CASE STUDY

GREATSOILS

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Soil Biology and Soil Health Partnership Research Case Study

Testing the long-term effect of pH on soil health

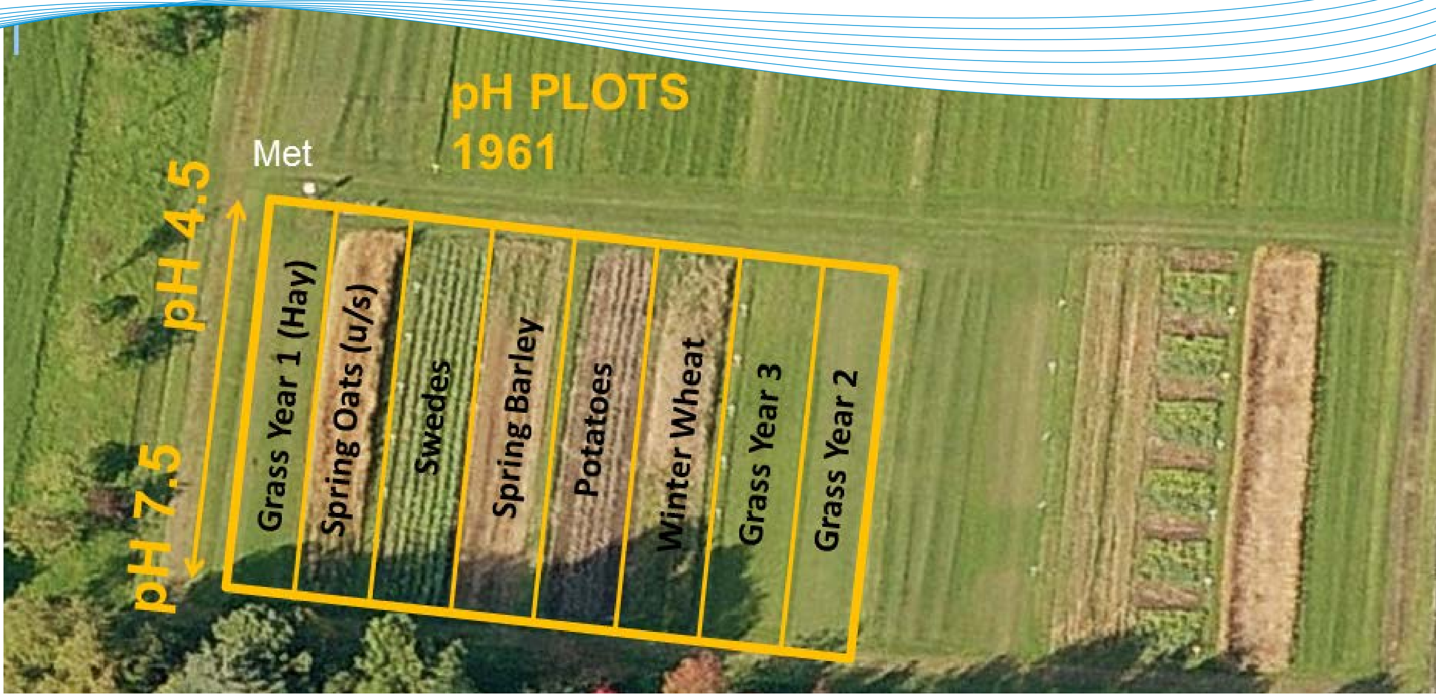

Figure 1. Aerial image of the Woodlands long-term experiment at Craibstone. Crop rotation: Three-year grass/clover ley (Grass Year 1-3), winter wheat, potatoes, spring barley, swede, spring oats undersown (u/s) with grass-clover

Background

Food and fibre crops need suitable soils that are maintained to provide optimal soil structure, water retention and nutrient availability. The physical, chemical and biological properties of soil interact to deliver these functions. Measuring soil health, therefore, requires an integrated approach, combining the assessment of these three factors. The chemical and physical constraints of soil on crop and grassland productivity are well understood, but the role of soil biology is less clear. A key aim of the Soil Biology and Soil Health Partnership is to improve our understanding of soil biology and to explore the ways in which farmers can measure and manage soil health. The Partnership has developed a soil health scorecard, which aims to provide information on key indicators of soil chemical, physical and biological condition, to help guide soil and crop management decisions. This is now being tested at long-term experimental sites (LTEs), where the key drivers of soil biology – food source, physical and chemical environment – are being explored.

Long-term experiments at SRUC Craibstone

Soil pH is a key component of soil health because it affects soil chemical (e.g. availability of nutrients), biological (e.g. microbial activity) and physical properties (e.g. aggregation of clay minerals). The long-term pH trial in Woodlands Field at SRUC Craibstone near Aberdeen was set up in 1961. Here, the effects of pH levels ranging between 4.5 and 7.5 (in 0.5 increments) on soil properties and crop performance are being tested. The trial involves an eight-course rotation comprising 3-year grass/clover ley, winter wheat, potatoes, spring barley, swede and spring oats (undersown with grass/clover). Each crop in the rotation is present every year, enabling a comparison of the response of all crop types within the same season (Figure 1). Measurements of topsoil chemical, physical and biological properties were taken in October 2018 from four crops (second-year ley, following winter wheat, potatoes and spring oats) at four pH levels (4.5, 6.0, 6.5 and 7.5).

Soil health scorecard

The scorecard brings together information about soil chemical, physical and biological properties. The integrated report uses traffic light coding to identify those properties requiring further investigation to determine the management steps needed to minimise potential risks to crop productivity. Here, we report initial testing of the scorecard for those soil properties that already have an established evaluation framework (e.g. soil nutrients, visual evaluation of soil structure score [VESS]). Research continues to develop interpretation frameworks for more soil properties, including biological indicators (e.g. microbial biomass/respiration, nematodes).

Figure 2. Example scorecard for Craibstone: effect of soil pH (averaged across the four different crop types)

Attribute*	pH 4.5	pH 6	pH 6.5	pH 7.5
pH**	4.9	6.1	6.6	7.5
SOM (%)	10.3	10.1	10.3	10.3
Ext. P (mg/l)**	22	11	10	15
Ext. K (mg/l)**	127	130	146	154
Ext. Mg (mg/l)**	18	74	106	121
VESS score**	2	1	2	1
Earthworms (number/pit)**	1	5	5	6

Investigate Monitor No action needed

*SOM: Soil Organic Matter – comparison to 'typical' levels for the soil type and climate; Partnership project 2 **ahdb.org.uk/greatsoils** Ext. P, K & Mg: Extractable Phosphorus, Potassium and Magnesium; See '*The Nutrient Management Guide - RB209*' for specific crop advice, **ahdb.org.uk/nutrient-management-guide-rb209** VESS: Visual Evaluation of Soil Structure – limiting layer score; **www.sruc.ac.uk/info/120625/visual_evaluation_of_soil_structure** Earthworms: total number of adults and juveniles; >8/pit = 'active' population for arable or ley/arable soils; Partnership project 2 **ahdb.org.uk/greatsoils**
**Attributes that showed a statistically significant difference between treatments (P<0.05)

The results show a clear effect of low soil pH on several soil properties – particularly nutrient availability and biological activity, as indicated by the number of earthworms. Measures of soil microbial biomass supported this finding, with the highest biomass measured at pH 6.5 and the lowest at pH 4.5. Intermediate levels were measured at pH 6 and 7.5, although a robust interpretation framework for this property has yet to be developed. There were also differences between crop types, with earthworm numbers being significantly lower in the potato crop and organic matter levels lowest in the oats grown before the three-year grass ley.

Crop yields also reflect the differences in pH, with highest yields attained between pH 5.5 and 6.0 (Figure 3).

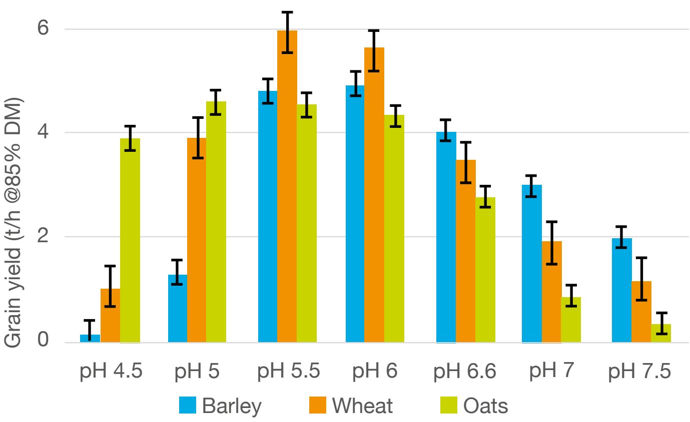

Figure 3. Cereal grain yield (48 year average)

Figure 4. Variation in crop growth with pH varying from 7.5 (left) to 4.5 (right). Growth of spring barley crop tails off at the high pH (left) and particularly the low pH (right)

Future work

Analysis of other soil biological properties continues. The scorecard is also being evaluated at other long-term sites to determine the effect of organic material additions, crop rotation, tillage and drainage status on soil health.

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