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Use and Development of NIR spectroscopy for quality assessment on oats

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Introduction

In addition to assessing agronomic characteristics of breeding lines in the field it is important to determine grain quality characters relevant to end use. High throughput phenotyping is desirable particularly within the winter oat breeding programme where a rapid turn around is required from harvest to re-sowing. NIR technology provides a method to screen for grain quality characters within our oat breeding programme. Our aim was to demonstrate that both laboratory and static field NIR instruments can be used to screen whole oats or groats for various traits.

Material and Methods

Laboratory based NIR

Using a FOSS NIRSystems 6500 instrument c. 20 g of sample was scanned in a transport quarter cup. Calibration equations were developed for oil and nitrogen content in the whole groat using samples originating from 9 harvest years, multiple sites and including both spring and winter varieties. Equations were also developed to predict β-glucan content in whole groats and kernel content in whole oats using samples from 2 harvest years.

Static field NIR

A Haldrup system incorporating a Zeiss Corona diode array NIR instrument was used to scan c. 300 g of sample. An equation to predict oil in whole oats was developed using samples from a single harvest year and including both naked and whole oats.

Equations were developed for each instrument using standard normal variate and detrend and second derivative transformations using partial least squares (PLS) regression. The performance of equations was assessed using cross validation and the RPD (ratio of the standard deviation of laboratory data and the standard error of cross validation (SECV)).

Results

Calibration statistics for the equations developed to date are shown in Table 1. It is clear that we have working calibrations (RPD > 3) for selection for oil or nitrogen content in the whole groat. Calibrations for β-glucan and kernel content require further development but currently may be adequate to identify potentially high lines to be analysed by wet chemistry.

Table 1 Calibration statistics

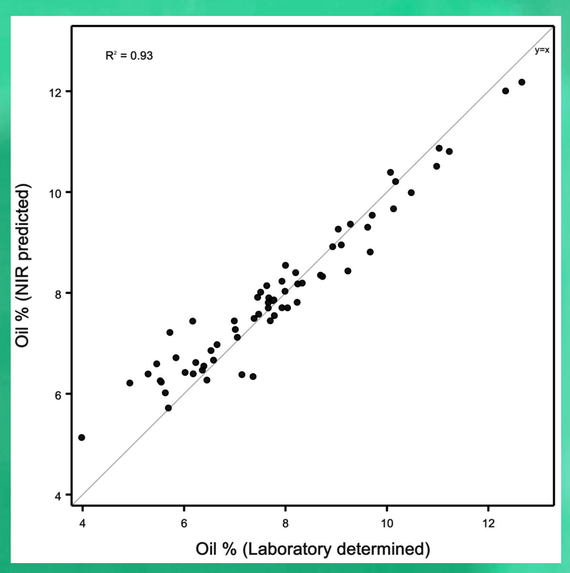
Constituent	n	Mean	Range	F	SECV	R^2	RPD
Laboratory based NIR							
Oil (%)	888	7.45	2.79 – 12.11	9	0.43	0.92	3.6
Nitrogen (%)	869	1.84	0.80 – 2.87	12	0.09	0.94	3.9
β-glucan (%)	271	4.42	2.27 – 6.57	9	0.39	0.70	1.8
Kernel content (%)	233	75.4	68.1 – 82.8	8	1.24	0.74	2.0
Static field NIR							
Oil (%)	117	9.49	7.34 – 12.73	8	0.35	0.91	3.3

n = Number of samples in calibration; F = Number of factors in calibration model; R^2 = Squared correlation coefficient (cross validation)

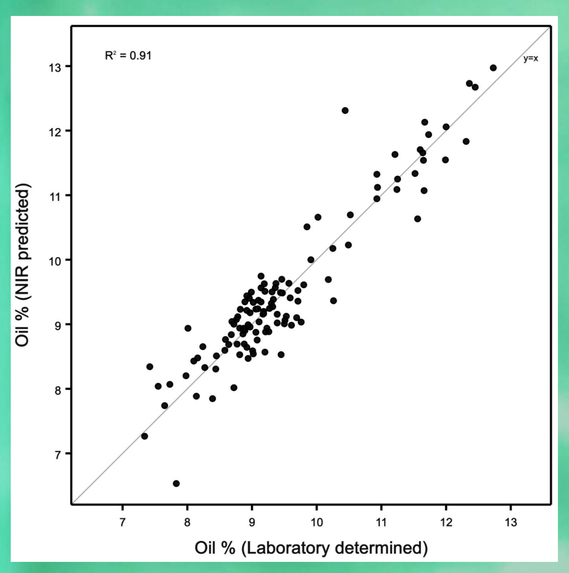
Figure 1 shows the relationships between NIR predicted and laboratory determined oil contents for each instrument. For the laboratory based NIR the samples were from an independent validation set whilst the static field NIR figure represents the calibration set. There is evidence to support using the static NIR for selection on the basis of oil.

Figure 1 Relationship between predicted and measured oil contents

a) Laboratory based NIR (n=65)



b) Static field NIR (n=117)



Conclusions

The laboratory NIR provides a route to more rapid phenotyping of oats and the static field NIR shows potential in this area. Equations for oil and nitrogen using laboratory based NIR are in routine use. Further calibrations will be developed to cover nitrogen, kernel content and β-glucan for the static field NIR with the ultimate aim of implementing these at the harvesting stage.

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