0.468 \pm 0.052* | 1.013 \pm 0.011 | 0.345 \pm 0.06* | 0.91 \pm 0.03 |

Table S4. Photosynthetic photon flux density (PPFD; $\mu\text{mol m}^{-2} \text{s}^{-1}$), gross primary production (GPP), ecosystem respiration (R_{eco}), net ecosystem exchange (NEE) and autotrophic respiration (R_a) of green (Eiko) and Chl-deficient (MinnGold) canopies averaged over the entire chamber gas exchange measurement period (July 21^a to 27^b). All flux data are in $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ (mean \pm standard error; n=4). Mann-Whitney-Wilcoxon test was used to compare the two accessions:
 * p-value<0.05; ** p-value<0.01; *** p-value<0.001.

| Variety | PPFD | GPP | R_{eco} | NEE | R_a |
|----------------|---------------|-------------------|------------------------------------|-------------------|-------------------------|
| Eiko | 1428 \pm 37 | -55.77 \pm 1.31 | 22.10 \pm 0.96 | -33.67 \pm 0.64 | 15.72 \pm 1.58 |
| MinnGold | 1420 \pm 35 | -53.11 \pm 1.80 | 21.36 \pm 0.66 | -31.75 \pm 1.33 | 16.60 \pm 0.56 |

Table S5. Quantum yield (ϕ ; $\mu\text{mol}(\text{CO}_2) \mu\text{mol}^{-1}(\text{photons})$) in leaves of pot-grown Chl-deficient (MinnGold) and green (MN0095) plants. The ratios between ϕ of MinnGold as compared with green MN0095 are also reported. ϕ was derived by fitting a non-rectangular hyperbolic model (Marshall & Biscoe, 1980) to net photosynthetic light-response data (A/PPFD) obtained using blue/red Li-6400 LED and green/yellow OSRAM metal halide light sources. Values represent mean \pm standard error (n=5).

| Variety | Light source | | | |
|----------|---|------------------------------|---|------------------------------|
| | blue/red Li-6400 LED | | green/yellow OSRAM metal halide | |
| | ϕ $\mu\text{mol}(\text{CO}_2) \mu\text{mol}^{-1}(\text{photons})$ | Ratio MinnGold/ MN0095 | ϕ $\mu\text{mol}(\text{CO}_2) \mu\text{mol}^{-1}(\text{photons})$ | Ratio MinnGold/ MN0095 |
| MN0095 | 0.038 \pm 0.004 | 1.27 (p = 0.55) | 0.027 \pm 0.001 | 0.83 (p = 0.008) |
| MinnGold | 0.048 \pm 0.006 | | 0.022 \pm 0.001 | |

Figure S1 - A/PPFD (panel A) and A/APPFD (panel B) response curves measured under ambient O₂ concentration on green (MN0095 and Eiko) and Chl-deficient (MinnGold) leaves of pot-grown plants in 2017. Each symbol represents mean ± standard error (n=4).

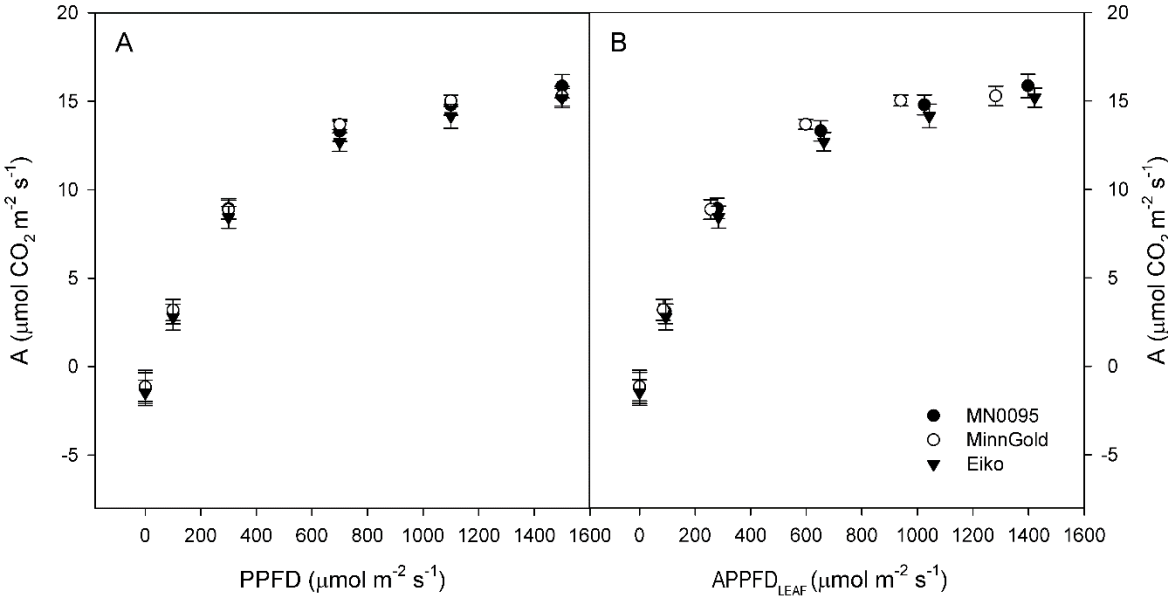


Figure S2. Reflectance (R), transmittance (T), and absorbance (A) spectra of MinnGold (dashed line) and MN0095 (solid line) leaves in the PPFD range measured under solar irradiance with a FluoWat leaf clip. Lines represent the mean values of sixteen leaves.

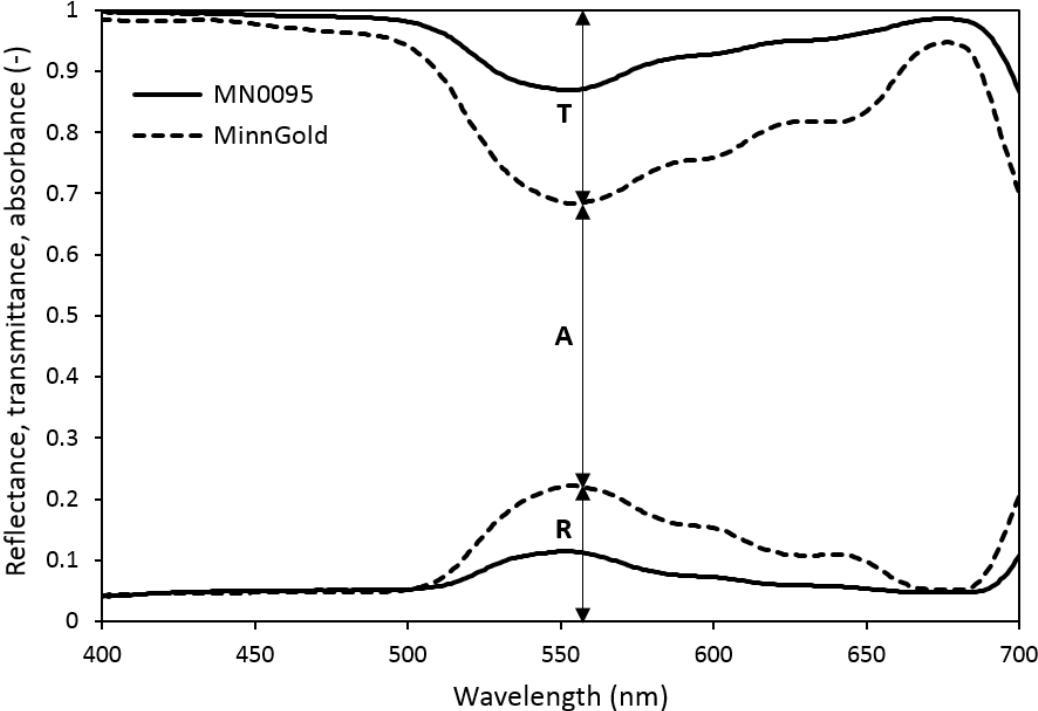


Figure S3. Mean diurnal albedo course (field data averaged between 7:00 and 17:00 LST in the period from July 22nd and August 8th 2016) for green (Eiko) and Chl-deficient (MinnGold) canopies. Vertical bars indicate standard error among measuring days.

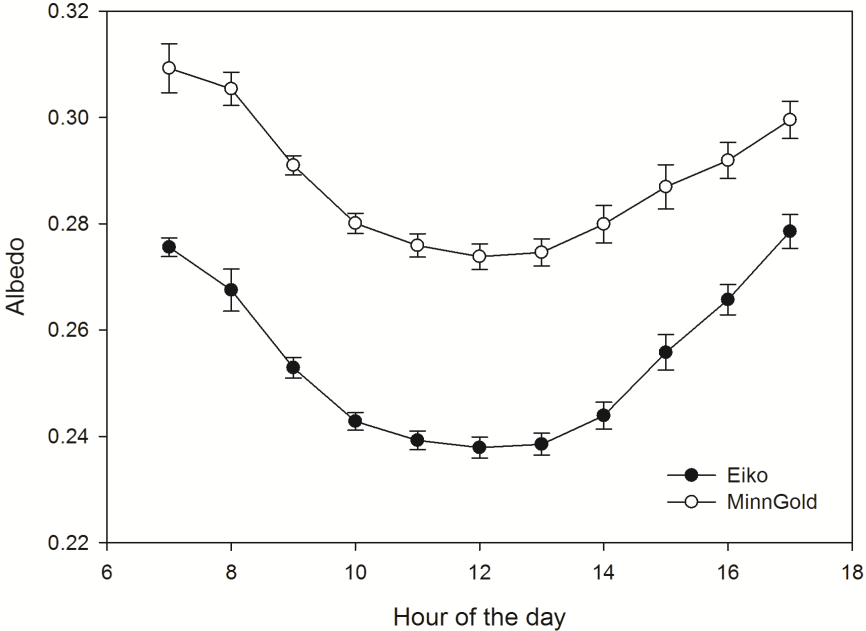


Figure S4. Light spectra for the LI-COR Li-6400 LED (dashed line) and the OSRAM metal halide (solid line) light sources.

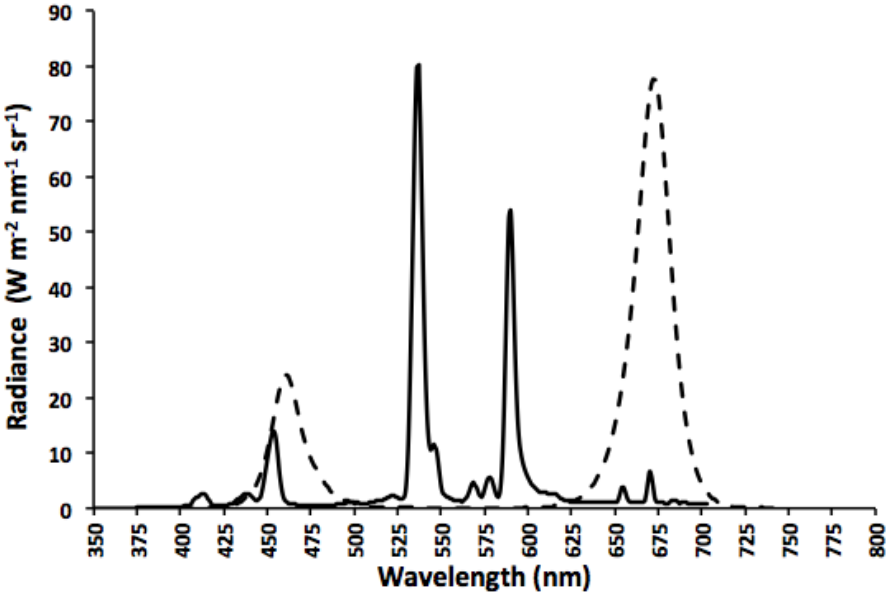
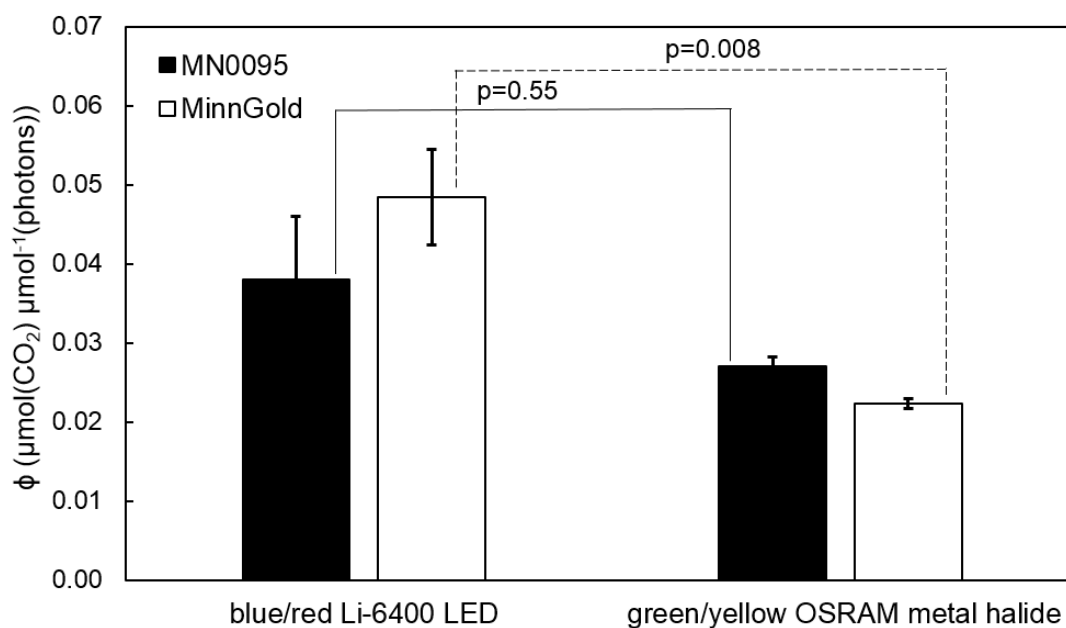


Figure S5. Quantum yield (ϕ ; $\mu\text{mol}(\text{CO}_2) \mu\text{mol}^{-1}(\text{photons})$) in leaves of pot-grown Chl-deficient (MinnGold) and green (MN0095) plants. ϕ was derived by fitting a non-rectangular hyperbolic model (Marshall & Biscoe, 1980) to net photosynthetic light-response data (A/PPFD) obtained using blue/red Li-6400 LED and green/yellow OSRAM metal halide light sources. Values represent mean \pm standard error (n=5). The Mann-Whitney-Wilcoxon test was used to compare ϕ derived from measurements with both light sources.



References:

Ethier G.J. & Livingston N.J. (2004) On the need to incorporate sensitivity to CO₂ transfer conductance into the Farquhar–von Caemmerer–Berry leaf photosynthesis model. *Plant, Cell and Environment* **27**, 137–153.

Kromdijk J., Głowacka K., Leonelli L., Gabilly S.T., Iwai M., Niyogi K.K. & Long S.P. (2016) Improving photosynthesis and crop productivity by accelerating recovery from photoprotection. *Science* **354**, 857–861.

Marshall B. & Biscoe P.V. (1980) A model for C₃ leaves describing the dependence of net photosynthesis on irradiance. I. Derivation. *Journal of Experimental Botany* **31**, 29–39.