

**FT-NIR**

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## Fast and Effective Alternative FT-NIR Spectroscopy Method for Quantifications of Fertilizer Parameters (Nitrogen, Phosphorus, Kalium and Magnesium)

compost carryover is therefore important for cost-effective soil fertility planning. This study investigated aspects of nutritive carryover such as nitrogen (N), phosphorus, Magnesium (Mg) and Kalium (K) in compounded forms. For the past decades, UV-VIS and Atomic absorption spectrometers were commonly used. The content of elements such as K, B, Mg were analysed using AA or P,N using UV post sample digestion, and the concentration can be expressed as weigh% of oxide form or elemental form. However, due to increasing industry demand in rapid quality control in laboratory, Fourier Transform Near Infra-Red (FT-NIR) were developed in quantitation of the respective compounds. In addition, it is more environments friendly using FT-NIR compared with colorimetric UV-VIS and AAS spectroscopic methods.

### Introduction

In plantation industry, compost or fertilizer is essential raw materials because crop yield is severely affected by the supplied compost or fertilizer. It plays a central role in organic soil fertility plans but is bulky and costly to apply. Determining

## Experimental

### Fertilizer Mixture Preparations - Calculated Percentages of P/K/N/Mg

Ten different fertilizer mixtures with various percentages of N, P, K and Mg were prepared based on the table as shown below from the straight fertilizers of ERP (Eppawala Rock phosphate), containing 28% P<sub>2</sub>O<sub>5</sub>; MOP (Muriate of Potash), containing 60% K<sub>2</sub>O; SOA (Sulphate of Ammonia), containing 21% N and Kieserite, containing 27% of MgO (Table 1).

### Instrument Settings and Chemometrics Calibration Models

Fertilizer samples were analyzed with Near Infra-Red accessory (NIRA) accessory on a PerkinElmer Frontier model FT-IR (Figure 1a). The measurements were made with 32 scans at 8 cm<sup>-1</sup> resolution for NIRA over the wavelength range of 10000-4000 cm<sup>-1</sup>. Calibration models of the compounded forms of N, P, K and Mg were performed using PerkinElmer Spectrum Quant Advanced Chemometrics software. The N, P, K and Mg calibration models were normalized with the PerkinElmer proprietary Absolute Virtual Instrument (AVI) instrument feature. With the present of AVI, it allows calibration models to be shared and transferred from one instrument to another with minimal bias correction or slope adjustment of the calibration lines. And thus, re-calibration or re-validation of quantitative models issues that plagues dispersive grating-type Near Infrared (NIR) instruments were completely resolved with this technology.

Table 1. Multiple components mixing ratios for samples (New Mix1-10) with the straight fertilizers (ERP - Eppawala Rock phosphate), MOP - Muriate of Potash, SOA - Sulphate of Ammonia, GML - Kieserite) for calibration models.

	P <sub>2</sub> O <sub>5</sub> (%)	K <sub>2</sub> O (%)	N (%)	MgO (%)
ERP	28	0	0	0
MOP	0	60	0	0
SOA	0	0	21	0
GML	0	0	0	27
New Mix1	6.21	22.18	4.43	5.33
New Mix2	0	10.24	17.41	0
New Mix3	12.52	5.32	0	12.52
New Mix4	3.43	42.86	3.43	0
New Mix5	22.39	3.73	0	3.73
New Mix6	3.41	13.66	13.66	0
New Mix7	0	42.4	6.16	0
New Mix8	9.2	0	0	18.2
New Mix9	4.1	0	0	23.06
New Mix10	0	8.53	11.38	8.53

NIRA accessory is designed to direct the diffusely reflected beam from the sample in an internal detector so that the components absorbed by the sample can be measured (Figure 1b). For quantitative FT-NIR application, NIRA approach works well in percentage level to give an accurate FT-NIR prediction.

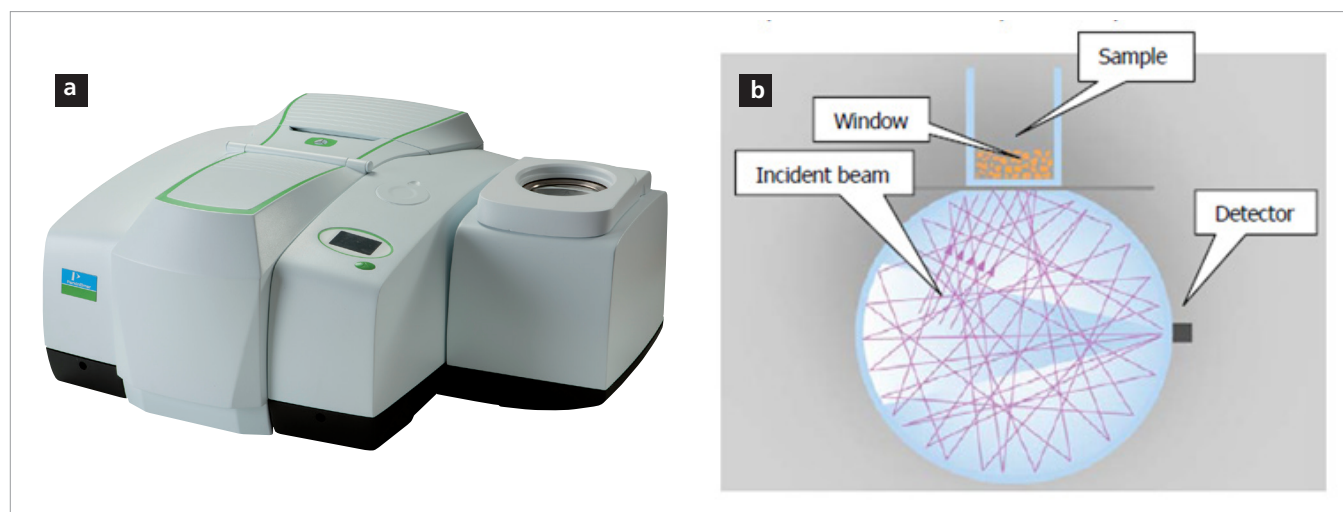


Figure 1. PerkinElmer Frontier FT-NIR System with Near Infra-Red Accessory (a: NIRA-left) and NIRA (b: right).

## Results

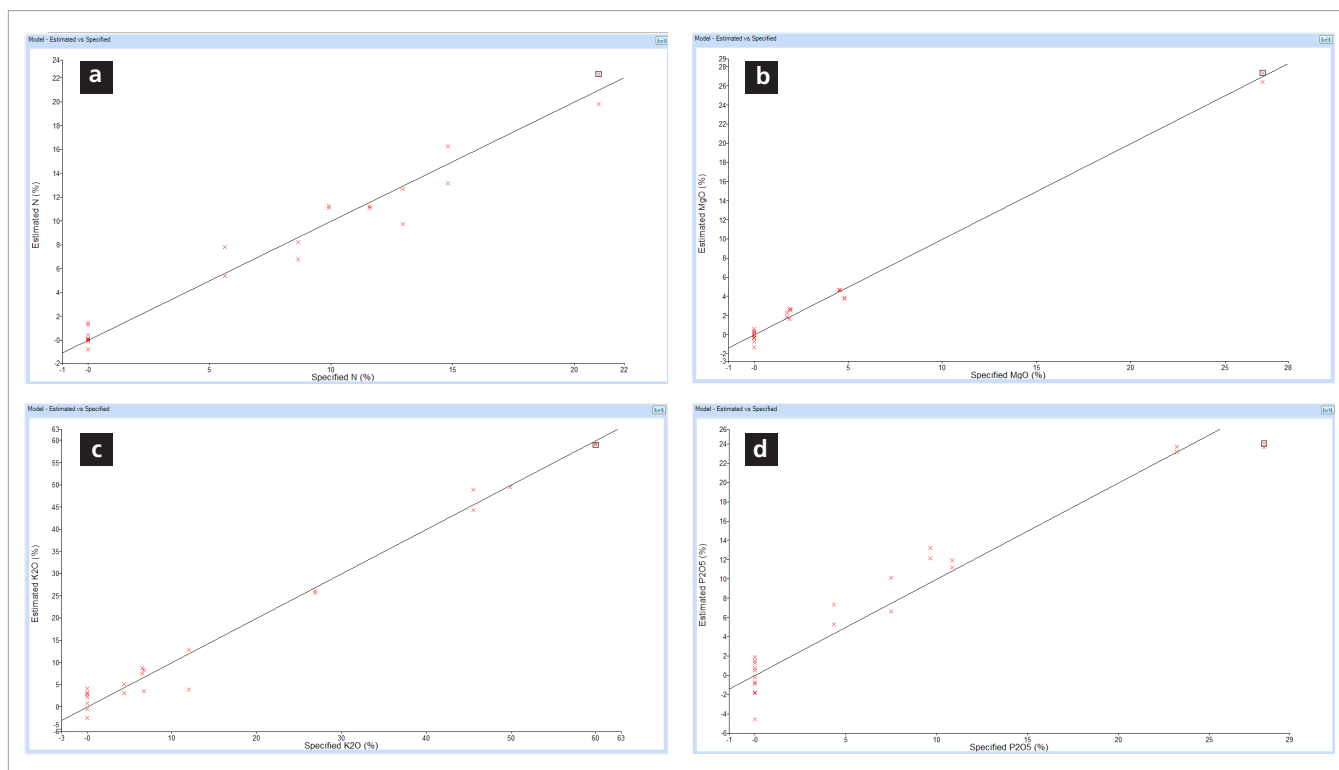


Figure 2. Calibration Models for Fertilizers of N, MgO, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O.

Table 2. FT-NIR-NIRA Method Calibration Summaries for Fertilizer Application.

Property	FT-NIR-NIRA Method % Variance (R Squared)
N	96.86%
MgO	99.40%
K <sub>2</sub> O	98.54%
P <sub>2</sub> O <sub>5</sub>	94.54%

FT-NIR-NIRA method worked well for the fertilizer application (Figure 2). The calibration models of the required parameters shown above depicted high % variance (Table 2). It could be further improved with more samples in order to bring down the standard error of predictions (SEP).

### Conclusion

PerkinElmer FT-NIR Analyser with the NIRA accessory provides an alternative rapid analytical tool for the determinations of N, P, K and Mg of fertilizer.