#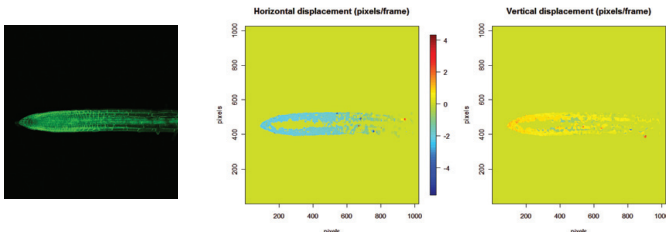 PlantVis: Quantitative motion analysis of time-lapse confocal laser scanning microscopy images: application to plant root growth.

Tracy A. Valentine[1], Nathalie Wuyts[1], Timothy J. Roberts[2], Cheng-Jin Du[2], M. Fraser Bransby[3], Stephen J. McKenna[2], A. Glyn Bengough[1]

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• PlantVis is a flexible image analysis tool developed for estimating motion in confocal microscopy images to sub-pixel accuracy.

• Root growth parameters can be calculated for individual Arabidopsis roots, or for specific zones of the root

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PlantVis: Analysis of motion in time-lapse confocal microscopy images

• PlantVis analysis of time-lapse image sequence (example image Fig. left) produces horizontal (Fig. middle) and vertical (Fig. right) motion estimates for trackable pixels.
• The certainty of each motion estimate being correct is also reported

Data analysis using R (www.R-project.org)

The open source data analysis package R is used to analyse and display the output from PlantVis:
Figs. from left to right, top to bottom
• Tracked pixels over laid on reconstructed image
• Longitudinal velocity of tracked pixels vs. distance from the quiescent centre along the central root spline.
• Radial velocity along spline.
• Step stool function over Absolute velocity along root axis (Peters & Baskin 2006)
• Elemental growth rate

Peters WS, Baskin TI. 2006. Tailor-made composite functions as tools in model choice: the case of sigmoidal vs bi-linear growth profiles. Plant Methods 2: 11-24
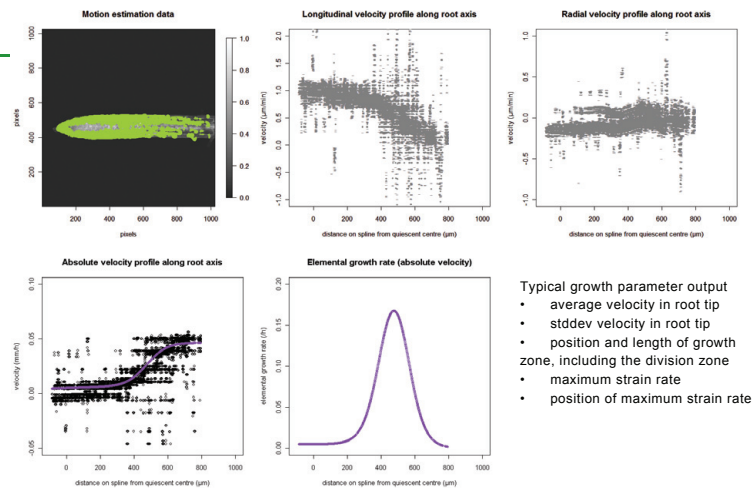
Typical growth parameter output
• average velocity in root tip
• stddev velocity in root tip
• position and length of growth zone, including the division zone
• maximum strain rate
• position of maximum strain rate

Other applications of PlantVis-R
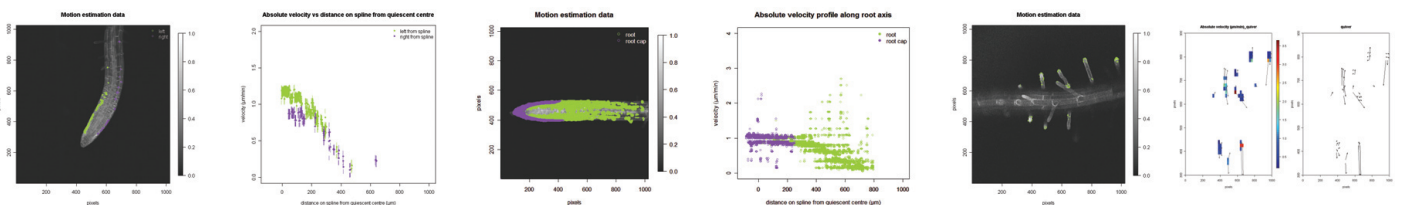
Analyses quantifying differential growth rates on bending roots (Figs. left), growth rates of individual tissues e.g. root cap vs. remainder of root (Figs. middle) or root hair growth (Figs. right).

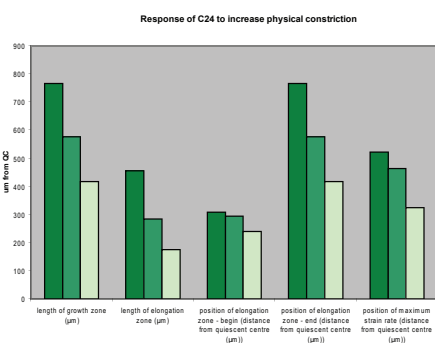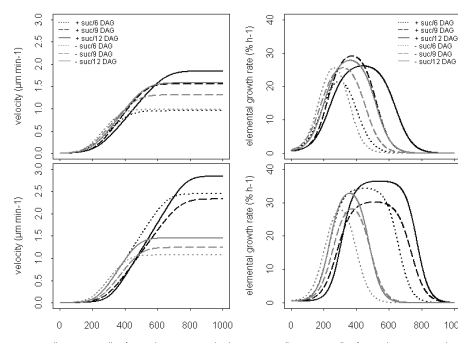## Root-environment interactions

Fig. Changes in root parameters in response to physical constraint by glass ballotini in agar

Figs. Root growth change with time and in response to sucrose for two contrasting genotypes.

Summary

• PlantVis is a flexible tool for analyzing motion in images.
• We have used PlantVis-R for the analysis of longitudinal and radial velocity during root elongation under physical impedance and presence of sucrose.

Acknowledgements