Supplemental information to **The effects of experimental forestry treatments on site conditions: short response study from an oak-hornbeam forest**

Kovács, B.1,2,3, Tinya, F.1, Guba, E.1, Németh, Cs.3, Sass, V.4, Bidló, A.4, Ódor, P.1,3

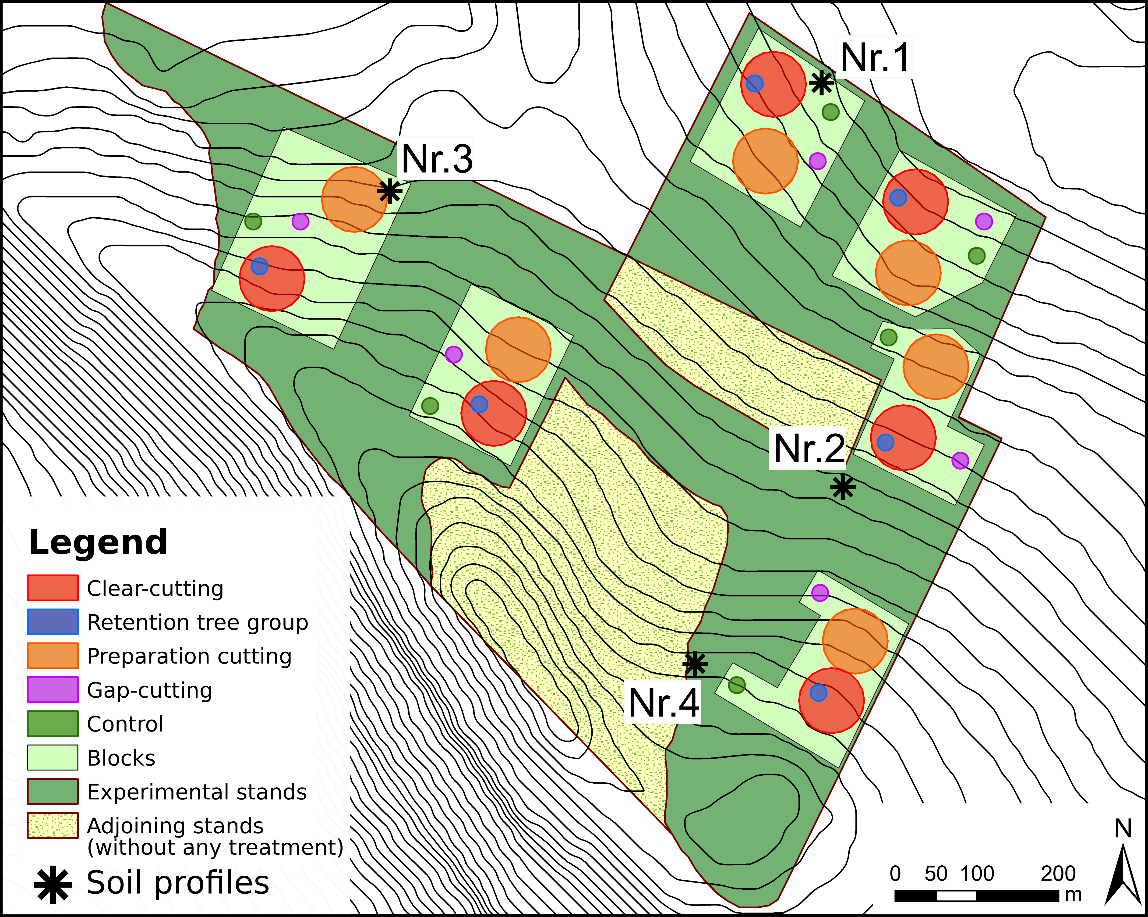
1MTA Centre for Ecological Research, Institute of Ecology and Botany, Alkotmány út 2-4, H-2163 Vácrátót, Hungary

2Department of Plant Systematics, Ecology and Theoretical Biology, Eötvös Loránd University, Pázmány Péter sétány 1/C, H-1117 Budapest, Hungary

3MTA Centre for Ecological Research**, GINOP Sustainable Ecosystems Research Group,** Klebelsberg Kuno utca 3, H-8237 Tihany, Hungary

4University of Sopron, Institute of Environmental and Earth Sciences, Bajcsy-Zsilinszky utca 4, H-9400 Sopron, Hungary

**Supplemental Information 1 –** Results of the soil profile analyses



**Figure S1.1.** Four soil profiles were conducted across the experimental site for studying the soil conditions. All soil profiles were established and analyzed in 18-19 June 2014. The locations are marked with asterisks.

Here we present a short description of soil characterization in the localities shown on Figure A1.1. and a brief overview about the results of the four soil profiles. According to the (MSZ-08-0205:1978) standards the following variables are shown on the tables: # – the number of the layer distinguished by expert judgement; layer – upper and lower limit horizon (cm from mineral soil surface); Coarse fragments – volume of the coarse particles (%); pH – pH measured by using H2O and KCl solutions, respectively; CaCO3 – presence / content of carbonates within a given layer (%); y1 – hydrolytic acidity; y2 – exchangeable acidity; soil texture – the volumetric content of clay (<0.002 mm), silt (0.002-0.02 mm), fine sand (0.02-0.2 mm) and coarse sand (0.2-2 mm), separately (%); C – soil organic carbon content (%); N – total nitrogen content (%); PAL – extractable phosphorus (mg/100 g soil); KAL – extractable potassium (mg/100 g soil).

Soil pH was potentiometrically measured using supernatant suspension of 10 g air-dried and sieved (<2 mm) samples and 25 ml of distilled water (pH(H2O)) and 25 ml of 1 mol/l KCL (pH(KCL)) solution, respectively (MSZ-08-0205:1978). In the case of y1, 40 g air-dried soil samples were extracted with 100 ml 1 mol/l Ca(CH3COO)2 solution; regarding to y2 extractions were made using unbuffered 1 mol/l KCl solution. In both cases measurements were performed by titration (Ballenegger and di Gléria 1962). Kuron’s method was applied for gauging hy of air-dry soils (Verstraeten & Livens, 1971): with 50% (v/v) H2SO4 solution and 35.2% RH according to (MSZ-08-0205:1978). Chemical compounds were evaluated on composite samples of the 1:1 mixture of the four, sieved (<0.5 mm) subsamples per plot. Total soil carbon and nitrogen content were determined by dry combustion method using Elementar vario MAX CNS-analyzer (Elementar Analysesysteme, Langenselbold, Germany) applying the ISO standards (ISO 10694:1995; ISO 13878:1998): soil samples were weighed up to 80-100 g, and a tungsten oxide catalyst was added. The applied combustion temperature was 1140°C. Plant available phosphorus and potassium were determined by ammonium lactate (AL) solution method (0.1M NH4-lactate + 0.4 M HOAc, adjusted to pH 3.75) developed by Egnér et al. (1960 cf. Carter & Gregorich, 2008) according to the operative Hungarian standards (MSZ 20135:1999). P2O5was measured colorimetrically, K2O5was quantified by flame photometry.

**Soil profile Nr.1**

|  |  |
| --- | --- |
| **Bedrock:**  loess with other sediments, limestone and sandstone stones and boulders are present  **Genetic soil type:**  brown forest soils with clay illuviation (luvisol)  **Soil texture**  loam / clay loam  **Coarse fragments:**  below the depth of 100 cm; 10 V/V%  **Notes:**  iron and manganese concretion in the deeper layers |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Layer (cm)** | **Coarse fragm. (%)** | **pH (H2O)** | **pH (KCl)** | **CaCO3**  **(%)** | **y1** | **y2** | **hy** | **Soil texture** | | | | **SOC (%)** | **N**  **(%)** | **P2O5** | **K2O** |
| **Clay (%)** | **Silt (%)** | **Fine sand (%)** | **Coarse sand (%)** | **mg/100 g soil** | |
| **1** | 0-10 | - | 4.9 | 4.0 | - | 30.74 | 21.89 | 2.08 | 23 | 34 | 37 | 6 | 4.57 | 0.20 | 2.6 | 9.5 |
| **2** | 10-20 | - | 4.6 | 3.7 | - | 30.01 | 21.70 | 1.74 | 21 | 30 | 43 | 6 | 2.05 | 0.10 | 1.5 | 6.3 |
| **3** | 20-40 | - | 4.8 | 3.7 | - | 26.52 | 21.70 | 1.93 | 9 | 46 | 39 | 6 | 1.90 | 0.10 | 0.4 | 6.6 |
| **4** | 40-70 | - | 4.8 | 3.7 | - | 19.17 | 18.03 | 2.40 | 33 | 26 | 35 | 6 | 1.40 | 0.08 | 1.6 | 7.8 |
| **5** | 70-100 | - | 5.1 | 3.7 | - | 12.58 | 11.09 | 2.86 | 33 | 24 | 36 | 7 | 0.60 | 0.05 | - | 8.0 |
| **6** | 100-150 | - | 6.1 | 5.2 | - | 8.82 | - | 2.81 | 29 | 30 | 37 | 4 | 0.62 | 0.04 | 1.9 | 6.4 |
| **7** | 150-200 | - | 7.4 | 6.9 | 15 | - | - | 1.75 | 17 | 28 | 42 | 13 | 0.85 | 0.03 | 1.6 | 5.1 |

**Soil profile Nr.2**

|  |  |
| --- | --- |
| **Bedrock:**  loess with other sediments  **Genetic soil type:**  brown forest soils with clay illuviation (luvisol)  **Soil texture:**  loam / clay loam  **Coarse fragments:**  minimal  **Notes:**  iron and manganese concretion in the deeper layers |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Layer (cm)** | **Coarse fragm. (%)** | **pH (H2O)** | **pH (KCl)** | **CaCO3**  **(%)** | **y1** | **y2** | **hy** | **Soil texture** | | | | **SOC (%)** | **N**  **(%)** | **P2O5** | **K2O** |
| **Clay (%)** | **Silt (%)** | **Fine sand (%)** | **Coarse sand (%)** | **mg/100 g soil** | |
| **1** | 0-10 | - | 4.6 | 3.7 | - | 39.01 | 23.38 | 1.95 | 23 | 26 | 45 | 6 | 3.97 | 0.19 | 4.0 | 7.5 |
| **2** | 10-20 | - | 4.4 | 3.5 | - | 37.41 | 26.23 | 1.64 | 21 | 30 | 43 | 6 | 2.52 | 0.13 | 1.0 | 5.3 |
| **3** | 20-50 | - | 4.7 | 3.6 | - | 25.10 | 20.01 | 1.64 | 21 | 32 | 41 | 6 | 1.21 | 0.07 | 0.2 | 5.2 |
| **4** | 50-90 | - | 5.1 | 3.8 | - | 13.57 | 10.08 | 2.84 | 31 | 30 | 34 | 5 | 0.58 | 0.04 | 2.2 | 8.8 |
| **5** | 90-130 | - | 5.5 | 4.8 | - | 10.39 | 4.77 | 2.91 | 29 | 30 | 35 | 6 | 0.46 | 0.04 | 6.2 | 8.8 |
| **6** | 130-210 | - | 7.8 | 6.8 | 5 | - | - | 1.83 | 17 | 32 | 44 | 7 | 0.72 | 0.04 | 2.8 | 5.4 |
| **7** | 210-250 | - | 7.7 | 6.9 | 2 | - | - | 3.80 | 39 | 20 | 28 | 13 | 0.47 | 0.04 | 2.9 | 7.2 |

**Soil profile Nr.3**

|  |  |
| --- | --- |
| **Bedrock:**  limestone and loess with other sediments  **Genetic soil type:**  rendzic leptosol and brown forest soils with clay illuviation (luvisol)  **Soil texture:**  loam  **Coarse fragments:**  increasing downwards  **Notes:**  - |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Layer (cm)** | **Coarse fragm. (%)** | **pH (H2O)** | **pH (KCl)** | **CaCO3**  **(%)** | **y1** | **y2** | **hy** | **Soil texture** | | | | **SOC (%)** | **N**  **(%)** | **P2O5** | **K2O** |
| **Clay (%)** | **Silt (%)** | **Fine sand (%)** | **Coarse sand (%)** | **mg/100 g soil** | |
| **1** | 0-10 | - | 4.6 | 3.7 | - | 40.89 | 20.49 | 2.23 | 19 | 28 | 44 | 9 | 5.70 | 0.26 | 0-10 | - |
| **2** | 10-20 | - | 4.6 | 3.5 | - | 33.75 | 19.29 | 1.96 | 25 | 26 | 39 | 10 | 2.53 | 0.12 | 10-20 | - |
| **3** | 20-30 | - | 5.3 | 4.1 | - | 18.08 | 7.33 | 2.36 | 29 | 26 | 34 | 11 | 2.25 | 0.12 | 20-30 | - |
| **4** | 30-70 | 21 | 6.9 | 6.2 | - | - | - | 3.61 | 35 | 26 | 27 | 12 | 2.63 | 0.12 | 30-70 | 21 |

**Soil profile Nr.4**

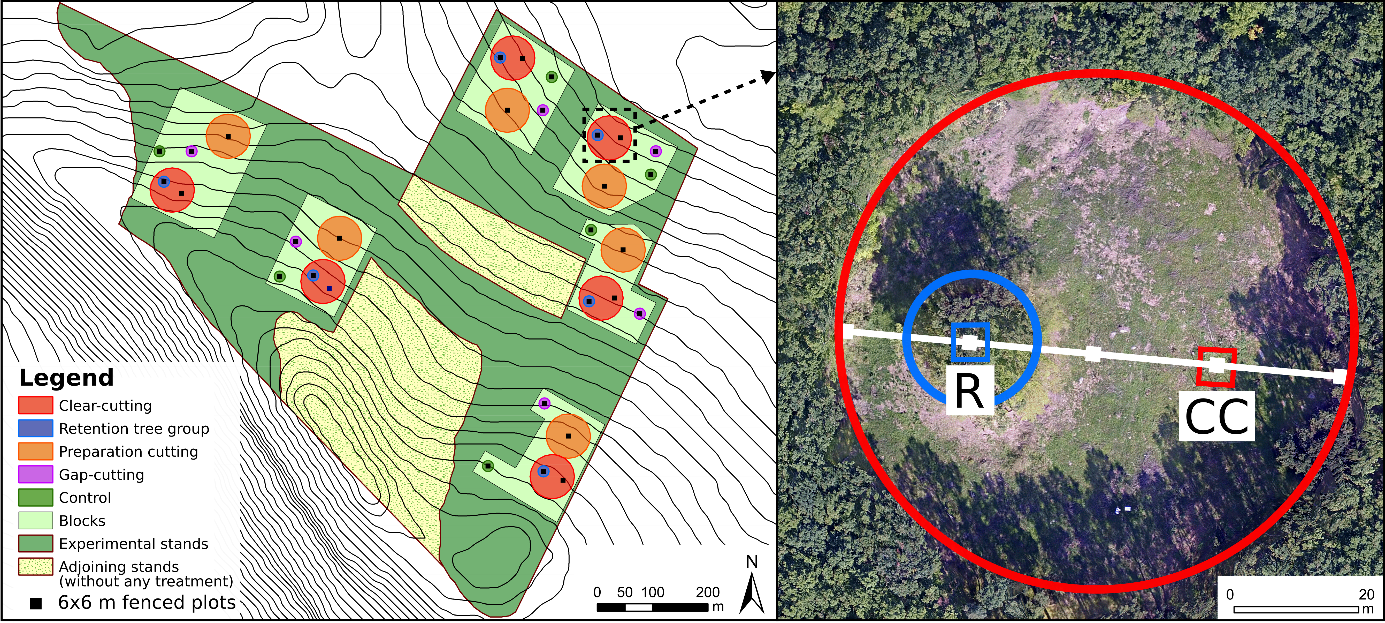
|  |  |
| --- | --- |
| **Bedrock:**  limestone and loess with other sediments  **Genetic soil type:**  brown forest soils with clay illuviation (luvisol)  **Soil texture:**  loam / clay loam  **Coarse fragments:**  minimal  **Notes:**  - |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Layer (cm)** | **Coarse fragm. (%)** | | **pH (H2O)** | **pH (KCl)** | **CaCO3**  **(%)** | **y1** | **y2** | **hy** | **Soil texture** | | | | **SOC (%)** | **N**  **(%)** | **P2O5** | **K2O** |
| **Clay (%)** | **Silt (%)** | **Fine sand (%)** | **Coarse sand (%)** | **mg/100 g soil** | |
| **1** | 0-10 | | - | 47 | 3.6 | - | 31.99 | 16.63 | 1.44 | 11 | 26 | 44 | 19 | 3.66 | 0.15 | 3.0 | 6.4 |
| **2** | 10-20 | | - | 4.3 | 3.6 | - | 25.39 | 19.12 | 0.99 | 11 | 26 | 42 | 21 | 2.04 | 0.08 | 0.8 | 3.5 |
| **3** | 20-50 | | - | 4.3 | 3.5 | - | 24.71 | 24.11 | 0.99 | 13 | 26 | 41 | 20 | 0.89 | 0.05 | 0.5 | 2.8 |
| **4** | 50-80 | | - | 4.7 | 3.5 | - | 24.16 | 23.02 | 2.11 | 25 | 22 | 38 | 15 | 0.59 | 0.04 | 0.1 | 6.1 |

**Supplemental Information 2 –** Additional information to the experimental site and treatments

|  |  |  |
| --- | --- | --- |
| Clear-cutting |  |  |
| Retention tree group |  |  |
| Preparation cutting |  |  |
| Gap-cutting |  |  |
| Control | F:\@ope\pilis kiserlet 2013\kepek\20140404\DSCN0611.JPG |  |

**Figure S2.1. Stand and fish-eye photos of the treatments within the Pilis Experiment.**



**Figure S2.2. Spatial configuration of the measurement plots within the different treatment types.**

The 6 × 6 m fenced plots are pictured as black squares (*left* panel). Plots of retention tree groups (R) and clear-cuttings (CC) were shifted to the 1:3 intersections along mainly the east-west diameter (photoon the *right*).



Soil water content and soil temperature sensor

Data logger

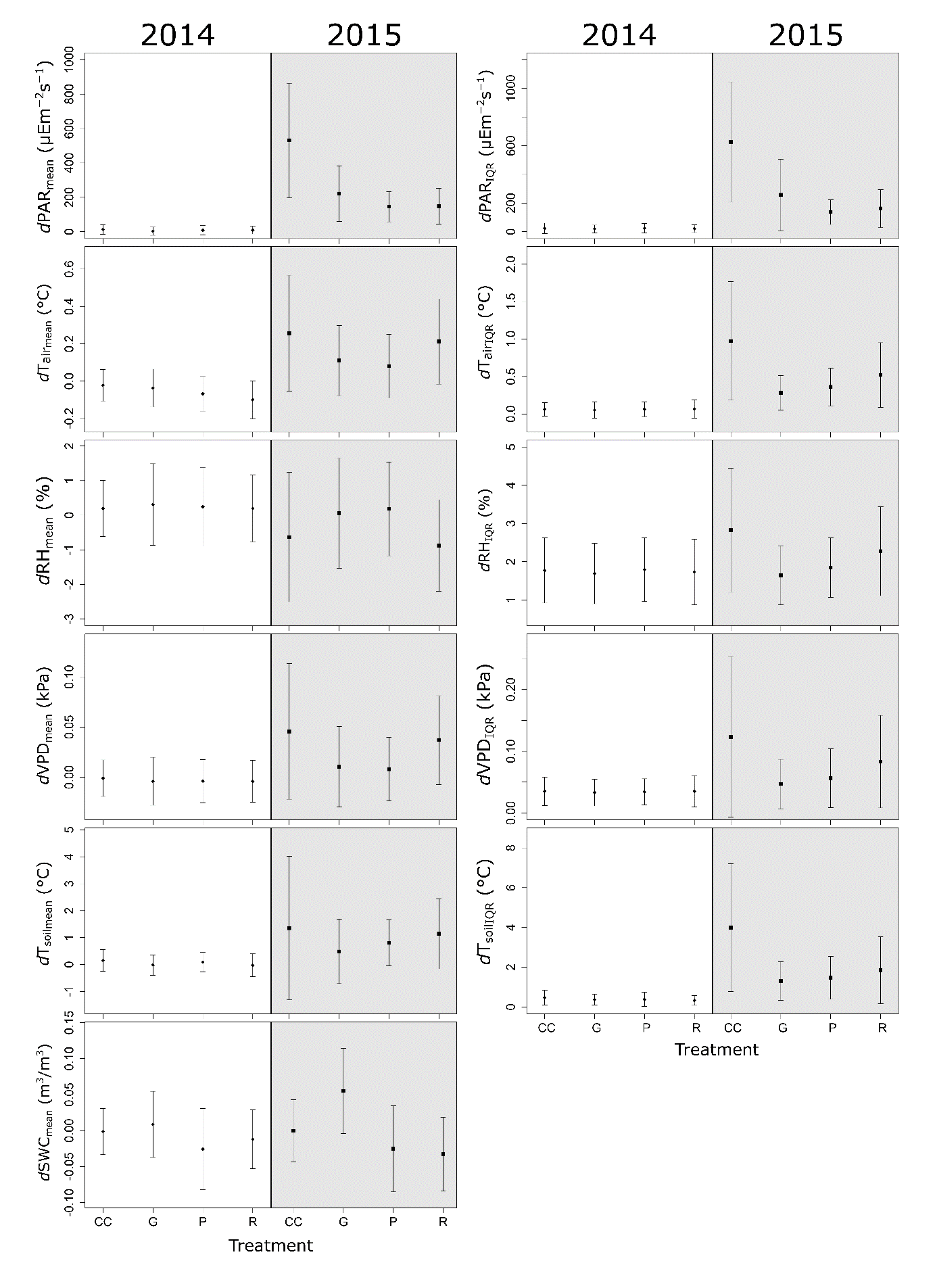
PAR sensor

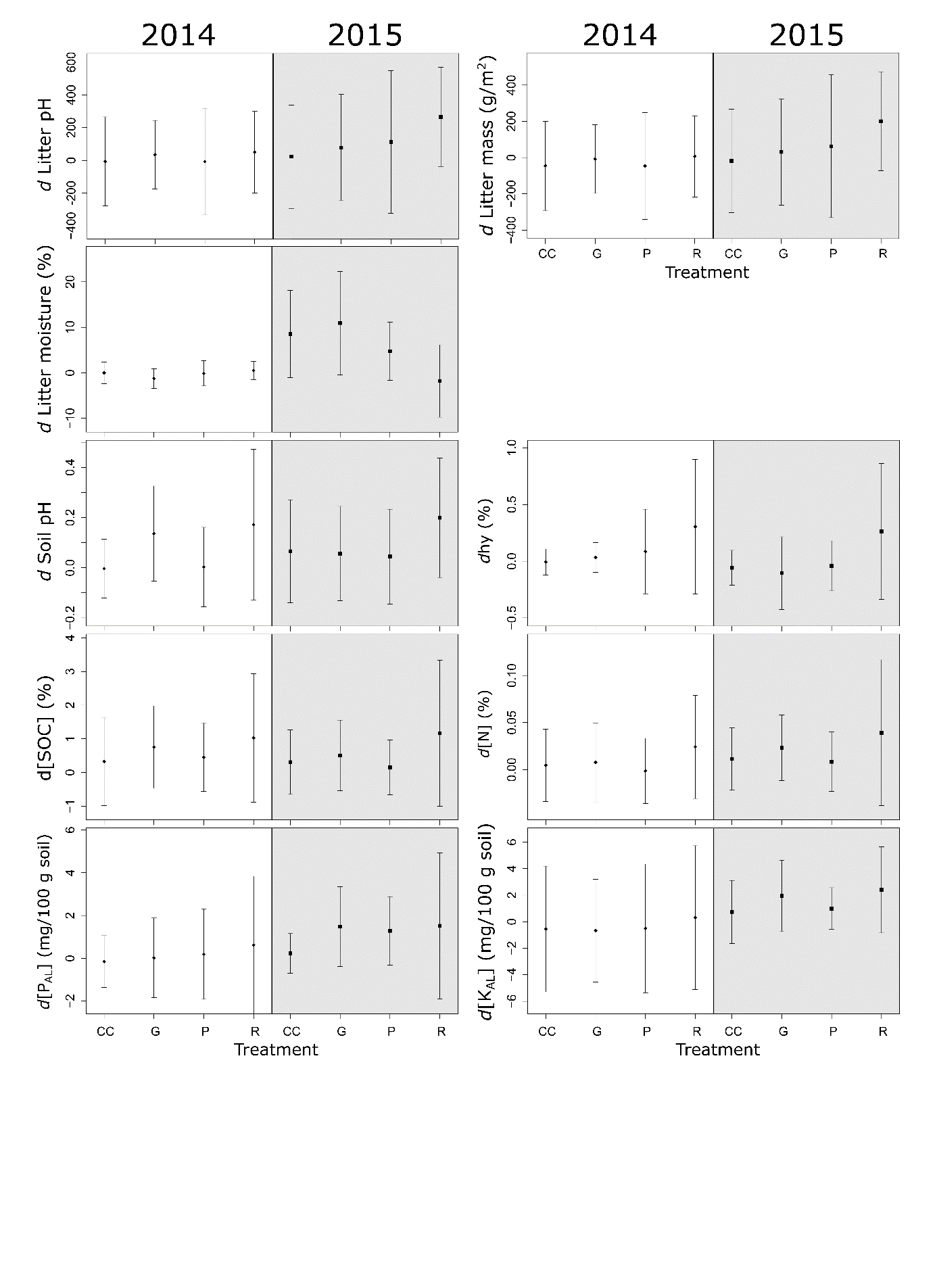
Air temparature and relative humidity

**Figure S2.3. The instrumentation of the microclimate measurements.**

4-channeled Onset ‘HOBO H021-002’ data loggers (Onset Computer Corporation, Bourne, MA) were mounted on wooden poles. Photosynthetically active radiation (PAR, λ=400-700 nm) was measured at 150 cm above ground level using Onset ‘S-LIA-M003’ quantum sensors. Air temperature and relative humidity data were collected at 130 cm above ground level with Onset ‘S-THB-M002’ combined T/RH sensors housed in standard radiation shields to avoid direct sunlight. Soil temperature was measured with ‘S-TMB-M002’ 12-Bit temperature sensors by Onset placed 2 cm below ground. Soil water content were collected by Onset ‘S-SMD-M005’ soil moisture sensors buried 20 cm below ground level to measure the average soil moisture in 10-20 cm soil depth.

**Supplemental Information 3 –** Microclimate, litter and soil variables before and after the treatments

****

**Fig. S3.1. Microclimate, litter and soil variables before (2014) and after (2015) the treatments.**

PAR: photosynthetically active radiation (μEm−2s−1); DIFN: relative diffuse light (%);Tair: air temperature (°C); RH: relative humidity (%); VPD: vapor pressure deficit (kPa); Tsoil: soil temperature (°C); SWC: soil moisture (m3/m3); Litter mass: total mass of collected litter on the surface (gm-2); Litter pH: litter pH in water; Litter moisture content: gravimetric moisture content of litter samples (%); Soil pH: soil pH in water; hy: Kuron’s hygrscopicity (%); [SOC]: total soil carbon content (%); [N]: total nitrogen content (%); [PAL]: concentration of AL-soluble phosphorus (mg/100 g soil); [KAL]: concentration of AL-soluble potassium (mg/100 g soil). Letter ‘*d*’ in the variable abbreviations refers to the differences from the mean values measured in the ‘Control’ plots. Full circles show the mean; vertical lines denote the standard deviation of the samples.