Application of NIR hyperspectral imaging combined to chemometrics to assess the impact of tillage on the root system development of a winter wheat crop

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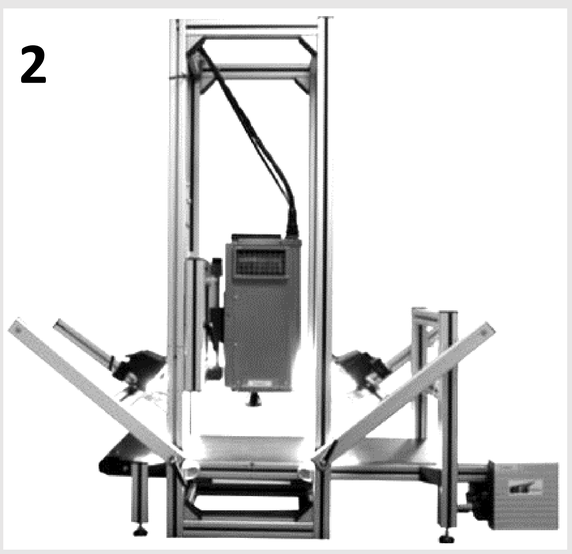
Introduction Nowadays, a better comprehension of the **root system of crops is seen as a major possible way to sustainably improve yields** [1]. So far, only a few techniques allow a precise quantification of the root system of field-cultivated plants. Within this context, this research applies an **innovative procedure of root system quantification of a crop throughout the crop season** consisting in the combination of **Near Infrared Hyperspectral imaging (NIR-HSI) and chemometric tools** [2]. Its major advantage lies in its ability to rapidly perform measurements and to discriminate the roots from other soil elements.

Material and method A total of 384 soil samples were collected by soil coring at 4 different dates during the 2011-2012 crop season in the 0-30 cm soil layer. Two tillage systems were studied : conventional tillage (CT=Ploughing the 0-25 cm soil layer) and reduced tillage (RT=Tillage in the 0-10 cm soil layer). The roots were extracted from cores by washing on sieves. The dried samples (fig. 1) were scanned by a **NIR hyperspectral line scan instrument working in the 1100-2498 nm spectral range and combined with a conveyor belt** (fig. 2). Each obtained image was analyzed by a classification tree (fig. 3) based on successive **Support Vector Machines (SVM) models** to separate the spectra into 4 spectral classes: background, soil, crop residues and roots (fig. 4). Finally, a regression line allowed to convert a number of pixels to grams of roots [2].

1

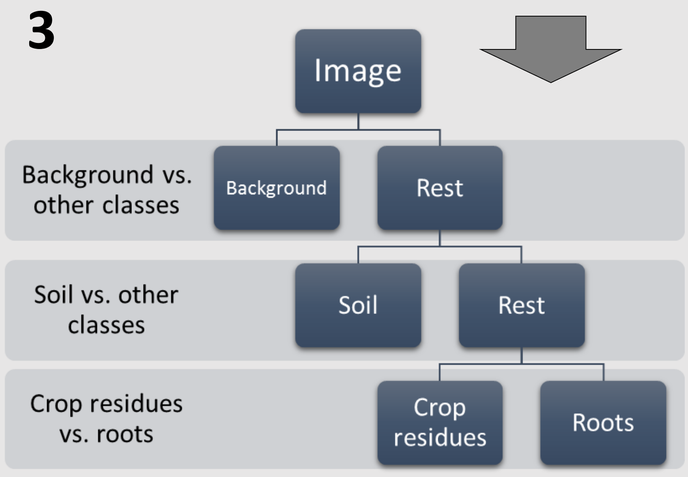
Acquisition of NIR images

2



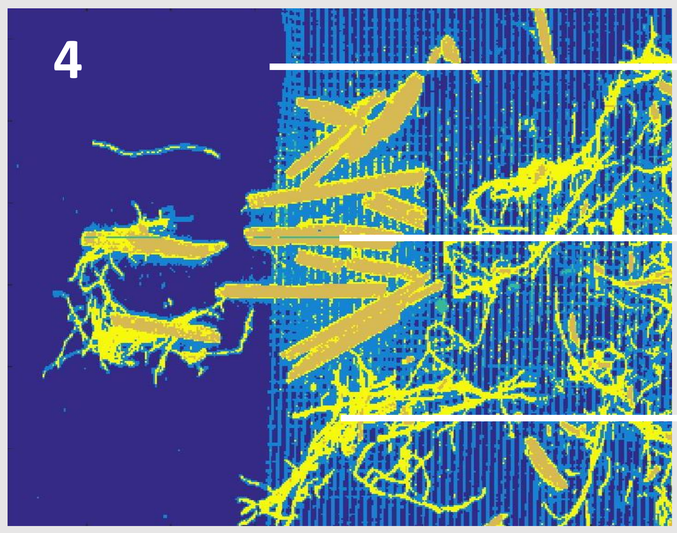
Application of SVM models on NIR images

3

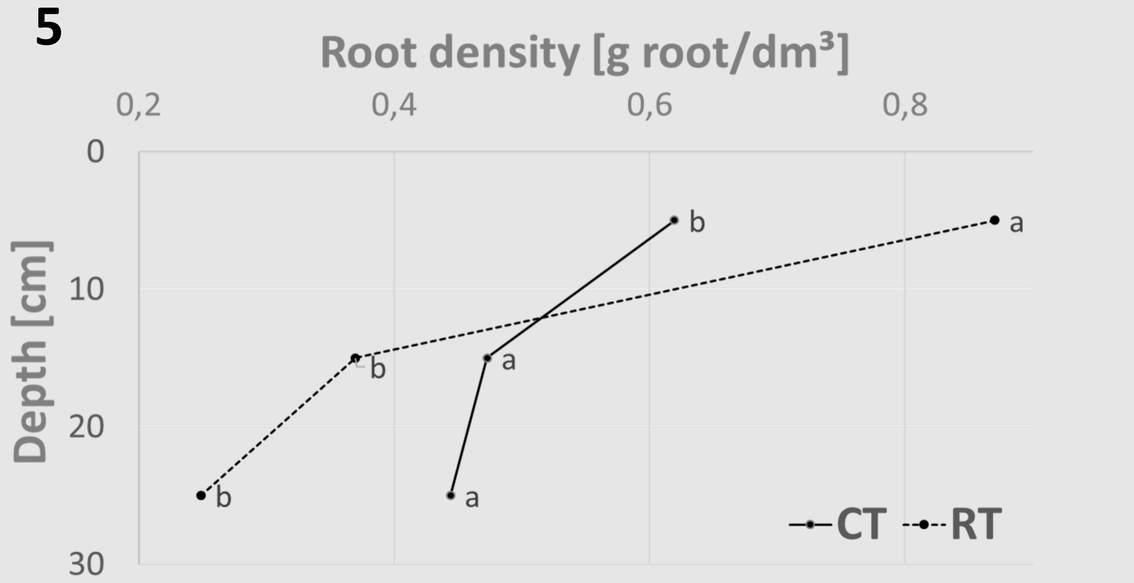


Prediction

4



5



Use of a regression line to convert the number of pixels predicted as roots to root mass

Results and discussion A **significant influence of tillage on the development of the root system was highlighted** (fig. 5 - Within each layer, letters indicate the statistical difference between treatments). The CT allowed a more homogeneous development of the root system in the soil profile compared to RT for which a concentration of the root system in the 10 first centimeters of soil was noticed. This observation was explained by the different soil humidity and density in the two tillage systems.

Conclusion This study highlights the real potential of the root biomass quantification method based on NIR-HSI technology for **agronomical applications related to the soil**. Thanks to this technology, we were able to assess the impact of tillage on the root development of a winter wheat crop.

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References

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