Winter Oilseed Grower Bulletin #5: Brassica NIRS models for determining pennycress seed contents – Potential tool for the elevator

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NEAR INFRARED SPECTROSCOPY (NIRS) is an industry-wide technique used commonly in the analysis of seeds for oil, protein, fiber and glucosinolate content for rapid, cheap, and accurate phenotyping. The initial plan was to develop NIRS calibration equations specific to pennycress; however, we soon realized that we did not have the wide range of variation required for developing calibrations. Calibration development is also expensive and requires a large seed supply and long timelines. Therefore, in order to quickly screen a large mutant pennycress population, we tested the hypothesis that readily available Brassica calibration equations for NIRS could be used as a proxy to qualitatively assess the chemical diversity within these populations. As a result, we found that Brassica NIRS calibration equations can indeed be used to make predictions for pennycress seed composition. While the NIRS predicted values of the wild-type line MN106 for total oil, protein, and glucosinolate content did not exactly match the wet lab analysis values, there was consistent agreement between NIRS predictions and wet lab analyses on the pennycress line MN106 (Table 1).

Table 1: Seed composition determined using wet lab analysis and NIRS predictions for the wild-type line, MN106.

Traits	Mean (SD) – Wet Lab	Mean (SD) - NIRS
Total Oil Content (%)	31.50 (±1.48)	32.64 (±1.16)
Total Protein Content (%)	23.22 (±0.60)	25.12 (±0.49)
Total Glucosinolate Content (µmol/g)	111.12 (±18.28)	105.85 (±5.27)

We further used this approach to evaluate the utility of Brassica NIRS on the mutant population that exhibited the variation for oil, protein and glucosinolate content (Chopra et al. 2019), followed by wet-lab analysis on lines selected to represent the range of variation. On comparing the NIRS values with the wet lab estimations, we observed strong correlations for the oil (0.92), protein (0.82) and glucosinolate (0.78) content (Figure 1). These correlations demonstrate the usefulness of Brassica NIRS data to evaluate pennycress populations at harvest.

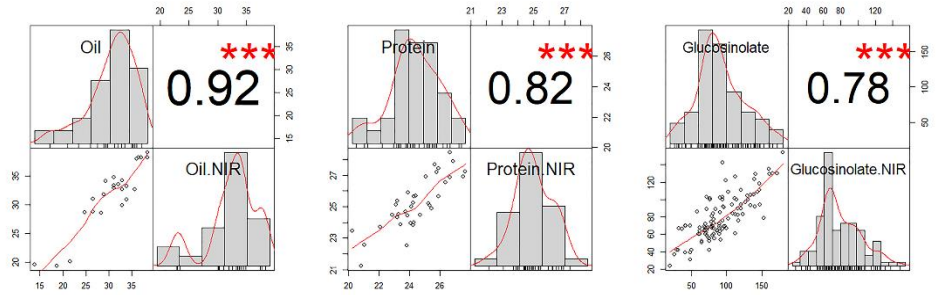

Figure 1: Histograms representing the distribution of the predicted and wet lab values for oil, protein and glucosinolate content and the correlation plot between the predicted and wet lab values of the selected mutants. The top left panel for each trait represents the range of selected lines for wet-lab validation, while bottom right panel for each trait represents the range of selected lines from the NIRS predictions. The bottom left panel for each trait displays the scatter plot showing the correlation between the predicted and wet lab values and the top right panel for each trait displays the r value with the level of significance.

References:

Chopra R, Folstad N, Lyons J, Ulmasov T, Gallaher C, Sullivan L, McGovern A, Mitacek R, Frels K, Altendorf K, Killam A, Ismail B, Anderson JA, Wyse D, Marks MD. The Adaptable Use of Brassica NIRS Calibration Equations to Identify Pennycress Variants to Facilitate the Rapid Domestication of a New Winter Oilseed Crop. Industrial Crops and Products, 2019