Table 1. Summary of typically observed variation in thermally-relevant leaf traits with canopy height and/or between sun and shade leaves

| trait | symbol | units | response* | forest type(s)[†] | reference(s)[‡] |
|---|---|---|---|---|---|
| **Leaf anatomy and morphological traits** | | | | | |
| leaf area | *LA* | $cm^2$ | ↓ H | TrB, TeB, BoN | 7, 8, 10 |
| | | | ↓ L | TrB, TeB, BoN | 7, 8, 3, 10 |
| leaf mass per area (or inverse of specific leaf area) | *LMA (or 1/SLA)* | $g\ cm^{-2}$ | ↑ H | TrB, TeB, TeN, BoN | 1, 55, 7, 2, 3, 4, 6 |
| | | | ↑ L | TrB, TeB, TeN, BoN | 1, 7, 2, 3, 5, 6 |
| leaf thickness | | µm | ↑ H | TrB, TeB, TeN | 15, 11, 2, 13, 16 |
| | | | ↑ L | TrB, TeB, TeN | 11, 15, 2, 5 |
| leaf density | | $g\ cm^{-3}$ | ↑ H | TeB | 2 |
| | | | ↑ L | TrB, TeB | 6, 2 |
| | | | ≈ L | TeN | 5 |
| pinnate lobation | | $cm^2$ | ↑ H | TeB | 3 |
| | | | ↓ H | TeB | 8 |
| | | | ↑ L | TeB | 8, 3 |
| leaf packing | | n /cm stem | ↑ L | TeN | 25, 26 |
| blade inclination angle (vertical) | *φB* | ° | ↑ H | TrB, TeB | 21, 22, 23 |
| | | | ↑ L | TrB, TeB | 21, 24, 23, 22, 48 |
| trichome density | | $mm^{-2}$ | ↑ H | TrB | 17 |
| | | | ↑ L | TrB, TeB | 17, 18, 19, 20 |
| stomatal density | $D_{stomata}$ | $mm^{-2}$ | ↑ H | TrB, TeB, TeN | 11, 12, 3, 13, 4 |
| | | | ↑ L | TrB, TeB | 12, 11, 3 |
| total vein density | *VLA* | $mm\ mm^{-2}$ | ↑ H | TeB | 46 |
| | | | ↑ L | TeB | 46, 47 |
| minor vein density | $VLA_{min}$ | $mm\ mm^{-2}$ | ↑ H | TeB | 14 |
| | | | ↑ L | TeB | 14, 47 |
| upper cuticle thickness | *CT* | µm | ↑ H | TrB, TeN | 27, 4 |
| | | | ↑ L | TrB, TeB | 27, 28 |
| **Traits related to metabolic capacity and efficiency** | | | | | |
| nitrogen content | *N* | $g\ m^{-2}$ | ↑ H | TrB, TeB, TeN, BoN | 55, 7, 29, 30, 32, 31, 9 |
| | | $mg\ g^{-1}$ | ≈↓ H | TrB, TeB, TeN | 55, 15, 7, 29, 30, 32, 34 |
| | | | ≈↓ L | TrB, TeB, TeN | 7, 35, 29, 30, 32, 5 |
| phosphorous content | *P* | $g\ m^{-2}$ | ↑ H | TrB, TeB, TeN | 55, 15, 36, 1, 37 |
| | | | ↑ L | TrB, TeB, TeN | 15, 5 |
| | | | ≈ L | TrB, TeB | 1 |
| | | $mg\ g^{-1}$ | ≈↓ H | TrB | 55, 15, 35, 1 |
| | | | ≈ L | TrB, TeB | 15, 35, 1 |

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| trait | symbol | units | response* | forest type(s)[†] | reference(s)[‡] |
|---|---|---|---|---|---|
| chlorophyll content | *Chl* | mg $cm^{-2}$ | ↓ H | TrB, TeB | 40, 41 |
| | | | ↓ L | TrB, TeB | 42, 41 |
| chlorophyll a/b ratio | *chl a/b* | mol $mol^{-1}$ | ↑ H | TrB, TeB, BoN | 42, 30, 6 |
| | | | ↑ L | TrB, TeB, BoN | 42, 30, 39, 22, 6 |
| carbon isotope ratio | $\delta^{13}C$ | ‰ | ↑ H | TrB, TeB, TeN | 55, 7, 43, 31 |
| | | | ↑ L | TrB, TeB, TeN | 7, 29, 31 |
| intercellular $CO_2$ concentration | $C_i$ | µmol $mol^{-1}$ | ↓ H | TeB, BoN | 51, 30, 44 |
| | | | ↓ L | TeB | 30, 44 |
| **Light absorption or reflectance** | | | | | |
| PAR absorptance | | % | ≈ H | TrB | 42, 45 |
| | | | ≈↑ L | TrB | 42, 45 |
| absorptance efficiency per unit biomass | | % $g^{-1}$ | ↓ H | TrB | 42, 45 |
| | | | ↓ L | TrB | 42, 45 |
| PAR transmittance | | % | ↓ H | TrB | 42, 45 |
| | | | ↓ L | TrB | 42, 45 |
| Reflectance | | % | ≈ H | TrB | 42, 45 |
| | | | ↑ H | BoN | 6 |
| | | | ≈ L | TrB | 42, 45 |
| **Biochemical protection against light and heat damage** | | | | | |
| β-carotene and lutein | | µmol $m^{-2}$ | ↑ H | TrB, TeB, BoN | 30, 42, 6 |
| | | | ↑ L | TrB, TeB, BoN | 30, 38, 6 |
| xanthophyll cycle pigments | *VAZ* | µmol $m^{-2}$ | ↑ H | TrB, TeB | 38, 30, 22 |
| | | | ↑ L | TrB, TeB | 39, 30 |
| isoprene emission ability | *I* | nmol $m^{-2}$ $s^{-1}$ | ↑ H (peak in mid-canopy) | TrB | 49 |
| | | | ↑ L (peak in mid-canopy) | TrB | 49 |
| | | | ↑ L | TeB | 50 |
| isoprene emission (in emitting species) | *I* | nmol $m^{-2}$ $s^{-1}$ | ↑ H (peak in mid-canopy) | TrB | 49 |
| | | | ↑ L (peak in mid-canopy) | TrB | 49 |

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| trait | symbol | units | response* | forest type(s)[†] | reference(s)[‡] |
|---|---|---|---|---|---|
| | | | ↑ H | TeB | 32, 60 |
| | | | ↑ L | TeB | 32, 61, 62 |
| monoterpenoid emissions | *MT* | $\mu g\ m^{-2}s^{-1}$ | ↑ H (peak in mid-canopy) | TeB | 63 |
| | | | ↑ L (peak in mid-canopy) | TeB | 63 |
| **Thermal tolerance** | | | | | |
| photosynthetic heat tolerance | $T_{50}$ | ˚C | ↓ H** | TrS | 52 |
| | | | ≈↑ L | TrB, TeB | 53, 54 |
| critical temperature beyond which Fv/Fm declines | $T_{crit}$ | ˚C | ≈↑ L | TrB, TeB | 53 |
| **Phenology** | | | | | |
| bud break | | day of year | ↓ H | TeB | 56 |
| leaf lifespan | | months | ↓ H | TrB | 57 |
| | | | ↓ L | | |
| drought deciduous leaf habit | | % | ↑ H | TrB | 58, 59 |

**1.** Mau et al. 2018; **2.** Coble and Cavaleri 2014; **3.** Sack et al. 2006; **4.** Chin and Sillett 2019; **5.** Wyka et al. 2012; **6.** Atherton et al. 2017; **7.** Kenzo et al. 2015; **8.** Kusi and Karasi 2020; **9.** Dang et al. 1997; **10.** Gebauer et al. 2015; **11.** Marenco et al. 2017; **12.** Kafuti et al. 2020; **13.** Van Wittenberghe et al. 2012; **14.** Zhang et al. 2019; **15.** Weerasinghe et al. 2014; **16.** Oldham et al. 2010; **17.** Ichie et al. 2016; **18.** Gregoriou et al. 2007; **19.** Levizou et al. 2005; **20.** Liakoura 1997; **21.** Fauset et al. 2018; **22.** Niinemets et al. 1998, **23.** Ishida et al. 1998; **24.** Millen and Clendon 1979; **25.** Smith and Carter, 1988; **26**. Hadley and Smith 1987; **28.** Baltzer and Thomas 2005; **29.** Coble et al. 2016; **30.** Scartazza et al. 2016; **31.** Duursma and Marshall, 2006; **32.** Harley et al. 1996; **33.** Hernandez et al. 2020; **34.** Turnbull et al. 2003; **35.** Chen et al. 2020; **36.** van de Weg et al. 2012; **37.** M.A Cavaleri et al. 2008; **38.** Koniger et al. 1995; **39.** Mastubara et al. 2009; **40.** Harris and Medina 2013; **41.** Hansen et al. 2001; **42.** Poorter et al. 1995; **43.** Coble et al. 2016; **44.** Niinemets et al. 2004; **45.** Poorter et al. 2000; **46.** Zwieniecki et al. 2004; **47.** Sack and Scoffoni, 2013; **48.** Ball et al., 1988; **49.** Taylor et al. 2021; **50.** Niinemets et al. 2010; **51.** Brooks et al. 1997; **52.** Curtis et al. 2019; **53.** Slot et al. 2019; **54.** Hamerlynck and Knapp 1994; **55.** Lloyd et al. 2010; **56.** Augspurger and Bartlett, 2003; **57.** Osada et al. 2001; **58.** Meakem et al. 2018; **59.** Condit et al. 2000; **60.** Harley et al. 1997; **61.** Niinemets and Sun, 2014; **62.** Sharkey and Monson, 2014; **63.** Simpraga et al. 2013