ABSTRACT

Plant specific cell cycle regulation in response to developmental and environmental signals was investigated at the level of gene expression in the model plant *Arabidopsis thaliana* (L.) Heynh. Specific attention was paid to the regulation of the mitotic cyclin *CYCB1;1*, by means of a mutant approach, during lateral root development and in salt stress conditions. Analysis of the activity of a GUS reporter line of *CYCB1;1* promoter (*CYCB1;1::uidA*) in anatomical sections of the wild type root apical meristem revealed specific localization into the cortical and epidermal cell layers. With the aim to identify factors acting in trans on the *CYCB1;1* promoter the *CYCB1;1::uidA* line was targeted to chemical mutagenesis. In a reduced *CYCB1;1::uidA* mutant (*rcb*), identified from the mutant screen, the meristematic expression was absent while it was ectopically induced in lateral root cap initial cells, however, without effect on root morphology. In the root cap of *rcb* the *CYCB1;1* promoter activity appeared at the time of root cap maturation and at the time the expression disappeared from the wild type root cap, indicating that the *CYCB1;1* promoter was under a cell-type specific regulation mediating both positive and negative regulation depending on the tissue. Candidate genes for *CYCB1;1* promoter regulators were identified from a microarray study.

To investigate the effects of phytohormone auxin on the cell cycle regulation during lateral root organ development a lateral root inducible (LRI) system was developed. The system was based on successive treatments with polar auxin transport inhibitor (NPA) and exogenous auxin (NAA) allowing G1 phase specific cell cycle block on NPA and fast and uniform cell cycle reactivation in the xylem pole pericycle upon NAA treatment. Auxin was shown to downregulate the CDK inhibitor *KRP2* gene, thereby releasing the cell cycle block. Development of a synchronized lateral root inducible (LRI) system allowed for the first time genome wide expression analysis of the developmental process and thereby characterization of putative signaling cascades involved. Upon auxin signal perception two of the auxin-signaling systems, the Aux/IAA and heterotrimeric G protein alpha dependent responses were initiated. The G1-to-S phase transition was activated within four hours as marked by induction of cell cycle marker genes as well as DNA replication and protein synthesis related genes. Thereafter G2-to-M phase specific genes were induced together with a new set of signal transduction genes.

The cell cycle regulation in response to environmental conditions was investigated using salt stress as a test system. The results showed that, next to cell expansion, there is a critical role for the cell cycle regulatory mechanism during the adaptation process to salt stress. Transcriptional control of the cell cycle in response to salt stress resulted in modulation of cell division activity, which was followed by an adaptive growth response.

The identification of developmentally regulated genes during lateral root initiation has formed a base for future work on root branching in plants. Functional genomic approaches will be used to reveal their tissue localization as well as their putative roles in the developmental process. Identifying target genes for the transcription factors by transactivation assays will help to build understanding of the signaling cascades involved in auxin mediated signaling towards lateral root initiation.