Supplement

Title:

The linkage of ^{13}C and ^{15}N soil depth gradients with C:N and O:C stoichiometry reveals tree species effects on organic matter turnover in soil

Authors:

Marcel Lorenz[1], Delphine Derrien[2], Bernd Zeller[2], Thomas Udelhoven[3], Willy Werner[4], Sören Thiele-Bruhn[1*]

Affiliations:

[1] University of Trier, Soil Science Department, FB VI, Behringstrasse 21, D-54296 Trier, Germany

[2] INRAe Grand Est Nancy, UR 1138 Biogéochimie des Écosystèmes Forestiers, F-54000 Nancy, France

[3] University of Trier, Environmental Remote Sensing & Geoinformatics Department, FB VI, Behringstrasse 21, D-54296 Trier, Germany

[4] University of Trier, Geobotany Department, FB VI, Behringstrasse 21, D-54296 Trier, Germany

*** Corresponding author:**

thiele@uni-trier.de, Tel.: + 49 (0)651 201-2241

Number of appendices: 5

Table S1

Soil chemical properties of the parent material that was used for the afforestation at all forest sites.

	Parent material
$\delta^{13}C$ [‰]	-29.69 ± 0.13
$\delta^{15}N$ [‰]	-0.89 ± 0.09
C [mg g^{-1}]	2.0 ± 0.5
N [mg g^{-1}]	0.3 ± 0.0
O [mg g^{-1}]	10.9 ± 0.8
C:N	7.5 ± 1.2
O:C	4.20 ± 1.30

Table S2

Overview about the number of samples that were taken in this study. The litterfall samples represent average samples from 12 samples per plot that were taken monthly over a period of one year.

	Tree species	Horizons	Plots	Points	Total number of samples
Forest floor	4	3	5	1 pooled sample from 4 points	60
Mineral soil	4	3	5	1 pooled sample from 4 points	60
Roots	4	4	5	5	400
Litterfall	4	-	5	1	20

Table S3

Chemical characterization of litterfall and root inputs of different tree species. Root properties are given on horizon level as well as on average of roots in the forest floor and mineral soil, irrespective of soil horizons ("*Roots general*"). Values are means ± SD. Differences between tree species are marked by different letters. Significant *p* values (< 0.05) are highlighted in bold font style.

				Roots in			
		Litterfall	Roots (general)	Forest floor	0-5 cm	5-10 cm	10-30 cm
C	Douglas fir	503.9 ± 6.7b	486.9 ± 28.7b	509.6 ± 13.5b	465.1 ± 39.5	476.3 ± 25.0	496.3 ± 6.8
[mg g^{-1}]	Pine	497.6 ± 7.2b	461.9 ± 36.5ab	486.7 ± 23.4b	454.0 ± 26.5	448.1 ± 44.6	459.0 ± 44.7
	Beech	475.4 ± 0.43a	485.3 ± 24.3b	508.7 ± 15.8b	486.6 ± 17.1	466.9± 28.1	479.3 ± 17.6
	Oak	481.1 ± 0.44a	460.5 ± 26.0a	431.5 ± 31.0a	461.0 ± 19.7	465.3 ± 6.8	484.1 ± 7.4
	p values	**<0.0001**	**0.0042**	**0.0001**	0.2970	0.7046	0.0727
N	Douglas fir	10.1 ± 1.8a	13.0 ± 4.0b	15.7 ± 5.1ab	12.8 ± 3.0bc	12.4 ± 4.4c	10.9 ± 2.2b
[mg g^{-1}]	Pine	8.9 ± 0.7a	13.5 ± 4.1b	19.0 ± 3.4b	13.3 ± 1.4c	10.5 ± 1.2bc	11.0 ± 2.7b
	Beech	13.7 ± 0.5b	8.1 ± 3.2a	12.2 ± 1.1a	8.4 ± 2.6ab	6.0 ± 2.0ab	5.7 ± 1.6a
	Oak	13.0 ± 2.4b	7.6 ± 3.5a	11.1 ± 4.0a	8.9 ± 2.0a	5.6 ± 2.1a	4.7 ± 0.9a
	p values	**0.0004**	**<0.0001**	**0.0154**	**0.0056**	**0.0019**	**0.0001**
O	Douglas fir	334.1 ± 3.1a	375.5 ± 24.4ab	388.3 ± 15.9b	355.9 ± 19.0ab	367.4 ± 28.7ab	390.2 ± 19.1ab
[mg g^{-1}]	Pine	344.2 ± 5.1b	355.1 ± 24.1a	370.7 ± 11.5ab	349.2 ± 19.7ab	343.4 ± 29.3a	357.1 ± 29.3a
	Beech	341.2 ± 1.9b	353.4 ± 44.8a	355.1 ± 71.2ab	332.0 ± 30.0a	348.6 ± 33.6ab	377.8 ± 33.3ab
	Oak	356.8 ± 2.7c	385.0 ± 38.4b	350.0 ± 50.5a	376.5 ± 24.8b	401.13 ± 26.3b	412.1 ± 16.4b
	p values	**<0.0001**	**0.0091**	**0.0268**	**0.0486**	**0.0280**	**0.0252**
CN	Douglas fir	59.55 ± 10.01b	48.27 ± 16.63a	42.89 ± 20.34ab	44.42 ± 11.12a	50.72 ± 22.57a	55.03 ± 12.10a
ratio	Pine	65.60 ± 4.40b	42.87 ± 10.80a	30.82 ± 6.66a	40.02 ± 3.75a	50.40 ± 8.05a	50.25 ± 9.98a
	Beech	40.65 ± 1.58a	82.29 ± 34.74b	48.66 ± 3.36b	75.33 ± 31.42b	100.23 ± 36.77b	104.93 ± 29.40b
	Oak	44.74 ± 10.17a	89.53 ± 50.61b	52.38 ± 26.72b	62.48 ± 11.76b	118.59 ± 74.64b	124.67 ± 22.49b
	p values	**0.0002**	**<0.0001**	**0.0493**	**0.0100**	**0.0089**	**<0.0001**
OC	Douglas fir	0.50 ± 0.01a	0.58 ± 0.03a	0.57 ± 0.03ab	0.58 ± 0.03ab	0.58 ± 0.04ab	0.59 ± 0.02
ratio	Pine	0.52 ± 0.01b	0.58 ± 0.02a	0.57 ± 0.02ab	0.58 ± 0.00ab	0.58 ± 0.03ab	0.58 ± 0.02
	Beech	0.54 ± 0.01c	0.55 ± 0.07a	0.52 ± 0.09a	0.51 ± 0.06a	0.56 ± 0.05a	0.59 ± 0.07
	Oak	0.56 ± 0.01d	0.63 ± 0.04b	0.61 ± 0.05b	0.61 ± 0.05b	0.65 ± 0.04b	0.64 ± 0.03
	p values	**<0.0001**	**<0.0001**	**0.0175**	**0.0116**	**0.0174**	0.0961

Table S4

Chemical Properties of forest floor horizons (OL, OF, OH) and mineral soil layers (0-5, 5-10, 10-30 cm). Values are means ± SD. Differences between tree species are marked by different letters. Significant *p* values (< 0.05) are highlighted in bold font style.

		OL	OF	OH	0-5 cm	5-10 cm	10-30 cm
$\delta^{13}C$	Douglas fir	-27.37 ± 0.56b	-28.21 ± 0.30c	-27.93 ± 0.29b	-26.91 ± 0.17d	-26.62 ± 0.20b	-26.19 ± 0.20c
[‰]	Pine	-27.63 ± 0.30b	-28.44 ± 0.26bc	-28.56 ± 0.44a	-27.21 ± 0.10c	-27.01 ± 0.32a	-26.80 ± 0.20b
	Beech	-29.05 ± 0.36a	-29.06 ± 0.50ab	-29.04 ± 0.39a	-27.54 ± 0.13b	-26.99 ± 0.13ab	-26.60 ± 0.19bc
	Oak	-28.53 ± 0.56a	-29.37 ± 0.30a	-28.95 ± 0.19a	-28.13 ± 0.21a	-27.32 ± 0.12a	-27.39 ± 0.41a
	p values	**0.0015**	**0.0002**	**0.0004**	**<0.0001**	**0.0007**	**<0.0001**
$\delta^{15}N$	Douglas fir	-3.72 ± 0.37b	-2.81 ± 0.47b	-2.25 ± 0.72b	-2.13 ± 0.34	-0.97 ± 0.86	0.34 ± 0.73b
[‰]	Pine	-6.93 ± 0.72a	-5.27 ± 0.65a	-4.04 ± 0.87a	-2.37 ± 0.72	-1.46 ± 0.58	-0.42 ± 0.80ab
	Beech	-6.48 ± 0.69a	-5.12 ± 0.54a	-3.27 ± 0.29ab	-1.63 ± 0.59	-1.15 ± 0.42	0.54 ± 0.68b
	Oak	-6.12 ± 0.59a	-4.86 ± 0.63a	-3.70 ± 0.51a	-2.85 ± 1.11	-1.75 ± 0.46	-1.36 ± 0.50a
	p values	**<0.0001**	**<0.0001**	**0.0025**	0.1150	0.5930	**0.0019**
C	Douglas fir	418.3 ± 53.5a	229.2 ± 83.5	102.5 ± 69.2	22.5 ± 8.1b	8.9 ± 1.4b	4.8 ± 1.0b
[mg g^{-1}]	Pine	500.1 ± 24.6b	289.6 ± 73.8	113.6 ± 36.0	11.0 ± 4.4ab	5.1 ± 1.1a	3.9 ± 1.2ab
	Beech	445.2 ± 34.1ab	217.2 ± 72.9	57.3 ± 3.0	6.6 ± 2.3a	4.2 ± 1.2a	2.3 ± 0.5a
	Oak	457.1 ± 30.3ab	166.5 ± 88.4	92.1 ± 45.3	22.5 ± 15.6b	9.3 ± 5.3b	5.1 ± 1.8b
	p values	**0.0232**	0.1550	0.2750	**0.0280**	**0.0049**	**0.0096**
N	Douglas fir	15.5 ± 1.6b	9.4 ± 2.9	4.8 ± 2.8	1.0 ± 0.3c	0.6 ± 0.1c	0.3 ± 0.1ab
[mg g^{-1}]	Pine	13.8 ± 2.2b	10.7 ± 3.3	5.2 ± 1.7	0.6 ± 0.2ab	0.3 ± 0.1ab	0.3 ± 0.1ab
	Beech	15.3 ± 2.5b	9.6 ± 3.0	3.2 ± 0.2	0.4 ± 0.1a	0.3 ± 0.1ab	0.2 ± 0.0a
	Oak	10.1 ± 0.5a	6.3 ± 3.7	4.3 ± 2.0	1.1 ± 0.8bc	0.5 ± 0.2bc	0.4 ± 0.1b
	p values	**0.0011**	0.2000	0.4620	**0.0123**	**0.0094**	**0.0312**
O	Douglas fir	219.9 ± 24.8a	171.5 ± 58.0	86.7 ± 59.3	26.7 ± 6.4ab	15.1 ± 1.7c	12.9 ± 1.0
[mg g^{-1}]	Pine	263.7 ± 11.9b	222.9 ± 51.6	91.6 ± 21.9	18.9 ± 4.2ab	10.3 ± 1.9ab	10.3 ± 3.1
	Beech	248.3 ± 19.6ab	171.7 ± 53.5	56.5 ± 7.4	10.9±2.2a	8.5 ± 2.7a	9.3 ± 2.2
	Oak	269.0 ± 12.5b	132.3 ± 64.7	79.5 ± 32.1	31.6 ± 16.7b	13.9 ± 4.8bc	10.5 ± 1.7
	p values	**0.0024**	0.1380	0.4420	**0.0142**	**0.0131**	0.0886
CN	Douglas fir	31.42 ± 2.21a	28.20 ± 2.67ab	24.00 ± 3.11ab	25.51 ± 2.54c	18.75 ± 1.61a	17.43 ± 0.75
ratio	Pine	42.99 ± 6.12b	32.04 ± 2.63b	25.58 ± 1.10b	22.26 ± 0.35b	18.89 ± 1.66a	16.85 ± 1.19
	Beech	34.82 ± 7.41ab	26.29 ± 2.97a	20.73 ± 1.07a	19.62 ± 0.49a	17.79 ± 1.35a	15.72 ± 1.15
	Oak	52.84 ± 4.25c	31.49 ± 1.63b	25.15 ± 1.00b	24.11 ± 0.75bc	21.90 ± 1.61b	16.63 ± 3.08
	p values	**<0.0001**	**0.0357**	**0.0026**	**0.0010**	**0.0047**	0.5240
OC	Douglas fir	0.40 ± 0.01a	0.57 ± 0.05	0.65 ± 0.13	0.92 ± 0.14	1.28 ± 0.13	2.07 ± 0.37a
ratio	Pine	0.40 ± 0.01a	0.58 ± 0.03	0.63 ± 0.09	1.36 ± 0.24	1.53 ± 0.22	2.07 ± 0.69a
	Beech	0.42 ± 0.01b	0.60 ± 0.07	0.74 ± 0.09	1.33 ± 0.45	1.55 ± 0.30	3.07 ± 0.59b
	Oak	0.44 ± 0.01c	0.61 ± 0.07	0.69 ± 0.13	1.59 ± 0.29	1.22 ± 0.25	1.60 ± 0.28a
	p values	**<0.0001**	0.6130	0.4240	0.5210	0.0861	**0.0097**

Table S5

Results of the linear regression analyses between isotopic and stoichiometric ratios.

		Function	R^2	*p values*
$\delta^{13}C$ vs C/N	Douglas fir	y = -4.044x - 85.799	0.34	**0.0008**
	Pine	y = -6.072x - 141.205	0.23	**0.0076**
	Beech	y = -4.434x - 101.870	0.46	**<0.0001**
	Oak	y = -6.355x - 151.049	0.19	**0.0161**
$\delta^{13}C$ vs O/C	Douglas fir	y = 0.586x + 16.912	0.58	**<0.0001**
	Pine	y = 0.535x + 19.517	0.53	**<0.0001**
	Beech	y = 0.715x + 21.324	0.67	**<0.0001**
	Oak	y = 0.382x + 11.700	0.49	**<0.0001**
$\delta^{15}N$ vs C/N	Douglas fir	y = -3.352x + 17.773	0.79	**<0.0001**
	Pine	y = -3.393x + 14.856	0.77	**<0.0001**
	Beech	y = -2.557x + 15.208	0.78	**<0.0001**
	Oak	y = -5.646x + 9.261	0.72	**<0.0001**
$\delta^{15}N$ vs O/C	Douglas fir	y = 0.380x + 1.713	0.84	**<0.0001**
	Pine	y = 0.242x + 1.920	0.76	**<0.0001**
	Beech	y = 0.332x + 2.231	0.75	**<0.0001**
	Oak	y = 0.215x + 1.626	0.73	**<0.0001**