The goal of this research work was to determine widespread impact kiln-produced hardwood biochar has upon temperate agricultural soil characteristics in a long-term field experiment. This dataset is supplementary to the submitted research by [1] and presents select physical and chemical characteristics of the biochar and field plots amended with hardwood biochar. Data on soil gravimetric moisture content (GMC), soil acidity and soil nitrate-N concentration at lower depth of soil under different biochar application rates is presented. Fourier Transform Infrared (FTIR) spectroscopy is provided to demonstrate the difference between fresh and aged biochar in terms of surface functional group content.

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1. Data

The biochar used was investigated for changes in the gravimetric moisture content 48 hours after a rain event (Fig. 1). Differences were not significant for biochar treatment levels at the 20–40cm depth, however gravimetric moisture content increased significantly at the 0–20cm soil depth ($p < 0.05$).
Nitrate content in soils during years 2 and 3 were determined at 0–20, 20–40, and total 0–40 cm depth (Figs. 2 and 3) and were twice each season, at both typical PSNT timing and at harvest of sweetcorn. Sub-plots were fertilized with calcium ammonium nitrate after PSNT soil samples were taken. No significant differences in nitrate concentrations were found, except at PSNT in the 3rd year.
(2014) where biochar treatments of 4, 6, and 8% were significantly lower than the control and 2% biochar treatments.

The control soil maintained pH values below 6, whereas the biochar amended soils all had elevated soil pH, increasing throughout the experiment and maintaining pH values of 6.2—6.8 [1]. It is important to note, that all biochar treatment levels significantly increased the soil pH within the acceptable range for field crop growth. Higher Al³⁺ concentration corresponded to lower application rate of biochar (Fig. 4).

The FTIR revealed functional group content differences between fresh and aged biochar samples on the content of polar and O-containing functional groups on the surface of biochar (Fig. 5, Table 1). The presence of the new functional groups in aged biochar at 753.07 and 875.49 cm⁻¹ can be assigned to C—O—O— stretch from peroxide functional groups (Fig. 5).
2. Experimental design, materials and methods

2.1. Soil gravimetric moisture content

Soil samples were collected and tested for variations in the total moisture content. Samples were collected 2 days after a rain event. Crucibles were oven dried for 24 hours at 100 °C and weighed before adding soil samples. Crucible weights were recorded with the added soil. Crucibles and soil were then again oven dried at 100 °C for 72 hours and reweighed. Moisture content was then calculated as grams of moisture lost per dry soil weight.

Fig. 4. Soil pH at time of harvest and corresponding Al³⁺ concentration. Yellow, green, blue, red and purple correspond to 0, 2, 4, 6 and 8% biochar respectively.

Fig. 5. FTIR spectra peaks of fresh and aged sugar maple hardwood biochar.
2.2. Soil Al/nitrate-N concentration determination

The data on soil Al and nitrate-N concentration is provided in Figs. 2–4 respectively. Soil samples were extracted in 40 mL of Modified Morgan Extractant and shaken at 200 oscillations per minute for 15 minutes, as recommended by the North East Soil Testing Laboratory Manual. Samples were filtered using medium grade filter paper and diluted 1:5 with deionized H2O. Samples were analyzed for nitrate-N using flow injection analysis (QuickChem 8000, by LaChat Instruments, Loveland, CO). Samples from the above soil filtrates were then analyzed for Al using the microwave plasma atomic emission spectrophotometry MP-AES Agilent 4100 (Agilent Technologies, Santa Clara, CA). Table 1

2.2.1. FTIR

The infrared spectra (FTIR) were recorded from pellets containing 2 mg of the air-dried biochar. The surface functional groups of fresh and aged biochar samples were identified using a PerkinElmer Spectrum One spectrometer with ATR attachment. IR spectra were collected from 4000 to 650 cm\(^{-1}\) with a resolution of 2 cm\(^{-1}\). The functional groups were identified according to published references (Table 1).

All data were analyzed by one-way ANOVA using the GLM Procedure in SAS 9.4 (SAS Institute Inc., Cary, NC).

**Table 1**

| Fresh biochar (2012) | Aged biochar (2016) | Corresponding characteristic vibration | Functional groups | reference |
|---------------------|---------------------|----------------------------------------|-------------------|-----------|
| 753.07              | 753.07              | C–H bending (675–1000), C–H out of plane bending (650–770) | Alkene, Aromatic | [10,11] |
| 875.49              | 875.49              | C–H bending (675–1000), C–H out of plane bending (830 and 874), C–O–C–O symmetric stretching (875), \(\gamma\)-CH of furan (875), 1 adjacent H deformation | Aromatic, peroxide | [2,6,8–10] |
| 1038.89             | 1002.92             | C–O stretch (1050–1150), C–O–C symmetric stretching (1097 cm\(^{-1}\)), C–O–C–O (1000–1300), C–O–C (1046), C–O–O– (1031), Aromatic C=O stretching (1054–1060) | Aromatic, Alcohol&phenol, aliphatic (Aryl-alkyl ethers) | [8–12] |
| 1577.01             | 1569.57             | C=C and C=O stretching (1600–1700 cm\(^{-1}\)), C=C stretch (1400–1600), Aromatic skeletal vibration with C=O stretching vibration (1597), C=O (1587), asymmetric stretching vibrations of COO- (1560), | Aromatic, benzene ring | [8,10–12] |
| 2018.32             | 2355.76             | C=C stretch (2100–2260), CO2 adsorption (2332), Carbonyl bond group | Alkyne | [6,7] |
| ND                  | 3400                | O–H (3200–3550), O–H stretch (3428–3437), | Carboxylic acid or water adsorption | [5] |

\(\text{ND (Not Detected).}\)

2.2. Soil Al/nitrate-N concentration determination

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**Conflict of interest**

There is no conflict of interest.
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