Application Note

Instrument: TruMac® CNS

Determination of Carbon, Nitrogen, and Sulfur in Plant Tissue

LECO Corporation; Saint Joseph, Michigan USA

Introduction

Nitrogen and sulfur are considered essential macro nutrients for plant development, playing key roles in the formation of enzymes and proteins. Determination of carbon, nitrogen, and sulfur concentrations in crop plant tissue provides an important diagnostic tool to the grower, giving an indication of nutritional health and nutrient uptake efficiency from the soil, as well as an avenue for monitoring high-value, intensively managed crops such as tobacco, cotton, and fruits. Often the combination of the carbon, nitrogen, and sulfur analysis in both the crop plant tissue and surrounding soil will be used to diagnose and correct any nutritional-related growth issues. Historical plant tissue carbon, nitrogen, and sulfur analysis can provide valuable information to aid in decisions regarding fertilizer management and crop nutrient use.

Sample Preparation

A representative, uniform sample is required. Samples should be ground to pass a No. 100 (149 µm) sieve.

Accessories

528-203 Combustion Crucible, 502-321 Com-Cat™

Calibration Sample

502-654 BBOT, 502-298 Sulfamethazine, or other suitable pure compounds.

Analysis Parameters

Furnace Temperature	1350 °C
Dehydration Time	0 seconds
Purge Cycles	3

Element Parameters

	Carbon	*Nitrogen*	*Sulfur*
Baseline Delay Time	0 s	10 s	0 s
Min. Analysis Time	18 s	35 s	15 s
Endline Time	2 s	2 s	2 s
Conversion Factor	1.00	1.00	1.00
Significant Digits	5	5	5
IR Baseline Time	1 s	—	1 s
TC Baseline Time	—	10 s	—

Burn Profile

Burn Cycle	*Lance Flow*	*Purge Flow*	*Time (s)*
1	Off	On	5
2	On	On	End

Ballast Parameters

Equilibrate Time	30 s
Not Filled Timeout	300 s

Aliquot Loop

Equilibrate Pressure Time	4 s

Procedure

1. Prepare instrument for operation as outlined in the operator's instruction manual.
2. Determine blank.
   a. Enter 1.0000 g mass into Sample Login (F3) using Blank as the sample name.
   b. Add ~1.0 g of 502-321 Com-Cat™ into a 528-203 Crucible.
   c. Transfer crucible to the appropriate position of the sample carousel.
   d. Repeat steps 2a through 2c a minimum of five times.
   e. Initiate the analysis sequence (F5).
   f. Set the blank using the last three results following the procedure outlined in the operator's instruction manual.

   Note: The standard deviation of the last three blanks should be less than or equal to 0.001% (10 ppm). Additional blanks beyond the recommended five may be required in order to achieve the recommended precision.
3. Calibrate.
   a. Weigh 0.15 to 0.25 g of pure compound calibration sample (BBOT, Sulfamethazine, etc.) into a 528-203 Crucible.

   *Note: Multi-point (fractional weight or multiple calibration samples) may be used to calibrate if desired. Typically single-point calibration using a pure compound provides a suitable and cost-effective calibration. Refer to the operator's instruction manual for details regarding multi-point cal*ibration.

   b. Enter sample mass and identification into Sample Login (F3).
   c. Tare balance, add ~1.0g of Com-Cat™ to the crucible and thoroughly mix with the sample.
   d. Transfer crucible to the appropriate position of the sample carousel.
   e. Repeat steps 3a through 3d a minimum of three times.
   f. Initiate the analysis sequence (F5).
   g. Calibrate the instrument using single standard calibration (fixed at origin) following the procedure outlined in the operator's instruction manual.
4. Analyze Samples.
   a. Weigh ~0.25 g of plant tissue into a 528-203 Crucible.
   b. Enter mass and identification information into Sample Login (F3).
   c. Tare balance, add ~1.0 g of Com-Cat™ to the combustion crucible and thoroughly mix with the sample.

d. Transfer crucible to the appropriate position of the sample carousel.
e. Initiate the analysis sequence (F5).

Note: Carbon, Nitrogen, and Sulfur results for Plant material samples are typically reported on a dry basis. Therefore, either the materials must be dried prior to analysis or the moisture content determined using a thermogravimetric analyzer and entered during the Sample Login procedure. Samples are typically dried at between 80 °C and 85 °C for two hours prior to analysis.

*Typical Results**

Name	*Mass (g)*	*% Carbon*	*% Nitrogen*	*% Sulfur*
LECO 502-055	0.2536	50.33	2.04	0.152
Orchard Leaves	0.2512	50.34	2.04	0.150
@ 50.5% C, 2.04% N,	0.2547	50.33	2.06	0.157
0.146% S	0.2512	50.28	2.05	0.152
	0.2526	50.32	2.05	0.157
	Avg =	***50.32***	***2.05***	***0.154***
	s =	***0.02***	***0.01***	***0.003***
LECO 502-082	0.2538	46.01	2.56	0.603
Tobacco	0.2560	46.10	2.54	0.606
@ 46.16% C, 2.53% N,	0.2501	46.11	2.53	0.604
0.58% S	0.2545	46.02	2.53	0.595
	0.2572	45.94	2.52	0.597
	Avg =	***46.03***	***2.53***	***0.601***
	s =	***0.07***	***0.01***	***0.005***
LECO 502-273	0.2497	44.57	3.45	0.271
Alfalfa	0.2485	44.69	3.40	0.262
@ 44.8% C, 3.38% N,	0.2502	44.60	3.38	0.253
0.24% S	0.2514	44.67	3.39	0.244
	0.2496	44.60	3.38	0.240
	Avg =	***44.63***	***3.40***	***0.254***
	s =	***0.05***	***0.03***	***0.013***

**Based on a single standard, force through origin calibration utilizing LECO 502-897 BBOT. Results reported on a dry basis.*

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Form No. 203-821-539 9/22—REV1