

## Uncertainty in phenology parameterisation and model structure affect canola yield simulation in the APSIM Next Generation

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### Background:

Simulation modelling has been used to define optimal sowing and flowering periods of canola to assist growers reduce production losses caused by frost, heat and drought. Accurate prediction of canola flowering time is essential to evaluate canola response to different environmental and management changes. Previous work has demonstrated that the APSIM-Canola model (Classic) exhibited apparent parameter equifinality (multiple combinations of parameters could lead to the same simulation of canola phenology) caused by inadequate observed data to separate phenological phases when the crop was sensitive to vernalisation and photoperiod. This potentially led to incorrect parameterisation although the impact on simulated yield was small (He et al., 2017). APSIM-Canola Next Generation provides greater flexibility for users to adjust phenology parameters, the uncertainty in phenology parameterisation is not clear.

### Objective:

We aimed to understand the level of uncertainty in canola phenology prediction associated with changes in parameterisation in APSIM Next Generation and its impact on simulated yield.

### Methods:

We tested phenology parameterisation of APSIM-Canola Next Generation using experimental data comprising observations for 17 cultivars, 81 growing seasons in Australia (Kirkegaard et al., 2016). A global optimisation method was used to derive two sets of parameters, i.e., parameters describing vernalisation sensitivity and leaf phyllochron. Root-mean-square error (RMSE) between simulated and observed pre-flowering duration was used to select parameter ensembles. Two calibration strategies were tested, 1) only varying vernalisation sensitivity parameters; 2) varying both vernalisation and leaf phyllochron parameters.

### Results:

After the optimisation process, the predicted durations of the pre-flowering phase had an error (RMSE) of 4.3 days in calibration strategy one and 3.7 days in calibration strategy two. However, multiple combinations of parameters led to the same simulation accuracy for flowering time (difference < 1 day). For a given cultivar and environment (sowing date x year x location), using the ensemble parameter sets to simulate canola growth led to different simulated yields. The difference in yield was small with the parameters derived by calibration strategy one (< 547.9 kg/ha, coefficient of variation < 5.5%), while with the parameters derived by strategy two, the maximum difference in yield reached 2228.4 kg/ha (average was 993.8 kg/ha, coefficient of variation < 25.6%).

### Conclusions:

APSIM-Canola Next Generation was able to accurately simulate the flowering time of different cultivars in Australia, but apparent parameter equifinality was exhibited. Keeping leaf phyllochron as a constant parameter would reduce uncertainty in simulated yield caused by parameterization. However, experimental evidence has suggested that phyllochron and plastochron vary for different cultivars. Further work is needed to explore data requirements for effective phenology calibration and how to derive robust parameters for process-based models.

### References:

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