

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

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	temperate, tropical	Mau et al. 2018, Coble et al. 2017
			↑ with light	global	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	temperate, tropical	Beaumont and Burns 2009, Kafuti et al. 2020
			↓ with light	tropical	Slot et al. 2019, Sack et al. 2006
stomatal density	$D_{stomata}$	$mm^{-2}$	↑ with height	tropical	Kafuti et al. 2020
			↑ with light	global	Valladares and Niinemets, 2008
leaf thickness	$LeaThi$	$\mu m$	↑ with height	global, temperate	Poorter et al. 2019, Van Wittenberghe et al. 2012
trichome density	$trichome$	$mm^{-2}$	↑ with light	global	Poorter et al. 2019
			↑ with height	tropical	Ichie et al. 2016, Perez-Estrada et al. 2000
			↑ with light	sutropical, temperate, tropical	Gregoriou et al. 2007, Levizou et al. 2005, Liakoura 1997
blade inclination angle (vertical)	$\phi B$	°	↑ with height	temperate	Niinemets et al. 1998
lobation	$lobation$	$cm^2$	↑ with light	temperate	Niinemets et al. 1998
			↑ with height	temperate Quercus sp.	Sack et al. 2006, Baranski, 1975
			↑ with light	temperate Quercus sp.	Kusi and Karasi 2020, Sack et al. 2006
cuticle thickness	$CT$	$\mu m$	↑ with height	tropical, temperate	Panditharathna et al. 2008, Baltzer and Thomas 2005
			↑ with light	tropical, temperate	Panditharathna et al. 2008, Baltzer and Thomas 2005
<b>Leaf biochemical and physiological traits</b>					
			↑ with height	tropical, temperate	Coble and Cavaleri 2014, Scartazza et al. 2016, Hernandez et al. 2019
Nitrogen per leaf area	$N_a$	$g \cdot m^{-2}$	↑ with light	tropical, global	Martin et al. 2020, Hernandez et al. 2020, Poorter et al. 2019, Harley et al. 1996
			≈ with ???	tropical, temperate	Hernandez et al. 2020, Scartazza et al. 2016
Nitrogen per leaf mass	$N_m$	$mg \cdot g^{-1}$	≈ with light	temperate broadleaf	Harley et al. 1996, Bolstad et al. 1999
			↑ with height	tropical	M.A Cavaleri et al. 2008, J.Lloyd et al. 2009
Phosphorous per leaf area	$P_a$	$g \cdot m^{-2}$	↑ with light	tropical	Martin et al. 2020
			↑ with height	temperate	Scartazza et al. 2016, Niinemets et al. 1998
xanthophyll cycle pigments	$VAZ$	$\mu mol \cdot m^{-2}$	↑ with light	tropical, global	Mastubara et al. 2009, Valladares and Niinemets, 2008
			↑ with height	conifer, temperatre	Duursma and Marshall, 2006, Coble et al. 2017
carbon isotope composition	$\delta^{13}C$	‰	↑ with light	conifer	Duursma and Marshall, 2006
			↑ with height	tropical	Poorter et al. 1995
chlorophyll a/b ratio	$chl a/b$	$mol \cdot mol^{-1}$	↑ with light	tropical, global	Matsubara et al. 2009, Niinemets et al. 1998, Valladares and Niinemets, 2008
			≈ with height	tropical	Poorter et al. 1995, Lee and Graham, 1986
PAR absorptance	$ABS$	% nm	≈ with light	tropical	Poorter et al. 1995, Lee and Graham, 1986
			↑ with light	tropical	Poorter et al. 1995, Lee and Graham, 1986

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	$R_{dark}(T_{ref})$	$\mu mol \cdot m^{-2} s^{-1}$	↑ with height	temperate	Scartazza et al. 2016
			↑ with light	tropical	Bolstad et al. 1999, Slot et al. 2019
		$\mu mol (kg \text{ leaf})^{-1} s^{-1}$	↑ 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)	$I$	$nmol \text{ m}^{-2} s^{-1}$	↑ 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