02-02: Multiscale and multimodal spectral Imaging for mapping cell wall polymers in plant organs

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Plants are heterogeneous materials that present a multiscale organization (organs, tissues, cell types, subcellular compartments). Tissues and enclosed cell types are highly specialised and differ from other by structural features. Cell walls whose composition and properties vary according to cell types are of major interest as they are involved in many end-use properties of plant biomass. Histological studies are therefore of major importance for evaluating the quality of plant material. Histology includes measuring morphological information about cells and tissues and investigating the composition of cell walls according to cell types. Spectral imaging is used to reveal variability in the biochemical composition at the cellular level without any labelling of the samples. However, single techniques generally provide a partial characterisation of the plant polymers. More complete information can be obtained by combining several spectral imaging methods [1].

Relating histological measures to end use properties is not an easy task because end-use properties are generally evaluated at a macroscopic scale including plant variability. The need to compare multiple plant samples brings additional constraints. All these multiple sets of images generate large and complex image collections that require the development of adapted methods to analyse them.

The objective of the presentation is to show the development of a multiscale and multimodal strategy to map the heterogeneity of cell wall in maize stems. Macroscopic devices reveal the variability at the scale of a few cm^2: morphological information concerning cell size and vascular bundle distributions was obtained using visible imaging [2] and cell wall phenolic composition was studied by multispectral autofluorescence imaging [3]. At the microscopic scale, multimodal hyperspectral imaging was used to map cells walls in vascular bundles at the microscopic scale [1]. In parallel, enzymatic degradability of cell walls was mapped at the macroscopic scale using visible imaging and at the microscopic scale using both autofluorescence and FTIR imaging [4]. Model sections of the maize stem can be obtained from morphological measures. The integration of multiscale and multimodal information in the model section is discussed.

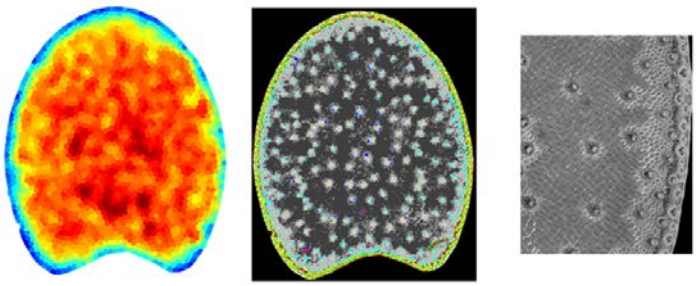

Fig. 1: multiscale and multimodal analysis of maize stem. Left: cell size mapping, middle and right: fluorescence properties mapping at two scales. Left, middle: 17x14 mm^2. Right: 4.3x3.4 mm^2

References

[1] ALLOUCHE, F., HANAFI, M., JAMME, F., ROBERT, P., BARRON, C., GUILLON, F., and M.-F. DEVAUX, 2012: Chemometrics and Intelligent Laboratory Systems, **117**, 200.

[2] LEGLAND, D., DEVAUX, M.-F., and F. GUILLON, 2014: Plos One, **9**, e90673.

[3] CORCEL, M., DEVAUX, M.-F., GUILLON, F., and C. BARRON, 2016: Computers and Electronics in Agriculture, **127**, 281.

[4] DEVAUX, M.-F., JAMME, F., ANDRÉ, W., BOUCHET, B., ALVARADO, C., DURAND, S., ROBERT, P., SAULNIER, L., BONNIN, E., and F. GUILLON, 2018: Frontiers in Plant Science, **9**, 200.