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Application Note 28020307

High Throughput, Low Interference Nutrient Analysis for Soil and Plant Samples Using Continuous Flow Analysis

Keywords
Agriculture
Continuous Flow Analyzer
Crop Management Practices
Drinking Water
FS 3100
Flow Solution
Nutrient Pollutants
Pasture Runoff
Plant Extraxts
Soil Extracts
Wastewater

Presented at the 2007 Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Chicago, IL February 25–March 1, 2007

Introduction

Recent increases in demand for soil testing and plant analyses are driving nutrient management regulations and associated requirements for environmental monitoring. The benefits of regular environmental examination are easily recognizable to the agricultural industry. A program of soil and plant analyses at defined intervals can eliminate unnecessary expenditures on fertilizers by preventing excessive plant nutrient loss to surface and groundwater runoffs.

Relative concentrations of nutrients (such as total nitrogen, nitrate-nitrogen, and total and extractable phosphorus) and essential cations (including aluminum, magnesium, manganese, and potassium) are used to evaluate plant health and soil/water quality for improved crop management. Manual colorimetric methods, which are often time-consuming and offer poor reproducibility, have traditionally been used to evaluate the levels and effects of these analytes. Interferences in extracted sample matrices can also impair analytical accuracy and may lower yields in target analyses. Such limitations tend to restrict the use of these analyses as a routine agricultural management practice.

Accordingly, the agricultural industry needs instrumentation that can efficiently automate large numbers of nutrient analyses and provide the reliable data necessary for sound crop management practices. In this application note, results were obtained employing an OI Analytical Flow Solution® FS 3100 Automated Ion Analyzer (shown in Figure 1). Soil/plant extracts and pasture runoff samples were examined using USEPA continuous flow analysis (CFA) methods developed to monitor nutrient pollutants in drinking water and wastewater samples.

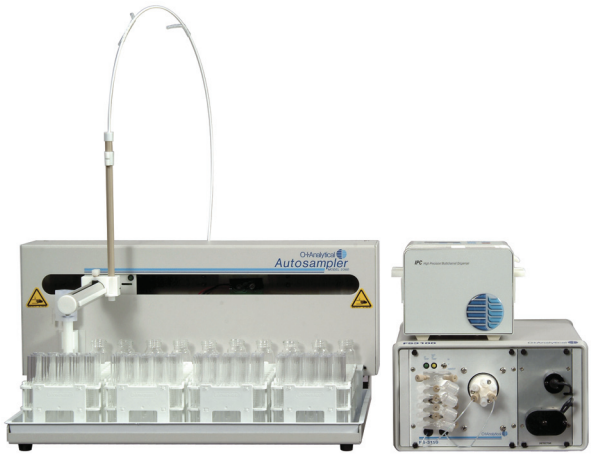

Figure 1. FS 3100 System

Experimental

Apparatus

OI Analytical Flow Solution® FS 3100 Automated Nutrient Analyzer, consisting of the following components:

- Model 3360 Autosampler: 360-position XYZ autosampler
- 16-Channel Precision Pump: multi-channel peristaltic pump
- Flow Injection Analysis (FIA) Module
- Expanded Range™ (ER) Photometric Detector
- VersaChem Multi-Test Manifold™
- Ammonia, Nitrate, and Phosphate Chemistry Kits
- Data Acquisition System with WinFLOW™ Software

Method Summary

Nutrient analyte evaluations were performed using OI Analytical FIA methods developed and validated for EPA drinking water and wastewater samples. Tested sample matrices consisted of pasture runoff and soil/plant extracts. Runoff water samples were filtered through 0.45-µm filters, while plant and soil samples were obtained through 2 N potassium chloride (KCl) extracts.

Results

When compared to the standard calibration curves, the calibration curves of the selected nutrients in Figures 2–4 indicate that the agricultural data produce results consistent with drinking water and wastewater samples. Tables 1–3 illustrate that the correlation associated with tests for the presence of ammonia, nitrate, and phosphate in agricultural samples falls within EPA regulatory limits and is exemplary, even when compared to the analyses of conventional EPA samples. In addition, due to minimal testing interference, the accuracy of these analyses exceeds requirements for agronomy and soil science applications of the derived data.

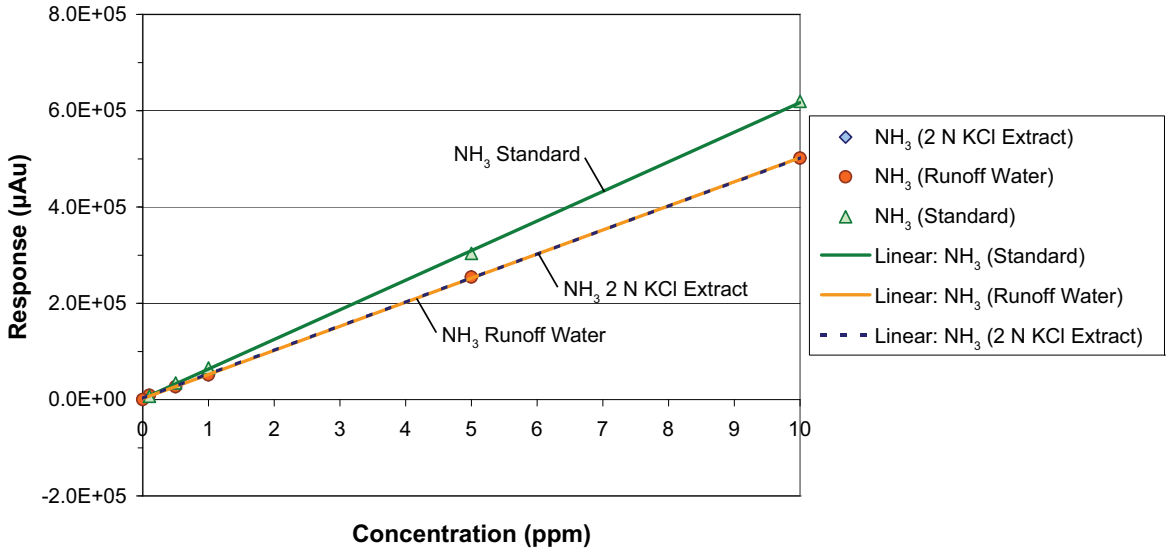

Figure 2. Ammonia Calibration Curves

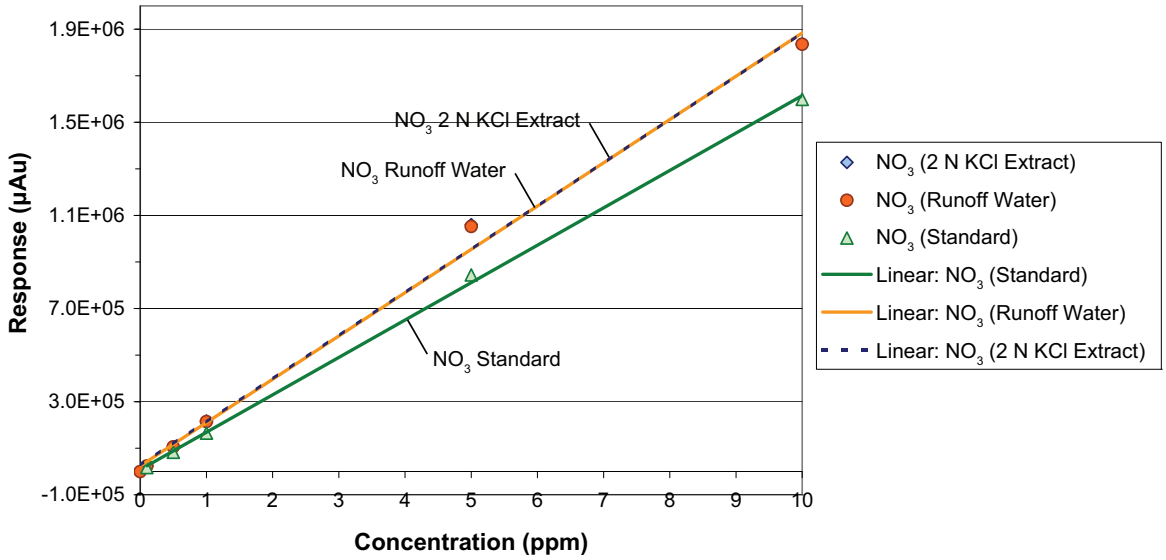

Figure 3. Nitrate Calibration Curves

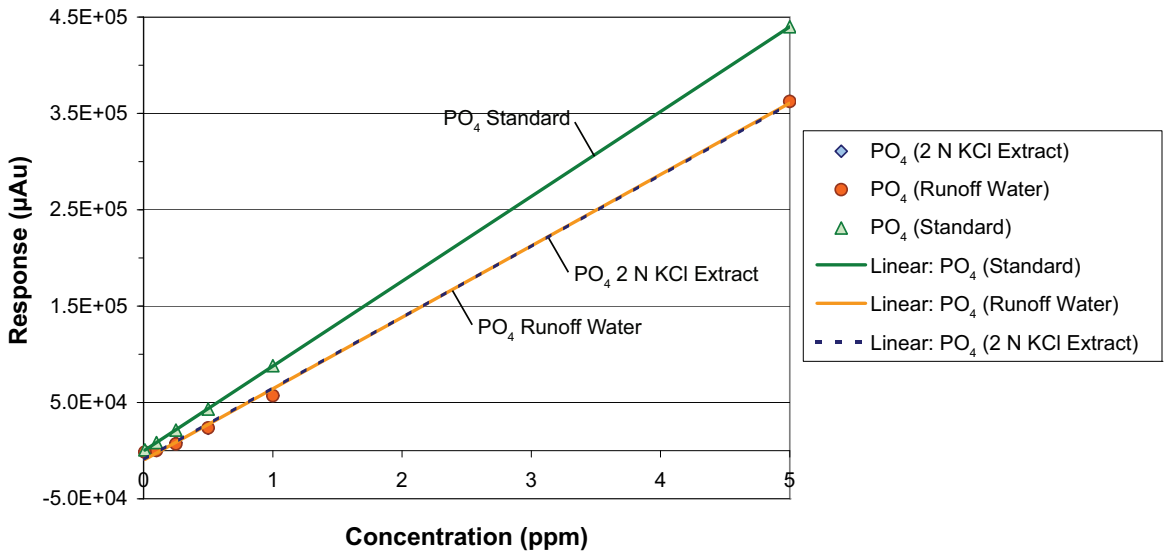

Figure 4. Orthophosphate Calibration Curves

Table 1. Runoff Water

Analyte	Concentration Range	Correlation Coefficient	Accuracy
Ammonia	0.01–10 mg	0.9999	101% at 5.0 ppm
Nitrate	0.1–10 mg	0.9994	106% at 5.0 ppm
Phosphate	0.01–5 mg	0.9993	85% at 0.5 ppm

Table 2. 2 N KCl Soil/Plant Extracts

Analyte	Concentration Range	Correlation Coefficient	Accuracy
Ammonia	0.01–10 mg	0.9999	75% at 5.0 ppm
Nitrate	0.1–10 mg	0.9976	83% at 5.0 ppm
Phosphate	0.01–5 mg	0.9976	86% at 0.5 ppm

Table 3. Standard EPA Samples

Analyte	Concentration Range	Correlation Coefficient
Ammonia	0.01–10 mg	0.9998
Nitrate	0.1–10 mg	0.9992
Phosphate	0.01–5 mg	0.9999

Summary and Conclusions

To be of practical use in agricultural settings, tests for nutrients in soil/plant extracts and pasture runoff waters must be attainable through accurate and reliable methods. The results indicate that USEPA-approved methods for drinking water and wastewater samples were successfully extended to monitor soil/plant extracts and pasture runoff samples using an automated ion analyzer and existing CFA techniques.

References

1. Vietor, D.M., T.L. Provin, R.H. White, and C.L. Munster. Runoff losses of phosphorus and nitrogen imported in sod or composted manure for turf establishment; *J. Environ. Qual.* **2004**, 33, pp 358–366.
2. OI Analytical FS 3100 Automated Methods for the Determination of Ammonia, Nitrate, and Orthophosphate.

Acknowledgements

Our thanks to Ronnie Schnell and Omar Harvey of the Texas A&M Department of Soil and Crop Sciences for producing the data used in this poster.

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Publication 28020307