

Table 1. Summary of 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)
<b>Leaf anatomy and morphological traits</b>					
leaf mass per area (or inverse of specific leaf area)	$LMA$ (or $1/SLA$ )	$g \cdot cm^{-2}$	↑ with height ↑ with light	temperate, tropical global	Mau et al. 2018, Coble et al. 2017 Hernandez et al. 2019, Mastubara et al. 2009, Martin et. al 2020, Coble et al. 2017, Slot et al. 2019
leaf area	$LA$	$mm^2$	↓ with height ↓ with light	temperate, tropical tropical	Beaumont and Burns 2009, Kafuti et al. 2020 Slot et al. 2019, Sack et al. 2006
stomatal density	$D_{stomata}$	$mm^{-2}$	↑ with height ↑ with light	tropical global	Kafuti et al. 2020 Valladares and Niinemets, 2008
leaf thickness	$LeaThi$	$\mu m$	↑ with height ↑ with light	global, temperate global	Poorter et al. 2019, Van Wittenberghe et al. 2012 Poorter et al. 2019
<b>Leaf biochemical and physiological traits</b>					
Nitrogen per leaf area	$N_a$	$g \cdot m^{-2}$	↑ with height ↑ with light	tropical, temperate tropical, global	Coble and Cavaleri 2014, Scartazza et al. 2016, Hernandez et al. 2019 Martin et al. 2020, Hernandez et al. 2020, Poorter et al. 2019, Harley et al. 1996
Nitrogen per leaf mass	$N_m$	$mg \cdot g^{-1}$	$\approx$ with ??? $\approx$ with light	tropical, temperate temperate broadleaf	Hernandez et al. 2020, Scartazza et al. 2016 Harley et al. 1996, Bolstad et al. 1999
xanthophyll cycle pigments	$VAZ$	$\mu mol m^{-2}$	↑ with height ↑ with light	temperate tropical, global	Scartazza et al. 2016, Niinemets et al. 1998 Mastubara et al. 2009, Valladares and Niinemets, 2008
carbon isotope composition	$\delta^{13}C$	‰	↑ with height ↑ with light	conifer, temperatre conifer	Duursma and Marshall, 2006, Coble et al. 2017 Duursma and Marshall, 2006
chlorophyll a/b ratio	$chl a/b$	$mol mol^{-1}$	↑ with height ↑ with light	tropical tropical, global	Poorter et al. 1995 Matsubara et al. 2009, Niinemets et al. 1998, Valladares and Niinemets, 2008

Table 2. Summary of 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)
<b>Stomatal conductance</b>					
max stomatal conductance	$g_{s_{max}}$	$mmol \cdot m^{-2} s^{-1}$	↑ with height	tropical, temperate	Kafuti et al. 2020, Van Wittenberghe et al. 2012, Roberts et al. 1990
			↓ with height	temperate	Coble and Cavaleri 2015; Ishii et al. 2008
			↑ with light	global, tropical	Valladares and Niinemets, 2008, Hernandez et al. 2019
stomatal conductance	$g_s$		↑ with light	tropical	Slot et al. 2019
optimum temperature of $g_s$	$T_{opt}$ of $g_s$	°C	≈ with light	tropical	Slot et al. 2019
frequency of stomatal closure			↑ with height	tropical	Roberts et al. 1990
<b>Photosynthesis</b>					
photosynthetic capacity	$A_A$	$\mu mol \cdot m^{-2} \cdot s^{-1}$	↑ with height	temperate, tropical	Niinemets et al. 2015, Mau et al. 2018
			↑ with light	temperate	Coble et al. 2017, Hikosaka and Terashima 1995, Evans 1989
light-saturated net photosynthesis	$A_{sat}$		↑ with light	tropical	Slot et al. 2019
optimum temperature of $A_{sat}$	$T_{opt}$ of $A_{sat}$	°C	≈↑ with light	tropical	Slot et al. 2019
light compensation point	$LCP$		↑ with light	tropical	Slot et al. 2019
maximal carboxylation rate	$V_{cmax}$	$\mu mol \cdot m^{-2} s^{-1}$	↑ with height	temperate	Scartazza et al. 2016
			↑ with light	global	Valladares and Niinemets, 2008
$V_{cmax}$ at optimal temperature	$V_{cmax}(T_{opt})$	$\mu mol \cdot m^{-2} s^{-1}$	≈ with light	tropical	Hernandez et al. 2020
electron transport rate	$J_{max}$	$\mu mol \cdot m^{-2} s^{-1}$	↑ with height	temperate	Scartazza et al. 2016
			↑ with light	global	Valladares and Niinemets, 2008
$J_{max}$ at optimal temperature	$J_{max}(T_{opt})$	$\mu mol \cdot m^{-2} s^{-1}$	≈ with light	tropical	Hernandez et al. 2020
thermal damage threshold	$T_{50}$	°C	≈↑ with light	tropical	Slot et al. 2019
			↓ with height*	savanna	Curtis et. al, 2018
<b>Respiration</b>					
dark respiration at reference T	$R_{dark}(T_{ref})$ , $R_d$	$\mu mol \cdot m^{-2} s^{-1}$	↑ with height	temperate	Scartazza et al. 2016
			↑ with light	tropical	Slot et al. 2019
		$\mu mol (kg \text{ leaf})^{-1} s^{-1}$	↑ with light	temperate	Bolstad et al. 1999
		$\mu mol (m \text{ leaf})^{-2} s^{-1}$	↑ with light	temperate	Bolstad et al. 1999
		$\mu mol (kg \text{ N})^{-1} s^{-1}$	↑ with light	temperate	Bolstad et al. 1999
temperature sensitivity of $R_{dark}$	$Q_{10}$	°C <sup>-1</sup>	≈↓ with light	temperate	Bolstad et al. 1999
<b>VOC production</b>					
isoprene emission rate (in emitting species)	$I$	$nmol m^{-2} s^{-1}$	↑ with height	temperate	Harley et al. 1996, Harley et al. 1997
			↑ with light	temperate	Niinemets and Sun, 2014, Harley et al. 1996, Sharkey and Monson, 2014

\*composite climatic stress variable from canopy temperature, vapour pressure deficit, and relative humidity is higher in lower canopy