ABSTRACT

The impact of changing environmental conditions on leaf growth, cell production and cell expansion, in *Phaseolus vulgaris* and *Pueraria phaseoloides* was investigated. The study has identified the cellular mechanism responsible for altered leaf area development in elevated CO_2, reduced sunlight and during a diurnal cycle.

In *P. vulgaris*, cell expansion was separated temporally from cell division and the impact of elevated CO_2 on either cell division, expansion or both was studied. The most interesting effect was observed for leaves exposed to elevated CO_2 during cell expansion, the phase when elevated CO_2 resulted in a large stimulation of leaf area development. For leaves exposed to elevated CO_2 during the cell division phase, reduced leaf area development was observed. Interestingly, when plants were exposed to elevated CO_2 during both phases, leaf area development was not affected. At a mechanistic level, the data from anatomical, biophysical and biochemical measurements suggested that leaf area development was primarily controlled by cell wall loosening, extensibility (WEx) and the activity of the cell wall loosening enzyme (XET). Although the data showed that both cell production and expansion were stimulated by elevated CO_2, leaf growth was only enhanced by exposure to elevated CO_2 in the cell expansion phase. Structural modifications of cell wall hemicellulosic polysaccharides revealed that cell wall loosening was mainly due to polymerisation of xyloglucan by endotransglycosylation and that this probably plays a critical role in the process responsible for the CO_2-induced cell expansion in *P. vulgaris*.

When *P. vulgaris* and *P. phaseoloides* leaves were exposed to two different photo-environments in the field, leaf area development was enhanced in shade (50% sunlight) compared to full sunlight. In both species, increased leaf growth was associated with enhanced cell expansion. Cell production was stimulated by full sunlight, but this was ineffective at stimulating leaf area development. Furthermore, during a diurnal cycle, leaf growth of *P. phaseoloides* was greater at night than during the day. Interestingly, on both occasions, the same intrinsic factors, cell wall loosening and extension, were still controlling leaf area development in the shade and in the dark.