Handheld short wavelength near infrared spectroscopy in horticulture

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Introduction

Short wavelength near infrared spectroscopy (SWNIRS) has been implemented in fruit packhouses for quality control on a number of attributes (e.g. fruit sugar and dry matter content), but assessment after harvest occurs too late to influence agronomic practice. We report on the development of a handheld NIRS unit and an exploration of application areas.

Materials and methods

A handheld technology was benchmarked against an in-line technology (InSight, Colour Vision Systems, Australia) of similar operating principle (halogen light source, interactance optics, 400–1000 nm wavelength region, approx. 10 nm wavelength resolution, data processed as second derivative of absorbance). Two development generations of the handheld technology were assessed [iQ and Nirvana (Figure 1)].

Figure 1. The Nirvana unit.

Table 1. Instrument repeatability. (600–1000 nm wavelength region).

Unit	Repeatability (mA)	Apple TSS PLS mode	
		R_c	*RMSECV*
In Sight	1	0.98	0.50
iQ	20	0.97	0.55
Nirvana	1	0.98	0.50

Measurement repeatability was assessed as the standard deviation of 30 repeated measures of a white tile. Field performance was assessed in terms of a partial least squares regression (PLSR) calibration developed across four independent populations of fruit, used in prediction of another population of fruit, maintained at different (tropical!) temperatures and light levels, and in terms of prediction of a further set of eight populations from different growing regions across the course of an Australian summer fruit season.

Results and discussion

The Nirvana unit possessed a repeatability value similar to the in-line InSight unit, with improvement over the earlier iQ unit, which was ascribed to improvement in the lamp timing and referencing procedure (Table 1).

The improved repeatability did not result in a similar increase in model performance on intact apple TSS (Table 2), but good model robustness in prediction of independent data sets was demonstrated (Figure 2).

The units were used to (a) monitor fruit maturation of selected (tagged) fruit in a given orchard in the weeks leading up to harvest; (b) assess average fruit maturity across blocks; (c) assess variability in fruit maturation in relation to canopy position; and (d) monitor picking crew effectiveness

Table 2. Instrument performance across varied environmental conditions, in prediction of % DM of intact mango fruit.

Condition	R_p	*RMSEP*
28 °C, indoor	0.95	0.86
28 °C, diffuse sun	0.95	0.86
38 °C, full sun	0.94	0.88
On tree	0.95	0.86

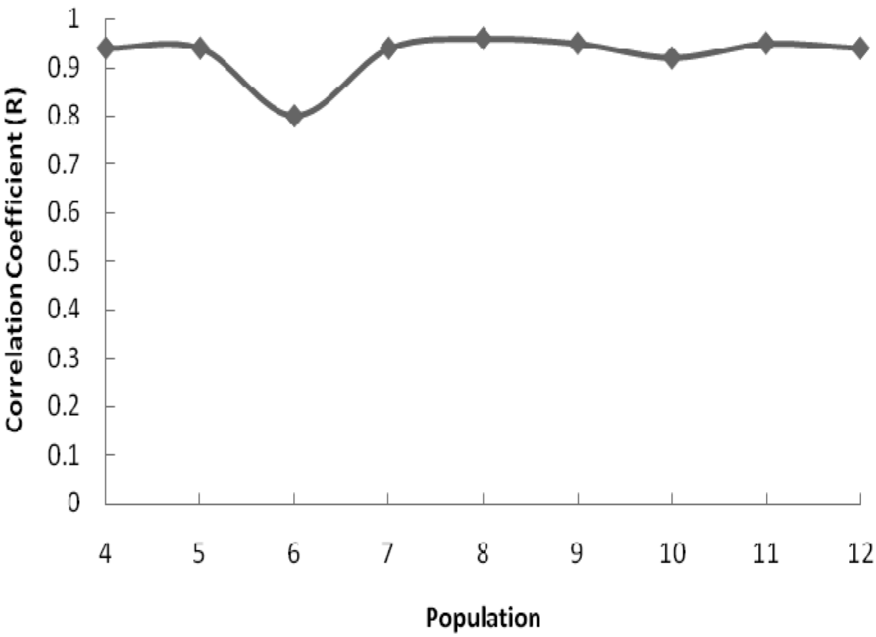

Figure 2. DM model performance (R) in prediction of independent populations.

(e.g. maturity of fruit in bin relative to that of fruit remaining on tree). These measures were used to guide time of harvest and within tree harvest procedure. Assessment procedures have been developed to estimate the maturity accurately within the tree or aspects of the tree, and also the maturity across blocks. As expected, fruit assessed as of high dry matter or flesh colour ripened quicker than low dry matter/flesh colour fruit, to fruit of lower Brix and perceived flavour.