Application Note
Soil

interline
spectroscopic analytical solutions

Introduction

Society demands sufficient food of good quality produced in a sustainable way. This requires knowledge about the actual soil nutrient status, so that proper nutrient application rates can be recommended. Compared to traditional soil testing techniques, NIR analysers provide a much more cost-efficient solution. They can run a large amount of samples in a short time with an analysis time per sample of less than one minute.

Analyser: The FT-NIR AgriQuant

The AgriQuant FT-NIR analyser is used for non-destructive analysis of heterogeneous agricultural samples. The lidded glass bottle can be used for archiving the sample and recording the NIR-spectrum at the same time. To ensure consistency and analysis of a large amount of the sample, the sample is mixed during analysis.

The analyser is powered by the latest ABB Bomem FT-NIR technology and measures the entire spectrum of the sample, i.e. in the range 14000-3800 cm^{-1} (700-2600 nm). It generates a large amount of high-quality spectral data, which makes it possible to precisely determine multiple components.

With no scheduled maintenance for five years, the AgriQuant is practically maintenance-free. It is equipped with parts with a long lifetime. For instance, the laser and NIR source have an expected lifetime of ten years.

AgriQuant is operated with the InfraQuant software, which makes it easy for everybody to work with analyses. Two clicks with the mouse is enough to make the analysis. Among the features is a wizard that guides the operator through the program, spectra are displayed right away, and sample information and trends can be reviewed easily.

Calibration Performances, Example

The sample preparation consisted of drying overnight at 40 °C and crushing (particle size < 2 mm). The spectra were recorded in the range of 10000-3750 cm^{-1} (1000-2666 nm) at a resolution of 16 cm^{-1}. The samples were scanned on a large rotating bottle accessory. Fifty scans were averaged during spinning, scanning an area of about 8 cm^2. The NIR spectra were pre-processed using a first derivative (Savitsky-Golay).

Due to the large range for the constituents the reproducibility for the chemical reference analysis is not constant. For example, dune sands usually have organic matter contents < 5 g kg-1, while peat soils can have organic matter contents of about 600 g kg-1. For both soil types different reproducibilities are found and needed. The prediction error (SEP) will vary accordingly. Consequently, the SEP values are set absolute at low ranges and relative at high ranges.

Source: Blgg Oosterbeek, The Netherlands

	Range, low	SEP, absolute	Range, high	SEP, relative
LOI (g kg-1)	1-60	3	61-721	5%
TOC (g kg-1)	0-40	2	41-180	5%
TIC (g kg-1)	0-5	0.5	6-60	10%
TN (g kg-1)	0-5	0.3	6-25	6%
TS (g kg-1)	0-3	0.15	4-7.7	5%
Clay (g kg-1)	0-300	15	301-642	5%

Table 1: Example of component ranges and obtained accuracy LOI (humus) = loss on ignition, TOC = total organic carbon, TIC = total inorganic carbon, TN = total nitrogen, TS = total sulphur, clay = particle size < 2 μ

Conclusion

The AgriQuant FT-NIR analyser is designed for analysing soil, compost and similar. The bottled sample is mixed during analysis to ensure consistency and to see a large amount of the sample, which will lead to reliable and stable results. The results are obtained in less than one minute on multiple components. This eliminates individual analysis on each constituent and saves manpower, training and time. The analysis can be automated using transport belt, bar code reader or radio frequency tagging.

Due to large regional differences, global models for soil have proven to be difficult, whereas local models work well. A large amount of calibration samples must be foreseen to make the application work as described above.

The Dutch central laboratory Blgg uses the concept profitably:

- We trust the Q-Interline systems as an important tool of the daily routine. Blgg runs 180,000 successful analyses on the Q-Interline systems every year, says Herman Vedder, Scientist R&D, Blgg, and continues: A third of these samples are soils. To get the soil application within specs was really hard work. An important factor for the successful introduction of this application was the instrumentation.

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