

*Nitrogen content in fresh rice leaves collected from three locations was measured by near infrared spectroscopy.*



## **South Korea: Determination of total nitrogen content in fresh rice leaves using visible and near infrared spectroscopy**

*The taste of rice is deeply related to its protein content, which is affected by the nitrogen content of the soil and fresh rice leaves. Thus nitrogenous fertilizing is becoming an issue for rice cultivation. The purpose of the research was to give guidance to rice farmers.*

### **Abstract**

Nitrogen content in fresh rice leaves collected from three locations was measured by near infrared spectroscopy. Using all samples, the determination coefficients ( $R^2$ ) of calibration equations were 0,879, 0,858 and 0,819 for samples collected from Iksan, Buan and Joungeup. After elimination of outliers, an improved calibration equation could be obtained. The  $R^2$  were 0,896, 0,878 and 0,880 for Iksan, Buan and Joungeup respectively. The  $R^2$  calculated from the combined samples from the three locations was 0,911.

### **Introduction**

In nutrition diagnosis of rice, nitrogen content has traditionally been measured through the drying and pulverization of fresh rice leaves. To avoid those procedures, the aim is to replace conventional analysis by near infrared spectroscopy (NIRS).

NIRS is one of the non-destructive methods for analyzing the interior and exterior characteristics of samples. This technique does not normally require extraction, filtration, dilution, reagent reaction or heating, and measured samples

can be recovered undamaged.<sup>1,2</sup> NIRS can also be used to observe changes during storage and processing of the same sample over a short period of time. Since no chemicals are used, NIRS prevents environmental pollution. In the past, some reports confirmed that nitrogen content in leaves, especially for forage, could be precisely determined by NIRS.<sup>3-5</sup>

### **Materials and methods**

*Samples* Rices (*Oryza sativa* var. *Dongjin1hobyeo*) and some other varieties maturing in early, mid and mid-late



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Region	N	Mean (%)	Range (%)	SEC (%)	N1-VR	SECV (%)
Iksan	150	3,583	2,58-4,47	0,156	0,832	0,193
Buan	101	3,229	2,37-4,04	0,173	0,878	0,199
Jeongeup	116	3,748	2,91-4,80	0,170	0,813	0,206
Total	367	3,532	2,16-4,76	0,153	0,863	0,195

Table 1. Results of validation test for determining total nitrogen content by partial least squares method in different rice groups  
SEC: standard error of calibration, SECV: standard error of cross validation, 1-VR: 1-variance ratio

Region	Outlier elim.	Bias	Slope	SD (%)	SEP (%)	N	R <sup>2</sup>
Iksan	Before	-0,004	0,997	0,477	0,166	153	0,878
	After	0,000	1,000	0,471	0,152	150	0,896
Buan	Before	-0,011	1,010	0,491	0,184	103	0,858
	After	-0,000	1,000	0,484	0,168	101	0,878
Jeongeup	Before	0,004	0,953	0,473	0,202	120	0,819
	After	0,001	1,001	0,479	0,165	116	0,880
Total	Before	-0,001	0,976	0,522	0,174	376	0,889
	After	0,001	0,995	0,525	0,157	369	0,911

Table 2. Calibration by partial least squares method in fresh rice leaves

SD: standard deviations, SEP: standard error of prediction, N: number of samples



season were used. Sampling was done at three locations including Iksan, Buan and Jeongeup. Sowing was done on 30 April 2004 and transplanting on 30 May 2004. The planting space was 30 x 15 cm. Samples were collected on 1, 6, 12, 19 and 26 July.

**NIR measurement and calculation**  
NIR spectra were measured with an NIR spectroscope model NIRSystems™ 6500 from FOSS. Spectra were measured in reflectance mode (400-2 500 nm) using half cup. A partial least squares (PLS) calibration equation was developed on first derivative spectra (1,4,4,1) using WinISI 1.5 software from Infrasoft International.

**Chemical analysis** Nitrogen content in fresh rice leaves was measured by Kjeldahl method using a FOSS Kjeltac™ 1035.

## Results and discussion

The spectra of various samples collected for comparison varied according to location and validation test. Tables 1 and 2 show that average nitrogen content, 1-VR and SECV values were similar for all locations. Bias, slope and R<sup>2</sup> values after outlier elimination were higher than before elimination, while standard deviation (SD) and standard error of prediction (SEP) values were low. However, average Global H values did not reveal a clear tendency. SEP limit and bias limit values were unchanged

## Conclusion

NIRS can be used to replace conventional analysis of nitrogen content in fresh rice leaves. The implementation of NIRS will help reduce the amount of chemicals and labour required. Moreover, samples can be used after analysis.

## References

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## Facts

Jeollabuk-do (North Jeolla) is a province in the southwest of South Korea, in the Honam region. The provincial capital is Jeonju, with a population of around 2 000 000. The province's western plain is one of South Korea's most important granaries. Besides rice cotton, barley and hemp are grown.

The province's Rural Development Administration employs 185 people. It has been focusing on development techniques for cultivating high-quality agricultural products at low cost, and on implementing the practical use of these techniques.

Kyungpook National University is in the city of Daegu. Established in 1951, it has some 24 000 students and a faculty of 825.

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