Choosing the scan number and wavelength range for routine analysis of plant tissues

G.D. Batten,[a] S. Ciavarella[a] and A.B. Blakeney[b]

[a]*NSW Agriculture, Yanco Agricultural Institute, PMB Yanco NSW 2703, Australia.*

[b]*BRI Australia Ltd, PO Box 7, North Ryde NSW 2113, Australia.*

Introduction

The analysis of rice and wheat shoot tissue by near infrared (NIR) spectroscopy is now an integral step in crop nitrogen management. The NIR technique was chosen because it is rapid and inexpensive and allows simultaneous determination of many constituents. At peak times, the rice NIR Tissue Test laboratory receives up to 300 samples per day and improvements in handling efficiency must be implemented.

Sample grinding time has been reduced from 65 to 42 seconds per 25 g sample by changing to a more powerful mill.[1] Here we report the advantages and disadvantages of time-saving scanning options.

Methodology

A scanning spectrometer model 6500 (NIRSystems) operating with NSAS software and supplied with power conditioned to 240 volts ± 3% Linear Load (Uninterruptible Power System SOLA 610) was used in this study to:

(1) check instrument noise in relation to scans per sample and

(2) scan less than the full spectrum, in the wavelength range from 1100 to 2500 nm only.

Results

Instrument noise test

Figure 1 indicates that noise tended to increase when fewer than eight scans were averaged. This is well below the default setting of 32 and could effect a time-saving of 10 to 15 seconds per sample (Figure 2).

Scanning range

A further time saving of one to two seconds can be gained by only scanning the NIR region of the spectrum (Figure 2). This option may not be available on other NIR software programs.

Predicting total N in ground rice samples

The nitrogen calibration used to test all 5500 samples in the 1999 Rice Tissue Test was used to predict the %N in:

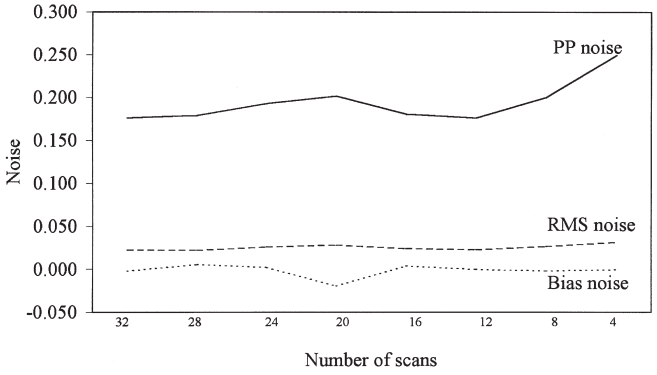

Figure 1. Noise vs number of scans per sample. PP (Peak-to-Peak) noise: the distance from the lowest valley to the highest peak reported in milliabsorbance units. The noise average across the wavelength scan. Bias noise: The difference from 0 absorbance. RMS noise: The root mean square of the noise measured in milliabsorbance units across all wavelengths scanned.

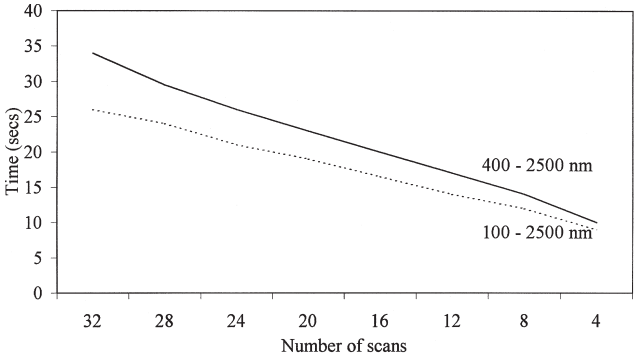

Figure 2. Analysis time and wavelength range vs number of scans per sample.

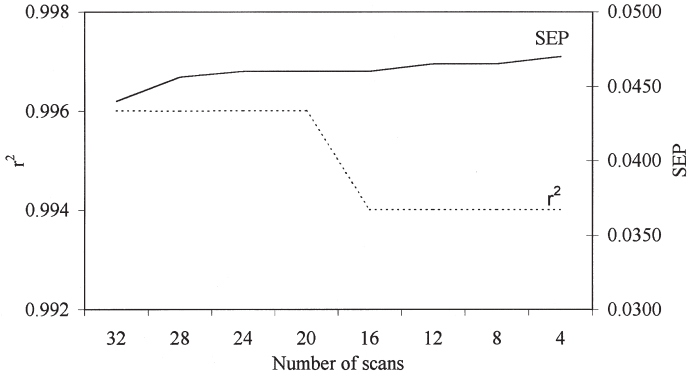

Figure 3. r^2 and *SEP* vs number of scans per sample.

Table 1. Total %N from single scans.

Sample No.	Laboratory Value %N	NIR Value %N	Residual
1	2.350	2.349	–0.001
2	2.350	2.356	0.006
3	2.350	2.350	0.000
4	2.350	2.329	–0.021
5	2.350	2.339	–0.011
6	2.350	2.348	–0.002
7	2.350	2.341	–0.009
8	2.350	2.351	0.001
9	2.350	2.353	0.003
11	2.350	2.339	–0.011
12	2.350	2.352	0.002
13	2.350	2.356	0.006
14	2.350	2.358	0.008
15	2.350	2.334	–0.016
16	2.350	2.340	–0.010
17	2.350	2.359	0.009
18	2.350	2.348	–0.002
19	2.350	2.349	–0.001
20	2.350	2.353	0.003
21	2.350	2.344	–0.006
22	2.350	2.345	–0.005
23	2.350	2.361	0.011
24	2.350	2.351	0.001
25	2.350	2.354	0.004
26	2.350	2.318	–0.032
27	2.350	2.341	–0.009
28	2.350	2.336	–0.014
29	2.350	2.344	–0.006
30	2.350	2.333	–0.017
31	2.350	2.326	–0.024
32	2.350	2.327	–0.023

(1) a verification set of 24 samples scanned 4, 8, 12, 16, 20, 24, 28 and 32 times. The r^2 and *SEP* for each verification are summarised in Figure 3. Reducing the scans had relatively small effects on r^2 and the *SEP*.
(2) a single rice sample (RTT99-27) when analysed 32 times using a single scan. The laboratory value was 2.350 %N, the predicted values ranged from 2.318 to 2.358 and the mean was 2.345 ± *SD* = 0.011 (Table 1). This amount of variation is negligible compared to plant to plant variation in a rice crop and would not reduce the reliability of N-fertiliser recommendations provided to rice producers.[2,3]

Conclusions

We estimate that the number of samples analysed per hour could be increased from 60 to 100 by averaging only eight scans per sample in the NIR range (1100 to 2500 nm). If scan time is reduced then packing of cells becomes the limitation to sample throughput. Further time savings of up to 20 seconds per sample could perhaps be achieved by presenting the sample to the NIR spectrometer in a plastic bag or using a fibre optic probe. Both options would eliminate the need to pack an NIR cell and position it over the detector.

References

1. A.M. Allan, A.B. Blakeney, G.D. Batten and T.S Dunn, *Communications in Soil Science and Plant Analysis* **30(15/16),** 2123 (1999).
2. G.D. Batten, A.B. Blakeney and S. Ciavarella, in Temperate Rice-Achievements and Potential, Ed by E. Humphries, E.A. Murray, W.S. Clampett and L.G. Lewin. NSW Agriculture, Griffith, Australia, p. 473 (1994).
3. A.B. Blakeney, G.D. Batten and S. Ciavarella, in *Temperate Rice-Achievements and Potential*, Ed by E. Humphries, E.A. Murray, W.S. Clampett and L.G. Lewin. NSW Agriculture, Griffith, Australia, p. 477 (1994).