Table 2. Summary of typically observed variation in leaf metabolism and thermal responses across the vertical gradient and/or between sun and shade leaves

| trait | symbol | units | response\* | forest type(s)† | reference(s)‡ | |
| --- | --- | --- | --- | --- | --- | --- |
| **Conductance** | | | | | |
| boundary-layer conductance | *gb* | mmol-2 s-1 | ↑ H | TrB | 3 | |
|  |  | mm s-1 | ↑ H | TeN | 12 | |
|  |  |  | ≈ L | TeN | 12 | |
| leaf hydraulic conductance | *Kleaf* | m-2 s-1 MPa-1 | ↑ L | TeB | 41 | |
| cuticle conductance | *gmin* | mmol m-² s-1 | ↑ L | TrB | 47 | |
| max stomatal conductance | *gs max* | mol m-² s-1 | ↑ H | TrB, TeB, BoN | 1, 2, 4 | |
|  |  |  | ↑ L | TrB, TeB, TeN, BoN | 8, 9, 10, 7, 4 | |
| stomatal conductance limitation | *gs* | mol m-2 s-1 | ↑ H | TrB, TeN | 9, 40, 5, 6, 7 | |
|  |  |  | ↑ L | TrB, TeN | 9, 40, 7 | |
| stomatal conductance at optimal temperature | *gs at Topt* | mol m-2 s-1 | ≈↑ H | TeB | 11 | |
|  |  |  | ↓ H | TrB | 40 | |
|  |  |  | ≈↑ L | TrB | 8 | |
| **Photosynthesis** |  |  |  |  |  | |
| maximum photosynthetic capacity | *Amax* | mol m-2 s-1 | ↑ H | TrB, TeB, BoN | 14, 11, 15, 4 | |
|  |  |  | ≈↓ H | TeB | 16 | |
|  |  |  | ↑ L | TrB, TeB, TeN, BoN | 14, 17, 18, 19, 10, 4 | |
|  |  | nmol g-1 s-1 | ≈ H | TrB | 20, 21 | |
|  |  |  | ≈ L | TrB, TeB, TeN | 20, 21, 19 | |
| maximum light-saturated net photosynthesis | *Asat* | µmol m-2 s-1 | ↑ H | TrB, TeB | 22, 23 | |
|  |  |  | ↑ L | TrB, TeB | 8, 23 | |
| Asat at optimum temperature | *Aopt* | µmol m-2 s-1 | ≈↑ H | TrB, TeB | 13, 11 | |
|  |  |  | ↑ H | TrB | 40 | |
|  |  |  | ↑ L | TrB | 8, 13 | |
| optimum temperature for photosynthesis | *Topt* | ˚C | ≈ H | TrB, TeB | 24, 11, 13 | |
|  |  |  | ↓ H | TrB | 40 | |
|  |  |  | ≈ L | TrB, TeB | 9, 8, 11 | |
| photosynthetic light compensation point | *LCP* | µmol m-2 | ↑ H | TrB, TeB, TeN | 25, 16 | |
|  |  |  | ↑ L | TrB, TeB, TeN | 8, 17, 16 | |
| maximal carboxylation rate | *Vcmax* | µmol m-2 s-1 | ↑ H | TrB, TeB | 2, 23, 14 | |
|  |  |  | ↑ L | TrB, TeB, BoN | 9, 23, 14, 10 | |
|  |  | nmol g-1 s-1 | ≈ H | TrB, TeB | 2, 23 | |
|  |  |  | ≈ L | TrB, TeB | 2, 23 | |
|  |  | nmol CO2 g-1 s-1 | ≈↓ L | TeB | 26 | |
| optimum temperature for *Vcmax* | *Vcmax (Topt)* | µ mol m-2 s-1 | ≈↑ H | TeB | 11 | |
|  |  |  | ≈ L | TrB | 9 | |
| electron transport rate | *Jmax* | µmol m-2 s-1 | ↑ H | TrB, TeB | 2, 40, 23, 14 | |
|  |  |  | ↑ L | TrB, TeB | 9, 23, 27, 14 | |
|  |  | nmol g-1 s-1 | ≈ H | TrB, TeB | 2, 23 | |
|  |  |  | ≈ L | TrB, TeB | 2, 23 | |
|  |  | nmol e-1 g-1 s-1 | ≈↓ L | TeB | 26 | |
| optimal temperature of *Jmax* | *ToptETR* | ˚C | ↓ H | TrB | 40 | |
|  | *Jmax(Topt)* | µmol m-2 s-1 | ≈ L | TrB | 9 | |
| high-temperature CO2 compensation point | *Tmax* | ˚C | ≈ H | TrB | 22 | |
|  |  |  | ≈ L | TrB | 8 | |
| photosynthetic heat tolerance | T50 | ˚C | ↓ H\*\* | TrS | 31 | |
|  |  |  | ≈↑ L | TrB, TeB | 8, 17 | |
| critical temperature beyond which Fv/Fm declines | *Tcrit* | ˚C | ≈↑ L | TrB, TeB | 8 | |
| **Respiration** |  |  |  |  |  | |
| respiration rate at 25 ˚C | *R* | µmol CO2  m-2s-1 | ↑ H | TrB, TeB, TeN | 40, 32, 33, 34 | |
|  |  | µmol CO2kg-1 s-1 | ≈ H | TrB, TeB, TeN | 32, 33 | |
|  |  |  | ↑ L | TrB, TeN | 32, 34, | |
| light respiration | *RL* | µmol m-2 s-1 | ↑ H | TrB | 22 | |
|  |  |  | ↑ L | TrB | 22 | |
| dark respiration | *Rdark* | µmol m-2 s-1 | ↑ H | TrB, TeB, BoN | 22, 14, 35, 23, 39 | |
|  |  |  | ↑ L | TrB, TeB, TeN, BoN | 22, 14, 23, 17, 10, 39 | |
|  |  | nmol g-1 s-1 | ≈↑ H | TrB | 2, 36 | |
|  |  |  | ≈ L | TrB | 2, 36 | |
| *Rdark* at reference *T* | *Rdark at reference T* | µmol m-2 s-1 | ↑ H | TrB, TeB, TeN | 22, 14, 35, 33 | |
|  |  | µmol (kg leaf)-1 s-1 | ↑ H | TrB, TeB, TeN | 22, 14, 35, 33 | |
|  |  | µmol (kg N)-1 s-1 | ↑ H | TeB,TeN | 35, 33 | |
|  |  | µmol m-2 s-1 | ↑ L | TrB, TeB | 22, 8, 35. | |
| temperature sensitivity of *Rdark* | *Q10* | ˚C-1 | ≈ H | TrB, TeB, TeN | 22, 40, 35, 34 | |
|  |  | ˚C-1 | ≈ ↑ H | TeB, TeN | 37, 33 | |
|  |  |  | ≈ ↓ L | TrB, TeB, TeN | 22, 35, 34 | |
|  |  |  | ↑ L | TeB | 37 | |
| activation energy of *Rdark* | *E0* | kJ mol-1 K-1 | ≈ H | TrB, TeB, TeN | 22, 38, 33 | |
|  |  |  | ≈ L | TrB | 22, 8 | |
| **VOC production** |  |  |  |  |  | |
| isoprene emission  (in emitting species) | *I* | nmol m-2 s-1 | ↑ H  (peak in mid-canopy) | TrB | 42 | |
|  |  |  | ↑ L  (peak in mid-canopy) | TrB | 42 | |
|  |  |  | ↑ H | TeB | 37, 43 | |
|  |  |  | ↑ L | TeB | 37, 44, 45 | |
| monoterpenoid emissions | *MT* | *µg m-2s-1* | ↓ H | TeB | 46 | |
|  |  |  | ↓ L | TeB | 46 | |

**1.** Kafuti et al. 2020; **2.** Van Wittenberghe et al. 2012; **3.** Roberts et al. 1990; **4.** Dang et al. 1997; **5.** Marenco et al. 2017; **6.** Ambrose et al. 2015; **7.** Zweifel et al. 2001; **8.** Slot et al. 2019; **9.** Hernandez et al. 2020; **10.** Urban et al. 2007; **11.** Carter and Cavaleri 2018; **12.** Martin et al. 1999; **13.** Mau et al. 2018;  **14.** Kosugi et al. 2012; **15.** Niinemets et al. 2015; **16.** Bachofen et al. 2020; **17.** Hamerlynck and Knapp 1994; **18.** Coble et al. 2017; **19.** Wyka et al. 2012; **20.** Rijkerse et al. 2000; **21.** Ishida et al. 1999; **22.** Weerasinghe et al. 2014; **23.** Scartazza et al. 2016; **24.** Miller et al. 2021; **25.** Harris and Medina 2013; **26.** Legner et al. 2014; **27.** Kitao et al. 2012; **28.** Fauset et al. 2018; **29.** Rey-Sanchez et al. 2016; **30.** Muller et al. 2021; **31.** Curtis et al. 2019; **32.** Mier et al. 2001; **33.** Turnbull et al. 2003; **34.** Araki et al. 2017; **35.** Bolstad et al. 1999; **36.** Kenzo et al. 2015; **37.** Harley et al. 1996; **38.** Xu and Griffin 2006; **39.** Atherton et al. 2017; **40.** Carter et al. 2021; **41.** Sack et al. 2003; **42.** Taylor et al. 2021; **43.** Harley et al. 1997; **44.** Niinemets and Sun, 2014; **45.** Sharkey and Monson, 2014; **46.** Saimpraga et al. 2013; **47.** Slot et al. 2021