Soil Testing in the Lab

Dr Steffi Carter

First published 27th May 2020

The soil testing was completed last year by Gordon Lennie at the Department of Agriculture – project partner on the soil project, who did a fantastic job handling so many samples on his own! Time constraints meant that I had to put on the lab coat myself this summer to get most of the soil tests completed – but not without some much-appreciated preparation work and guidance from Gordon.

Fortunately, I had a brilliant lab assistant – Kate Stenning – and we quickly got the hang of it and worked out an efficient routine. There were eight tests for a total of 88 samples to complete. In order to tackle this enormous job, we mainly went through one test at a time but a few tests had overnight stages; these we had to carry out simultaneously with others, which certainly increased the organisational challenge.

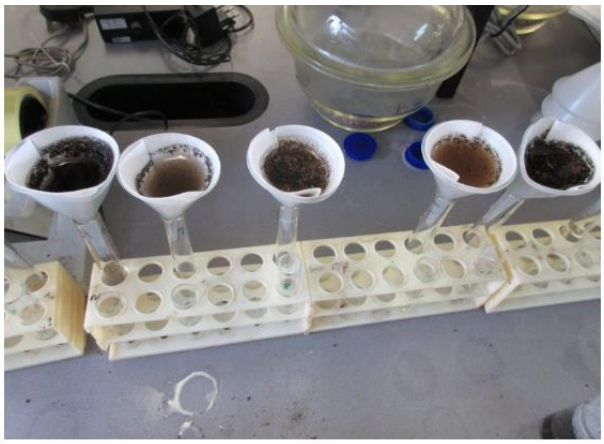
Steffi Carter carrying out chloride test.

Kate Stenning weighing samples for the organic matter test.

.

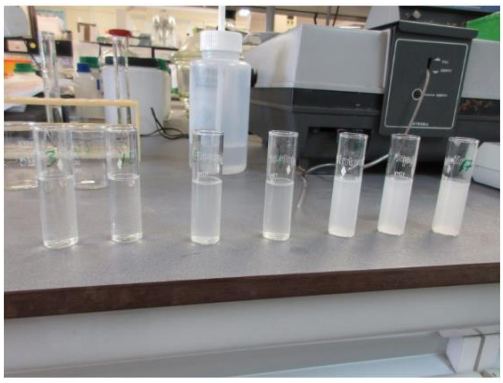
Analyses for nitrate, phosphate, potassium (aka NPK) and magnesium were carried out with Palintests and were quite straightforward: You combine a certain amount of soil with water and relevant extraction powder or tablets, shake it well for a minute or two, filter it and then you have your extract.

Filtering to obtain the extract.



Filtering to obtain the extract.

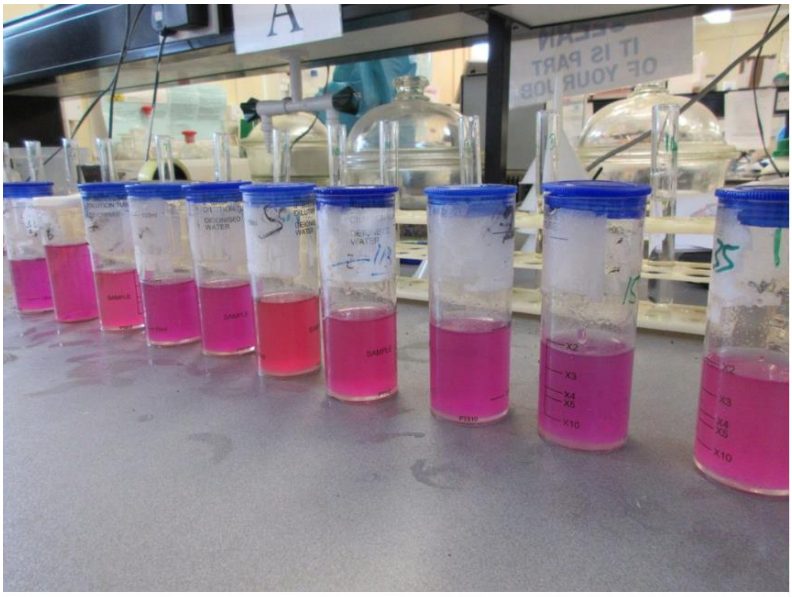
This extract is then either diluted or not (depending on the test) and relevant tablets are added, crushed and the whole solution stands for 2 or 10 minutes (depending on the test). The colour of the solution then changes and the vial is inserted into a photometer and a percentage – determined by spectrophotometry of colour intensity and optical scattering of light beam – is read off the photometer and cross-referenced with a table to get the final value in mg/L. The images below show potassium (cloudy) and magnesium (orange).



Test for potassium; the cloudier the solution, the higher the potassium content in the soil sample.

Test for magnesium; the stronger the orange, the higher the magnesium content in the soil.

Testing for calcium and chloride was a bit more challenging because the tests were more subjective. Palintests were used again but it does not involve a photometer. Into the diluted extract you add one tablet at a time and watch the colour change from pink to purple for calcium and yellow to brown for chloride. This sounds easier than it is and it takes a while to get your eye in. In the image below (photo 7) the sixth samples from the left has not completed its transformation into the final purple, therefore it needed an additional tablet which meant it had a higher calcium concentration than the other samples.



Test for calcium content

Determining the organic matter (OM) content of the soil samples is based on simple science: you place a known amount (in weight) of dried soil into the furnace at 500 °C for a minimum of 6 hours or overnight and then re-weigh the ash afterwards. The difference between the two is the OM content. Here comes the critical bit: the high temperature in the furnace burns off all writing from the crucibles so you need to place them in the furnace in a distinctive pattern so you know which sample is where and make drawings in the lab book to keep track of it all.

Look at the image below, for instance. The crucibles on the left show the oven-dried soil, the ones on the right the ash. The sample in the top left corner has a very high OM content, the oven-dried soil weighed 5.8878 g. the ash weighed 0.8033; the OM content therefore is 86.3% of the dried soil. You can also see how much this sample was reduced in volume. In contrast, the sample below it has a comparably low OM content of 30%.

What surprised me the most were the differences in colour and texture of the dried soils and the ash. All soil samples were taken from the top 20 cm of the soil profile, which in the Falkland Islands is a peat soil most of the time. Nonetheless, there is an extraordinary variation, which becomes apparent when dried soil or ash from different samples are compared. The different layers in Photo 9 show ash from different soil samples (thank you for the idea, Kate!).

Determining the organic mater content of the samples; dried samples on the left and ash after several hours in the furnace on the right.

Soil sample ash layered up in a jar; each layer came from a different sample.

Determining unrubbed (UR) fibre >0.149 mm was probably the most time consuming test. All samples for UR fibre were frozen upon arrival in the lab so that the test can be conducted on a moist sample. Once thawed, two subsamples, each weighing 10 g, were measured. One went into the oven to be dried, the other one was added to a flask with 200 ml of de-ionised water and 2 g of Calgon; this was left over night. The Calgon acts as a dispersing agent to improve the separating of particles. The next day the flask was shaken thoroughly and then poured into a brass sieve No. 100 (opening 149 microns). Hydrochlorid acid (2%) was added to dissolve any carbonates present in the soil and the sieve with all remaining particles were placed into the oven to be dried. The percentage of dried UR fibre >0.149 mm of the dried soil was then calculated.

Determining unrubbed fibre content; samples in water with Calgon were left overnight.

We left the pH test until the end because we were waiting for a brand-new electrode to be delivered from the UK and it arrived just in time. We determined the pH of the samples in water (H_2O) and in calcium chloride ($CaCl_2$). 10 g of soil are added to either 50 ml of water or 45 ml of water plus 5 ml of $CaCl_2$. After one hour the pH can be read with a pH meter.

Determining pH; samples were left for one hour before the readings could be taken with a pH meter.

All tests were completed in good time. The lab results as well as the field soil descriptions have been handed over to project partner Matt Aitkenhead at the James Hutton Institute in Aberdeen, Scotland, who will use the data to produce lots and lots of maps over the next few weeks. Watch this space…