

Quantification of Roots by the Use of NIR Hyperspectral Imaging and Chemometrics

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Introduction

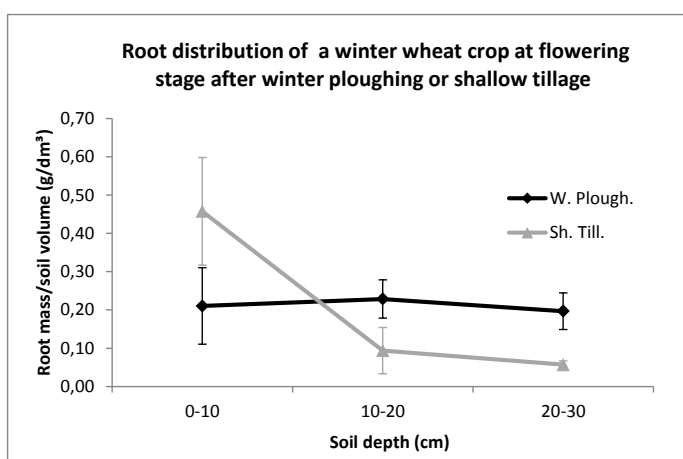
Estimation of root system development is often based on the soil coring method which allows repeated measurements during the growing season in the field as well as in different soil horizons. However, this method is limited due to the time needed to extract roots from soil cores and to manually sort them from crop residues before quantification. To avoid this tedious sorting step and remove operator subjectivity, a procedure based on NIR Hyperspectral Imaging (NIR-HSI) has been developed.

Material and Methods

After soil core washing, remaining elements, mainly roots and crop residues, were dried and laid on a conveyor belt under a push broom NIR-HSI camera (Eylenbosch *et al.*, 2014). Spectral data were then analyzed by a classification tree based on successive SVM models in order to characterize root spectra from other spectra coming from residual soil particles or crop residues. Finally, a linear equation allows converting the number of pixels detected as root in a mass of root by soil volume.

Results and Discussion

The procedure was applied on samples taken on a soil depth between 0 and 30 cm under a winter wheat crop in a long term trial on different tillage types. Results showed an important save of time allowing to handle more samples, a good discrimination of root spectra (92% of root spectra were well detected) and a good correlation between pixels detected as root and quantity of root in the sample ($R^2 = 0.98$). Predictions showed a homogeneous distribution of roots in the soil profile (0-30 cm) with winter ploughing and a concentration of root in the top soil (0-10 cm) with shallow tillage. These results are helpful to understand how crops adapt their root system after different types of tillage. Confusion between spectra of crop residues and roots were however observed, mainly in border areas of residues.



Conclusions

The method based on NIR-HSI and chemometrics allows rapid comparisons of quantities of winter wheat roots after different tillage types. However predicted quantities of roots must be used carefully when crop residues are present in samples because of spectral confusion. Based on spectral data, this method could easily be used with other crops. Preliminary studies have already been done with faba bean and associated crops of winter wheat and pea.

Eylenbosch D, Fernández Pierna JA, Baeten V, Bodson B (2014) Detection of wheat root and straw in soil by use of NIR hyperspectral imaging spectroscopy and Partial Least Square discriminant analysis. In: *Proceedings of the ESA XIIIth Congress*, Debrecen, Hungary, pp. 237-238. (<http://hdl.handle.net/2268/173128>)