Using remote sensing to measure mid-season rice crop nitrogen status

Brian Dunn[A], Remy Dehaan[B], Tina Dunn[A] and Andrew Robson[C]
[A] NSW Department of Primary Industries, Yanco NSW 2703
[B] Charles Sturt University, Wagga Wagga, NSW 2650
[C] University of New England, Armidale, NSW 2350

Introduction

In the Australian rice industry the application of nitrogen at panicle initiation is an important practice that impacts grain yield and profitability. Applying too much nitrogen to rice grown in southern Australia can be uneconomical and increase the risk of low temperature induced pollen sterility, which reduces grain yield. Rice growers have been utilising a tissue test service where they physically collect plant samples at panicle initiation (PI) which are analysed in a lab and nitrogen topdressing recommendations then sent to the growers. Only 30% of growers use the service with many saying the requirement to physically sample the crop is a major reason why it is not used. Remote sensing offers a potential opportunity to determine PI nitrogen uptake with reduced physical sampling while also identifying variability in nitrogen uptake across the field.

Materials and Methods

This research is investigating how accurately nitrogen uptake of rice at PI can be predicted using remote sensing sources collected on the ground, and from drones, aircraft and satellites. Each year a series of experiments were established with a range of nitrogen rates applied across several commercial rice varieties, to create rice plots with a large range of nitrogen uptake levels at PI. The plots were measured at PI using several remote sensing instruments and physical plant samples collected. The relationships between the remotely sensed data and the physically measured nitrogen uptake at PI was investigated. Multi-season correlations have been developed between the data and measured nitrogen uptake at PI for several multispectral and hyperspectral systems (Table 1).

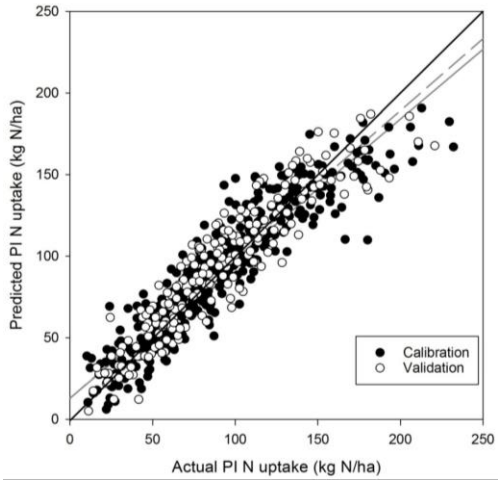
Table 1. The instruments used to collect remotely sensed data from the nitrogen experiments.

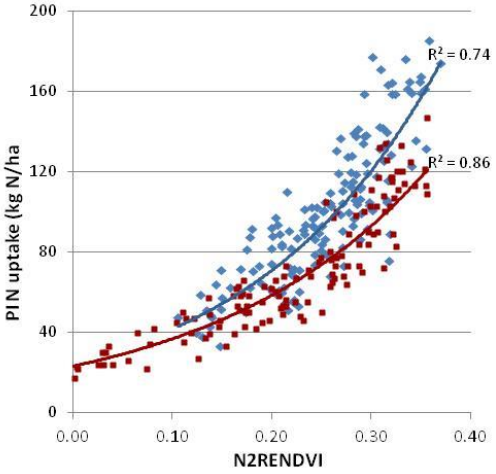
Remote sensing instrument	Collection method	Bands	Data collected
SVC 1024	Ground	Hyperspectral (330–2500 nm)	3 seasons
Greenseeker	Ground	NDVI	2 seasons
Aerial NDVI	Aerial	6 bands (490-900 nm)	3 seasons
micaSense	Aerial	4 bands with red edge	2 season
HyVista Hymap	Aerial	Hyperspectral (430–2450 nm)	1 season
Worldview 3	Satellite	8 bands (400–1040 nm)	3 seasons

Results and Discussion

The PI nitrogen uptake prediction obtained from three years of hyperspectral data (SVC 1024) was very encouraging with PI nitrogen uptake able to be predicted with an $r^2 = 0.86$ and RMSEP of 16.46 kg N/ha (Figure 1). There are currently no hyperspectral sensors available that are commercially viable but the data was used to determine the four wavelengths that were most significant in the full hyperspectral prediction (Dunn *et al*, 2016).

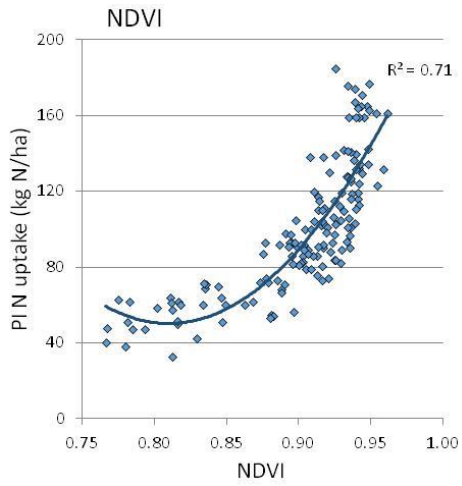
The Worldview 3 satellite and the newly released micaSense RedEdge camera have been tested for their abilities to predict PI nitrogen uptake. Both of the sensors measure the red edge, which is a narrow band of reflectance (710–740 nm) that corresponds to the rapid change from low red reflectance to high near infrared (NIR) reflectance. This band is very sensitive to plant stress and provides information on the chlorophyll and nutrient status of plants.

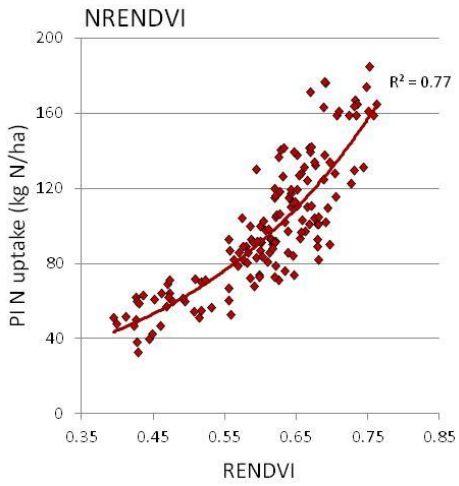




Figures 1 & 2. Hyperspectral data and Worldview 3 relationships with PI N uptake.

Data collected with the micaSense RedEdge camera was used to develop relationships between NDVI and Red Edge NDVI and PI nitrogen uptake (Figures 3 & 4). When using NDVI to measure rice PI N uptake, as PI N uptake goes above 90 to 100 kg N/ha the NDVI saturates and no difference in the NDVI reading occurs (Figure 3). This does not occur with RENDVI (Figure 4).





Figures 3 & 4. NDVI and Red Edge NDVI relationships with PI N uptake.

Conclusion

This research has proven that remote sensing does have a role to play in determining PI N uptake for making informed nitrogen topdressing decisions. The level of physical sampling required is still being determined. Research into incorporating remote sensing options into current PI nitrogen topdressing decision making systems is continuing.

This research is part of an ongoing Rural Industries Research & Development Corporation (RIRDC) research project.

References

Dunn BW, Dehaan R, Schmidtke LM, Dunn TS and Meder R (2016). Using field-derived hyperspectral reflectance measurement to identify the essential wavelengths for predicting nitrogen uptake of rice at panicle initiation. *Journal of Near Infrared Spectroscopy:**24,** 473-483*