Supplementary Material

Leaf-scale Study of Biogenic Volatile Organic Compound Emissions from Willow (*Salix* spp.) Short Rotation Coppices Covering Two Growing Seasons

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Figure S1. The two plots where the measurements were performed. (**A**) P1 (58°16′55″ N 12°46′20″ E) and (**B**) P2 (58°17'09" N 12°45'31" E). Black marks are the locations of the measurements. Maps are taken and modified from Karlsson et al. (2020) [42].
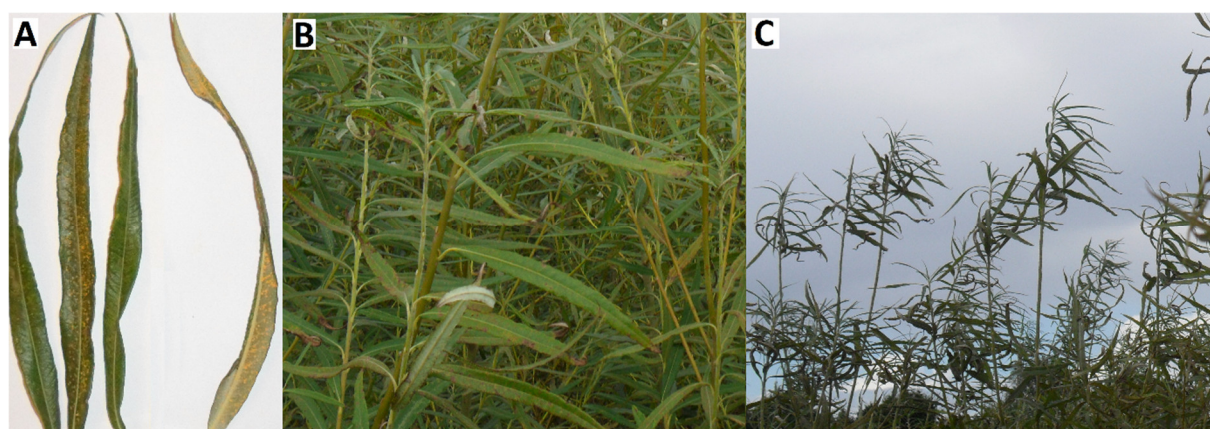
Figure S2. Impact of rust (*Melampsora* spp.) infestation on P1. (**A**) Visible yellow dots in late July. (**B**) Lower part of the trees in September where some parts of leaves have changed the color to red/brown (necrotic lesions) and started to fold. (**C**) Top of the trees in September. Many leaves were shed or folded.

Figure S3. (**A**) Leaves from the higher part (z_H) of the canopy that were measured with the branch chamber in October showing damage from leaf beetles (*Phratora vulgatissima*). (**B**) Leaves from the lower part (z_M) of the canopy in October measured with the branch chamber.

Table S1. Pure injected standards in the GC-MS analysis. Numbers in the parentheses ara CAS-number.

Hemiterpenes	Monoterpenes	Sesquiterpenes	other VOCs
isoprene * (78-79-5)	α-pinene § (80-56-8)	aromadendrene * (109119-91-7)	2-methylfuran * (534-22-5)
	camphene * (79-92-5)	humulene * (6753-98-6)	toluene § (108-88-3)
	β-pinene § (127-91-3)	nerolidol § (142-50-7)	1-octene § (111-66-0)
	myrcene § (123-35-3)		hexanal * (66-25-1)
	α-phellandrene § (99-83-2)		furfural * (98-01-1)
	p-cymene (99-87-6)		2-hexenal * (505-57-7)
	eucalyptol § (470-82-6)		p-xylene § (106-42-3)
	γ-terpinene § (99-85-4)		o-xylene § (95-47-6)
	ocimene § (502-99-8)		benzaldehyde § (100-52-7)
	terpinolene * (586-62-9)		1-octen-3-ol § (3391-86-4)
	linalool § (78-70-6)		octanal * (124-13-0)
			cis-3-hexenyl acetate § (3681-71-8)
			nonanal § (124-19-6)
			cis-3-hexenyl butyrate § (16491-36-4)

* These standards were produced by Sigma-Aldrich. § These standards were produced by Supelco.

Table S2. Measured (E) and standardized (E_S) emission rates ($\mu g\ g_{dw}^{-1}\ h^{-1}$, n = 663) for all compounds and all measurements. Numbers in parantheses are standard deviation (SD, $\mu g\ g_{dw}^{-1}\ h^{-1}$). No standardization is made for OVOCs (-).

BVOC	E ($\mu g\ g_{dw}^{-1}\ h^{-1}$)	E_S ($\mu g\ g_{dw}^{-1}\ h^{-1}$)
isoprene	23.5 (28.1)	45.2 (42.9)
Tot MTs	0.163 (0.117)	0.301 (0.201)
ocimene	0.137 (0.321)	0.255 (0.540)
limonene *	0.008 (0.042)	0.014 (0.081)
p-cymene	0.006 (0.042)	0.011 (0.069)
linalool	0.006 (0.017)	0.010 (0.035)
α-pinene	0.003 (0.021)	0.005 (0.034)
3-carene *	0.002 (0.019)	0.004 (0.040)
eucalyptol	0.001 (0.010)	0.002 (0.024)

myrcene	<0.001 (<0.001)	<0.001 (<0.001)
allo-ocimene *	<0.001 (<0.001)	<0.001 (<0.001)
Tot SQTs	0.035 (0.062)	0.103 (0.249)
caryophellene +	0.011 (0.031)	0.024 (0.080)
humulene	0.010 (0.090)	0.040 (0.409)
α-farnesene +	0.009 (0.062)	0.017 (0.125)
nerolidol	0.004 (0.049)	0.022 (0.243)
Tot other VOCs	0.751 (0.159)	-
cyclopentyl acetylene §	0.083 (0.205)	-
benzaldehyde (benzenoid)	0.065 (0.163)	-
hexanal (aldehyde)	0.064 (0.320)	-
nonanal (aldehyde)	0.061 (0. 147)	-
2-ethylhexanoic acid § (carboxylic acid)	0.059 (0.252)	-
pentanal § (aldehyde)	0.037 (0.226)	-
decanal § (aldehyde)	0.036 (0.148)	-
octanal (aldehyde)	0.030 (0.105)	-
2-methylbutane § (alkane)	0.027 (0.105)	-
2-pentanone § (ketone)	0.026 (0.208)	-
2-ethylhexanol § (alcohol)	0.024 (0.082)	-
2-hexanone § (ketone)	0.023 (0.146)	-
benzoic acid § (carboxylic acid)	0.023 (0.116)	-
1-dodecene § (alkene)	0.022 (0.205)	-
unknown 1 §	0.021 (0.150)	-
pentadecane § (alkane)	0.020 (0.078)	-
heptanal § (aldehyde)	0.019 (0.083)	-
furfural (aldehyde)	0.018 (0.149)	-
toluene (benzenoid)	0.018 (0.051)	-
phenol § (phenol)	0.016 (0.098)	-
cyclopropane, ethylidene- # (hemiterpene)	0.013 (0.033)	-
acetophenone § (ketone)	0.012 (0.049)	-
unknown 2 §	0.012 (0.234)	-
3-methylhexane § (alkane)	0.011 (0.081)	-
tetradecane § (alkane)	0.011 (0.074)	-

* These MTs were quantified with α-pinene as injected standard in GC-MS.

+ These SQTs were quantified with humulene as injected standard in GC-MS.

§ These other VOCs were quantified with toluene as injected standard in GC-MS.

This compound was quantified with isoprene as injected standard in GC-MS.

Table S3. Emission rates (STD for isoprene, MTs and SQTs, µg g_{dw}^{-1} h^{-1}) and fraction (%) of the total BVOC emission or within the BVOC group (MTs and SQTs) from z_H in 2015.

2015 z_H	July	Aug	Sep
isoprene	74.8 (98.5%)	70.4 (97.3%)	19.2 (96.7%)
MTs (tot)	0.580 (0.8%)	0.268 (0.4%)	0.286 (1.4%)
α-pinene	0.036 (6.2 %)	0.007 (2.6%)	0
ocimene	0.540 (93.1 %)	0.256 (95.6%)	0.286 (100%)
linalool	0	0.004 (1.6%)	0
eucalyptol	0.004 (0.7 %)	0.001 (0.2%)	0
SQTs (tot)	0.076 (0.1%)	0.040 (<0.1%)	0.171 (0.9%)

α-farnesene	0.022 (29.3%)	0.014 (35.0%)	0
humulene	<0.001 (0.2%)	0.001 (2.5%)	0
caryophyllene	0.053 (70.5%)	0.025 (62.5%)	0.171 (100%)
OVOCs (tot)	0.441 (0.6%)	1.640 (2.3%)	0.207 (1.0%)
BVOCs (tot)	75.896 (100%)	72.348 (100 %)	19.864 (100%)
T_C	23.2 (4.7)	28.9 (2.9)	19.3 (3.4)
PAR_C	562 (397)	467 (230)	329 (192)

Bottom: average T_C ($^{\circ}$C, mean and SD) and PAR_C (μmol m^{-2} s^{-1}, mean and SD) for each month.

Table S4. Values used for the fitted curves in Figure 3. E_S is the emission factor (μg g$_{dw}^{-1}$ h^{-1}), C_L is the correction factor for light (calculated by using mean PAR_C for the whole season and year, and α, T_S and C_{L1} adopted from Guenther et al. (1993) [55]). C_{T1} (J mol^{-1}), C_{T2} (J mol^{-1}) and T_m (K) are empirical constants.

	2015	**2016**
E_s (μg g$_{dw}^{-1}$ h^{-1})	93.8	97.1
C_L	0.8317	0.8688
C_{T1}	148700	135300
C_{T2}	211000	103000
T_m (K)	307	298

Table S5. Slope (E/PAR, μg g$_{dw}^{-1}$ h^{-1} μmol^{-1} m^2 s, n = 3–6) between different PAR values at different height levels for the fitted curves in Figure 4A.

PAR	Lower (z_L)	Middle (z_M)	Higher (z_H)
0–150 μmol m^{-2} s^{-1}	0.058	0.112	0.140
150–300 μmol m^{-2} s^{-1}	0.051	0.093	0.111
300–450 μmol m^{-2} s^{-1}	0.042	0.067	0.075
450–600 μmol m^{-2} s^{-1}	0.033	0.045	0.048
600–1000 μmol m^{-2} s^{-1}	0.020	0.023	0.023
1000–1500 μmol m^{-2} s^{-1}	0.009	0.008	0.008
E_S (μg g$_{dw}^{-1}$ h^{-1})	30.7	147.9	242.1
C_T	0.5142	0.3880	0.5207
α	0.0013	0.0018	0.002
C_{L1}	2.83	1.13	0.58

Bottom: values for the fitted parameters in Figure 4A.
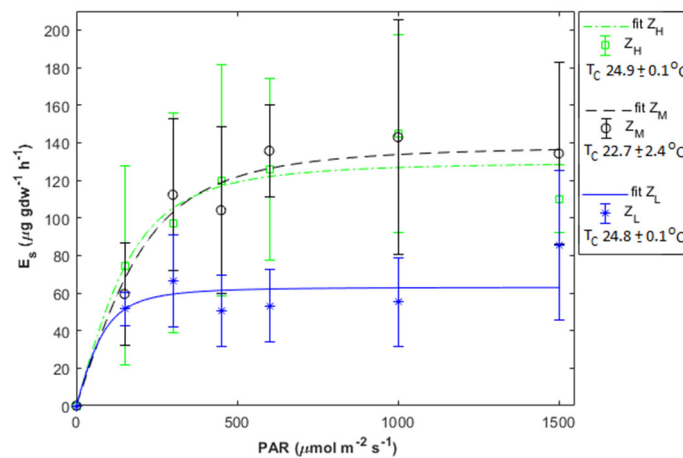
Figure S4. Standardized isoprene emissions rates (µg g_{dw}^{-1}, mean ± SD, n = 3–6) and fitted curves for different PAR values (µmol m^{-2} s^{-1}) using Equation (7) below at different heights. Values for the parameters can be seen in Table S10 below.

$$E_S = E_S^p \times C_T \times C_L \tag{S1}$$

**Table S6.** Values for the fitted STD isoprene curves in Figure S4. E_s^p is a STD potential emission factor (µg g_{dw}^{-1} h^{-1}). C_T was calculated by using mean T_C for the whole season and year, and C_{TI}, C_{TI}, T_S and T_M adopted from Guenther et al. (1993) [55].

	Lower (z_L)	Middle (z_M)	Higher (z_H)
E_s^p (µg g_{dw}^{-1} h^{-1})	27.2	118.6	89.6
C_T	0.5142	0.3880	0.5207
α	0.0093	0.0038	0.0046
C_{L1}	4.51	2.92	2.78

$$R_{E/A} = C_{E/A} \frac{\alpha_{E/A} PAR}{\sqrt{1 + \alpha_{E/A}^2 PAR_{E/A}^2}} \tag{S2}$$

Table S7. Values for the fitted E/A ratio curves in Figure 4B. The light-dependent part of isoprene (Equation 2) has been adopted and modified. $C_{E/A}$ (dimensionless) and $\alpha_{E/A}$ (dimensionless) are constants.

	Lower (z_L)	Middle (z_M)	Higher (z_H)
$C_{E/A}$	0.004	0.004	0.006
$\alpha_{E/A}$	0.0037	0.0026	0.0043
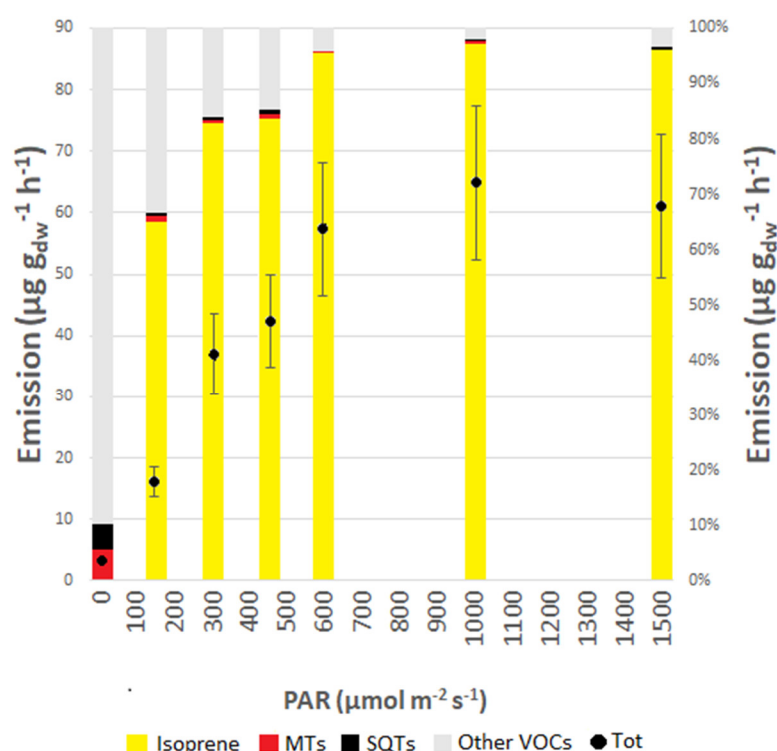
Figure S5. Total emission rates (µg g_{dw}^{-1}, mean ± SD, black circles and left y-axis), and the percentages (stacked bars and right y-axis) for the different BVOC groups at different light levels (µmol m^{-2} s^{-1}) at z_M (n = 6).

$$C_{L,300} = \frac{\alpha C_{L1}(PAR - 300)}{\sqrt{1 + \alpha^2(PAR - 300)^2}} \tag{S3}$$

$$C_{L,150} = \frac{\alpha C_{L1}(PAR - 150)}{\sqrt{1 + \alpha^2(PAR - 150)^2}} \tag{S4}$$

Table S8. Values for the fitted curves in Figure 6A,B using Equation (9) for ocimene and Equation (10) for α-farnesene instead of Equation (3) in Equation (2).

	ocimene	α-farnesene
E_S (µg g_{dw}^{-1} h^{-1})	0.10	0.29
C_T	0.4471	0.4471
α	0.0016	0.0015
C_{L1}	3.92	1.18

Table S9. Slope (A/PAR, µmol CO$_2$ m^{-2} s^{-1} µmol^{-1} m^2 s, n = 3–6) between different PAR values at different height levels in Figure 7A.

PAR	Lower (z_L)	Middle (z_M)	Higher (z_H)
0–150 µmol m² s^{-1}	0.0449	0.0465	0.0525
150–300 µmol m² s^{-1}	0.0159	0.0313	0.0224
300–450 µmol m² s^{-1}	0.0135	0.0230	0.0183
450–600 µmol m² s^{-1}	0.0028	0.0004	0.0147
600–1000 µmol m² s^{-1}	0.0029	0.0061	0.0049
1000–1500 µmol m² s^{-1}	-0.0001	0.0069	0.0024

Table S10. Values for the parameters of the fitted curves in Figure 7A using Equation (6). A_d and A_{max} are mean values (n = 2–6) at 0 and 1500 µmol m^{-2} s^{-1}, respectively.

	Lower (z_L)	Middle (z_M)	Higher (z_H)
A_d (µmol CO_2 m^{-2} s^{-1})	0.66 (0.28)	-0.21 (0.36)	1.27 (0.21)
A_{max} (µmol CO_2 m^{-2} s^{-1})	12.05 (3.01)	21.30 (2.92)	18.10 (4.89)
α_A (mol mol^{-1})	0.0541	0.0437	0.0538