Modelling the time course of senescence in winter wheat at the individual leaf and whole plant level

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Abstract

ADEL-wheat (Fournier *et al*, 2003) is a 3D architectural model developed for winter wheat, which exploits observed stable patterns regarding the timing of organ production, final organ size profile, and geometry. In order to accurately model the 3D-structure it is also important to similarly describe the time course of senescence both at the whole plant level and at that of the individual organs. This is particularly so for applications such as, for example, remote sensing in which the remote signal is known to be sensitive to LAI and leaf distribution, both of which require the evolution and the vertical profile of senescence to be well represented.

Field experiments were conducted in 2004 and 2006 on a total of 9 varieties. We then constructed a leaf senescence index for each shoot (SSI), and analysed its thermal time course. It has previously been observed that, in terms of leaf appearance, tiller development mimics that of the main stem, except that each tiller is delayed by a constant amount with respect to the main stem, and also that the profiles of the final sizes of organs on all axes are similar once the concept of a "phytomer shift" (e.g. Evers *et al*, 2005) is introduced. From the point of view of leaf senescence an analogous observation can be made - that once the developmental delay is accounted for the advancement of senescence on all axes is similar. These observations together mean that (once a certain point in the development has been reached) the instantaneous leaf area and vertical profile per shoot are conservative across all axes. At the individual leaf level senescence progresses more-or-less sequentially during the vegetative growth phase – with the senescence of a given leaf commencing as that of its predecessor finishes. This behaviour differs for the later leaves, which senesce simultaneously, albeit at varying rates, which also differ somewhat between genotypes. Finally, these observations permit a parsimonious parameterisation of the thermal time course of senescence which enables an improved modelling of 3D structure with relatively little increase in the size of the model's parameter set.

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