Lateral root growth: A framework to analyse the variability among elongation patterns and the impact of auxin and sugar signals

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A remarkable facet of lateral root (LR) behavior is variability affecting root development, leading to a large range of LR lengths and branching densities along the primary root. It has been argued that such variability among LRs could be a strategy to optimize soil exploration in a context of spatial and temporal heterogeneity of soil resources (Forde 2009).

In order to characterize variability in LR growth and evaluate the role of hormonal and biochemical signals that might influence it, we analyzed the patterns of development of hundreds of lateral roots in a set of maize seedlings grown in rhizotrons. The SmartRoot software (Lobet et al. 2011) was used to provide a comprehensive recording of individual root elongation dynamics.

Using a multivariate clustering method based on traits such as growth rates and apical root diameters, we identified a number of coherent growing states in maize LRs. This approach allows to quantify the variability of LR growth patterns in a root system in a probabilistic manner by computing the initial and transition probabilities among the different LR growing states.

Moreover, the molecular and cellular characterization of apical root samples revealed consistent variations in meristem size, as well as sugar and auxin status relative to the growing state of the root.

Keywords: lateral root growth, developmental pattern, probabilistic modelling, auxin, sugar signaling