2020.11.20.5818

# 1 The APSIM Oats Model

*Allan Peake, Hamish Brown, Rob Zyskowski, Edmar I. Teixeira, Neil Huth*

# 2 APSIM Description

The Agricultural Production Systems sIMulator (APSIM) is a farming systems modelling framework that is being actively developed by the APSIM Initiative.

It is comprised of

1. a set of biophysical models that capture the science and management of the system being modelled,
2. a software framework that allows these models to be coupled together to facilitate data exchange between the models,
3. a set of input models that capture soil characteristics, climate variables, genotype information, field management etc,
4. a community of developers and users who work together, to share ideas, data and source code,
5. a data platform to enable this sharing and
6. a user interface to make it accessible to a broad range of users.

The literature contains numerous papers outlining the many uses of APSIM applied to diverse problem domains. In particular, Holzworth et al., 2014; Keating et al., 2003; McCown et al., 1996; McCown et al., 1995 have described earlier versions of APSIM in detail, outlining the key APSIM crop and soil process models and presented some examples of the capabilities of APSIM.

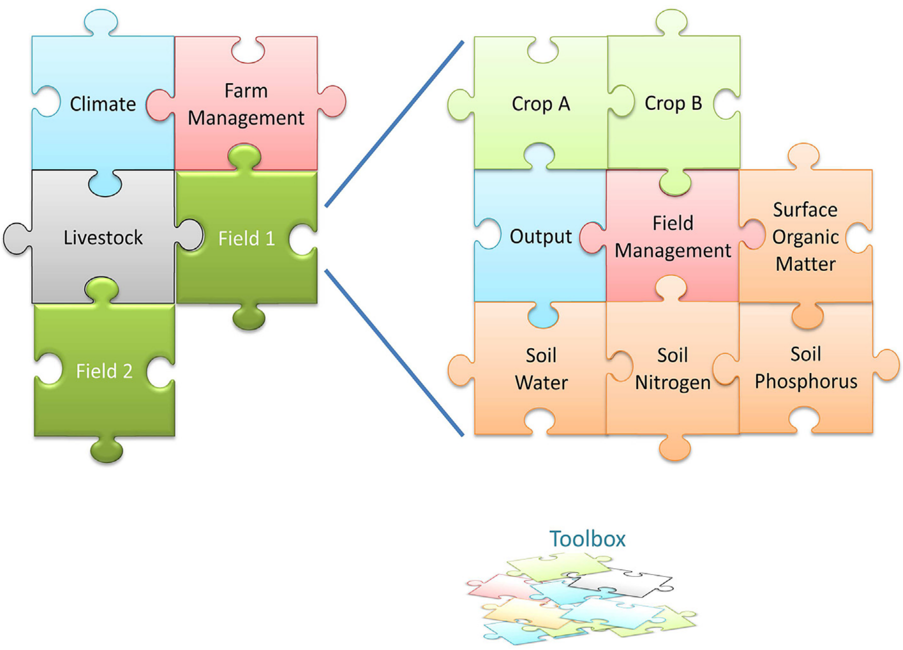



**Figure 2:** This conceptual representation of an APSIM simulation shows a “top level” farm (with climate, farm management and livestock) and two fields. The farm and each field are built from a combination of models found in the toolbox. The APSIM infrastructure connects all selected model pieces together to form a coherent simulation.*

The APSIM Initiative has begun developing a next generation of APSIM (APSIM Next Generation) that is written from scratch and designed to run natively on Windows, LINUX and MAC OSX. The new framework incorporates the best of the APSIM 7.x framework with an improved supporting framework. The Plant Modelling Framework (a generic collection of plant building blocks) was ported from the existing APSIM to bring a rapid development pathway for plant models. The user interface paradigm has been kept the same as the existing APSIM version, but completely rewritten to support new application domains and the newer Plant Modelling Framework. The ability to describe experiments has been added which can also be used for rapidly building factorials of simulations. The ability to write C# scripts to control farm and paddock management has been retained. Finally, all simulation outputs are written to an SQLite database to make it easier and quicker to query, filter and graph outputs.

The model described in this documentation is for APSIM Next Generation.

APSIM is freely available for non-commercial purposes. Non-commercial use of APSIM means public-good research & development and educational activities. It includes the support of policy development and/or implementation by, or on behalf of, government bodies and industry-good work where the research outcomes are to be made publicly available. For more information visit the licensing page on the APSIM web site

# 3 Model description

The Oats model is constructed from the following list of software components. Details of the implementation and model parameterisation are provided in the following sections.

**List of Plant Model Components.**

| Component Name | Component Type |
|---|---|
| Arbitrator | Models.PMF.OrganArbitrator |
| Phenology | Models.PMF.Phen.Phenology |
| Structure | Models.PMF.Struct.Structure |
| Grain | Models.PMF.Organs.ReproductiveOrgan |
| Leaf | Models.PMF.Organs.Leaf |
| Stem | Models.PMF.Organs.GenericOrgan |
| Root | Models.PMF.Organs.Root |
| Panicle | Models.PMF.Organs.GenericOrgan |
| MortalityRate | Models.Functions.Constant |

## 3.1 The APSIM Oats Model

*Allan Peake, Hamish Brown, Rob Zyskowski, Edmar I. Teixeira, Neil Huth*

The APSIM oats model has been developed using the Plant Modelling Framework (PMF) of Brown et al., 2014. This new framework provides a library of plant organ and process submodels that can be coupled, at runtime, to construct a model in much the same way that models can be coupled to construct a simulation. This means that dynamic composition of lower level process and organ classes (e.g. photosynthesis, leaf) into larger constructions (e.g. maize, wheat, sorghum) can be achieved by the model developer without additional coding.

The oats model consists of:

- a phenology model to simulate development through sequential growth phases
- a structure model to simulate plant morphology
- a collection of organs to simulate the various plant parts
- an arbitrator to allocate resources (N, biomass) to the various plant organs

This work builds upon an earlier APSIM Oats model that was constructed in 2007 and then published at the Australian Agronomy Conference in 2008 using data from Gatton, Tarlee and Pinery (Peake et al., 2008). However numerous changes have been made in the APSIM NextGen version, so simulations run under APSIM 7.10 and previous versions will give different predictions when run with APSIM NextGen.

The Oats model is broadly based on APSIM Wheat models such as NWheat (S Asseng et al., 2002, BA Keating, 2001), NWheatS (S Asseng et al., 1998), Cropmod-Wheat (Wang et al., 2002), and the earlier versions developed within the Plant Modelling Framework (Brown et al., 2014).

## 3.2 Cultivars

Most crop parameters can be specified individually for cultivars. Customized cultivar parameters are reported in this section.

Aladdin, Algerian, Bond, Brusher, Comet, Coolibah, Drover, Drummond, Drummond_orig, Genie, Hokonui, Kangaroo, Milton, Nugene, Stampede, Taipan, Wintaroo, Wizard

### 3.2.1 Drummond

This cultivar is defined by overriding some of the base parameters of the plant model.

Drummond makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 8.5
[Phenology].VrnSensitivity.FixedValue = 7
[Phenology].PpSensitivity.FixedValue = 3
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 3
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 2
[Structure].Phyllochron.BasePhyllochron.FixedValue = 75
[Structure].BranchingRate.StressFactors.CoverEffect.XYPairs.X = 0,0.2,0.35
[Leaf].CohortParameters.MaxArea.AreaLargestLeaves.FixedValue = 4000
[Structure].BranchingRate.PotentialBranchingRate.Vegetative.PotentialBranchingRate.XYPairs.X = 1,2,3.99,4,5,6,7,8,9
[Structure].BranchingRate.PotentialBranchingRate.Vegetative.PotentialBranchingRate.XYPairs.Y = 0,0,0,1,2,4,7,12,20
[Leaf].CohortParameters.GrowthDuration.AgeFactor.XYPairs.Y = 1,1,0.1
[Grain].MaximumPotentialGrainSize.FixedValue = 0.05
[Grain].NumberFunction.GrainNumber.GrainsPerGramOfStem.FixedValue = 40

### 3.2.2 Drummond_orig

This cultivar is defined by overriding some of the base parameters of the plant model.

Drummond_orig makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 9
[Phenology].VrnSensitivity.FixedValue = 0
[Phenology].PpSensitivity.FixedValue = 10
[Structure].Phyllochron.BasePhyllochron.FixedValue = 80
[Structure].BranchingRate.StressFactors.CoverEffect.XYPairs.X = 0,0.2,0.35
[Leaf].CohortParameters.MaxArea.AreaLargestLeaves.FixedValue = 4000
[Structure].BranchingRate.PotentialBranchingRate.Vegetative.PotentialBranchingRate.XYPairs.X = 1,2,3.99,4,5,6,7,8,9

### 3.2.3 Milton

This cultivar is defined by overriding some of the base parameters of the plant model.

Milton makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 8.5
[Phenology].VrnSensitivity.FixedValue = 7
[Phenology].PpSensitivity.FixedValue = 3
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 2
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 0
[Structure].Phyllochron.BasePhyllochron.FixedValue = 105
[Leaf].CohortParameters.MaxArea.AreaLargestLeaves.FixedValue = 4000
[Leaf].CohortParameters.SenescenceDuration.Multiplier.FixedValue = 3
[Leaf].CohortParameters.GrowthDuration.AgeFactor.XYPairs.Y = 1,1,0.1
[Grain].MaximumPotentialGrainSize.FixedValue = 0.05
[Grain].NumberFunction.GrainNumber.GrainsPerGramOfStem.FixedValue = 50
[Leaf].ExtinctionCoeff.FixedValue = 0.6

### 3.2.4 Hokonui

This cultivar is defined by overriding some of the base parameters of the plant model.

Hokonui makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 9
[Phenology].VrnSensitivity.FixedValue = 0
[Phenology].PpSensitivity.FixedValue = 10
[Structure].Phyllochron.BasePhyllochron.FixedValue = 90
[Leaf].CohortParameters.GrowthDuration.AgeFactor.XYPairs.Y = 1,1,0.1

### 3.2.5 Stampede

This cultivar is defined by overriding some of the base parameters of the plant model.

Stampede makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 9
[Phenology].VrnSensitivity.FixedValue = 0
[Phenology].PpSensitivity.FixedValue = 10
[Structure].Phyllochron.BasePhyllochron.FixedValue = 80
[Leaf].CohortParameters.GrowthDuration.AgeFactor.XYPairs.Y = 1,1,0.1

### 3.2.6 Coolibah

This cultivar is defined by overriding some of the base parameters of the plant model.

Coolibah makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 9
[Phenology].VrnSensitivity.FixedValue = 5.3
[Phenology].PpSensitivity.FixedValue = 3.0
[Structure].Phyllochron.BasePhyllochron.FixedValue = 90
[Leaf].CohortParameters.MaxArea.AreaLargestLeaves.FixedValue = 5000
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 0
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 2
[Structure].BranchingRate.StressFactors.CoverEffect.XYPairs.X = 0,0.25,0.5

### 3.2.7 Taipan

This cultivar is defined by overriding some of the base parameters of the plant model.

Taipan makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 9
[Phenology].VrnSensitivity.FixedValue = 10
[Phenology].PpSensitivity.FixedValue = 7.5
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 3
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 3
[Structure].Phyllochron.BasePhyllochron.FixedValue = 90
[Leaf].CohortParameters.MaxArea.AreaLargestLeaves.FixedValue = 8000

### 3.2.8 Wintaroo

This cultivar is defined by overriding some of the base parameters of the plant model.

Wintaroo makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 7
[Phenology].VrnSensitivity.FixedValue = 2
[Phenology].PpSensitivity.FixedValue = 2
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 0
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 2
[Structure].Phyllochron.BasePhyllochron.FixedValue = 90

### 3.2.9 Kangaroo

This cultivar is defined by overriding some of the base parameters of the plant model.

Kangaroo makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 7
[Phenology].VrnSensitivity.FixedValue = 4
[Phenology].PpSensitivity.FixedValue = 4
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 0
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 2
[Structure].Phyllochron.BasePhyllochron.FixedValue = 90

### 3.2.10 Brusher

This cultivar is defined by overriding some of the base parameters of the plant model.

Brusher makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 7
[Phenology].VrnSensitivity.FixedValue = 1
[Phenology].PpSensitivity.FixedValue = 1
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 0
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 2
[Structure].Phyllochron.BasePhyllochron.FixedValue = 80

### 3.2.11 Algerian

This cultivar is defined by overriding some of the base parameters of the plant model.

Algerian makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 9
[Phenology].VrnSensitivity.FixedValue = 12
[Phenology].PpSensitivity.FixedValue = 6
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 4
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 3
[Structure].Phyllochron.BasePhyllochron.FixedValue = 105
[Leaf].CohortParameters.MaxArea.AreaLargestLeaves.FixedValue = 5000
[Structure].BranchingRate.StressFactors.CoverEffect.XYPairs.X = 0,0.4,0.7

### 3.2.12 Nugene

This cultivar is defined by overriding some of the base parameters of the plant model.

Nugene makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 9
[Phenology].VrnSensitivity.FixedValue = 10
[Phenology].PpSensitivity.FixedValue = 7.5
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 3
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 3
[Structure].Phyllochron.BasePhyllochron.FixedValue = 90
[Leaf].CohortParameters.MaxArea.AreaLargestLeaves.FixedValue = 8000

### 3.2.13 Drover

This cultivar is defined by overriding some of the base parameters of the plant model.

Drover makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 9
[Phenology].VrnSensitivity.FixedValue = 4
[Phenology].PpSensitivity.FixedValue = 9
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 6
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 3
[Structure].Phyllochron.BasePhyllochron.FixedValue = 80
[Leaf].CohortParameters.MaxArea.AreaLargestLeaves.FixedValue = 8000

### 3.2.14 Genie

This cultivar is defined by overriding some of the base parameters of the plant model.

Genie makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 9
[Phenology].VrnSensitivity.FixedValue = 10
[Phenology].PpSensitivity.FixedValue = 7.5
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 3
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 3
[Structure].Phyllochron.BasePhyllochron.FixedValue = 90
[Leaf].CohortParameters.MaxArea.AreaLargestLeaves.FixedValue = 8000

### 3.2.15 Aladdin

This cultivar is defined by overriding some of the base parameters of the plant model.

Aladdin makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 9
[Phenology].VrnSensitivity.FixedValue = 10
[Phenology].PpSensitivity.FixedValue = 7.5
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 3
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 3
[Structure].Phyllochron.BasePhyllochron.FixedValue = 90
[Leaf].CohortParameters.MaxArea.AreaLargestLeaves.FixedValue = 8000

### 3.2.16 Comet

This cultivar is defined by overriding some of the base parameters of the plant model.

Comet makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 9
[Phenology].VrnSensitivity.FixedValue = 10
[Phenology].PpSensitivity.FixedValue = 7.5
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 3
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 3
[Structure].Phyllochron.BasePhyllochron.FixedValue = 90
[Leaf].CohortParameters.MaxArea.AreaLargestLeaves.FixedValue = 8000

### 3.2.17 Wizard

This cultivar is defined by overriding some of the base parameters of the plant model.

Wizard makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 9
[Phenology].VrnSensitivity.FixedValue = 10
[Phenology].PpSensitivity.FixedValue = 7.5
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 3
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 3
[Structure].Phyllochron.BasePhyllochron.FixedValue = 90
[Leaf].CohortParameters.MaxArea.AreaLargestLeaves.FixedValue = 8000

### 3.2.18 Bond

This cultivar is defined by overriding some of the base parameters of the plant model.

Bond makes the following changes:

[Phenology].MinimumLeafNumber.FixedValue = 9
[Phenology].VrnSensitivity.FixedValue = 10
[Phenology].PpSensitivity.FixedValue = 7.5
[Phenology].EarlyReproductivePpSensitivity.FixedValue = 3
[Phenology].EarlyReproductiveLongDayBase.FixedValue = 3
[Structure].Phyllochron.BasePhyllochron.FixedValue = 90
[Leaf].CohortParameters.MaxArea.AreaLargestLeaves.FixedValue = 8000

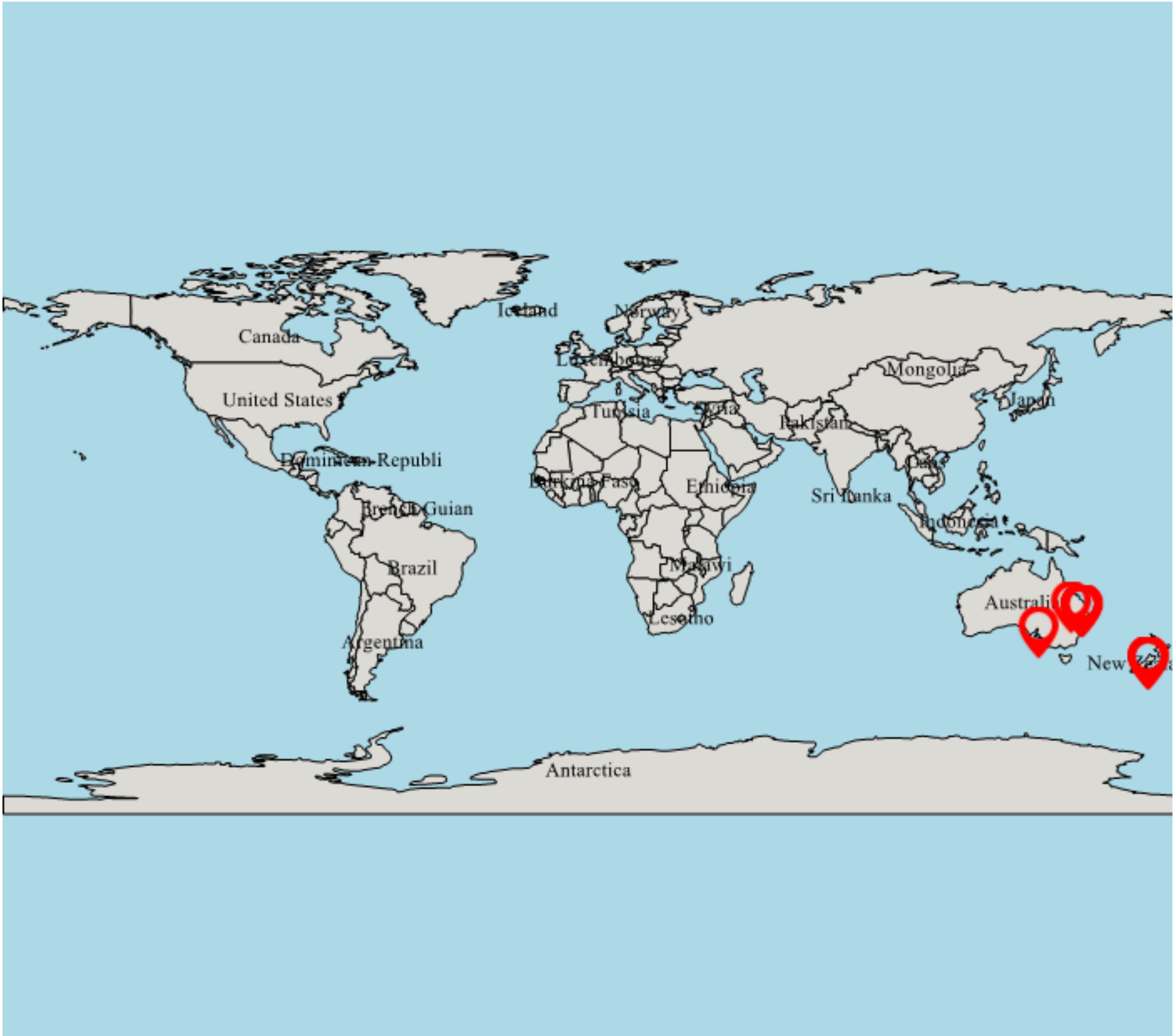
## 3.3 MortalityRate

*MortalityRate = 0*

# 4 Validation

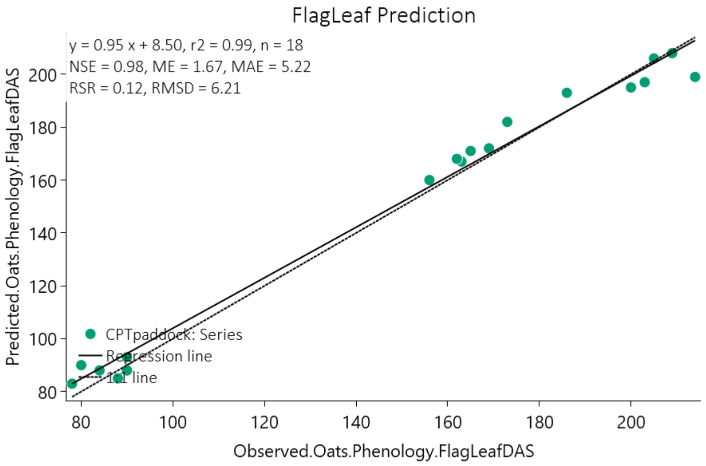
A test dataset has been developed to test the APSIM Oats model for a range of environmental (soil and climate) conditions, management options (sowing dates, populations, nitrogen rates, row spacing, irrigation), genetic backgrounds (different regions, cultivar types) and for special considerations such as defoliation (or simulated grazing). These tests have been groups into various geographical regions to allow the user to evaluate the suitability of the model for their particular region of interest. Graphs of model performance are provided for yield, biomass production, canopy development, phenological development, water and nitrogen uptake, and grain yield components.

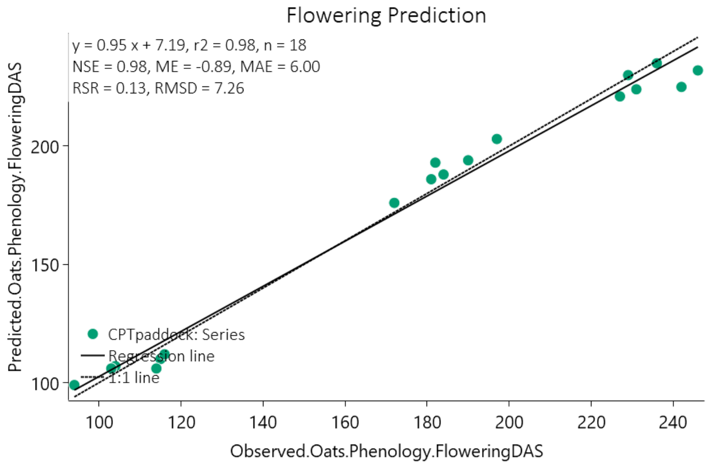
## 4.1 Map

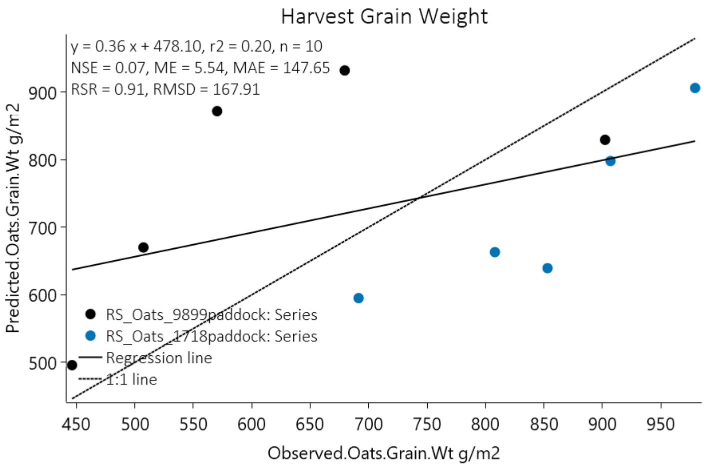


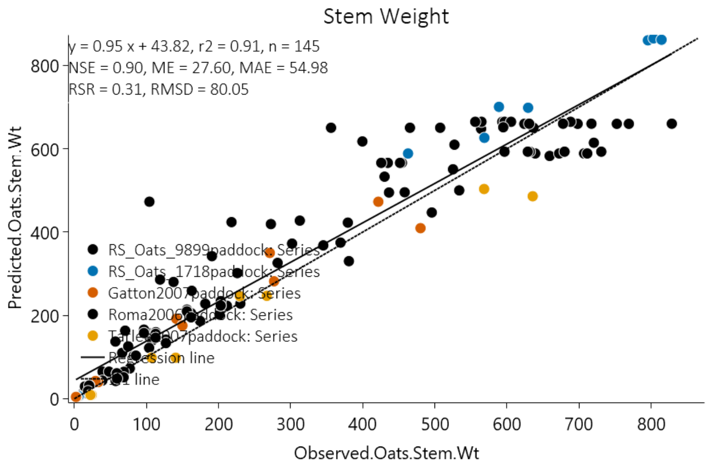

## 4.2 Combined Results

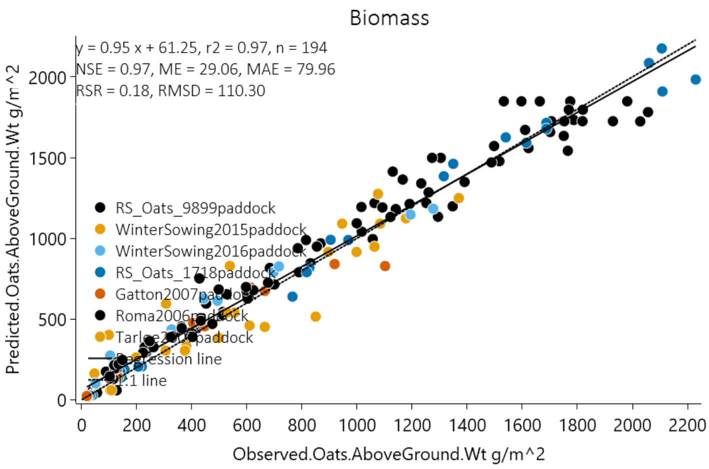
Simulation results for the combined datasets from the various countries are shown in the following graphs. The model is able to adequately capture the influence of growing conditions (soil, climate) and management (population, Nitrogen, irrigation, sowing date).




## 4.3 New Zealand

**List of experiments.**

| Experiment Name | Design (Number of Treatments) |
|---:|---:|
| RS_Oats_9899 | _Irrig (5) |
| WinterSowing2015 | (4) |
| WinterSowing2016 | (2) |
| CPT | (18) |
| RS_Oats_1718 | (6) |

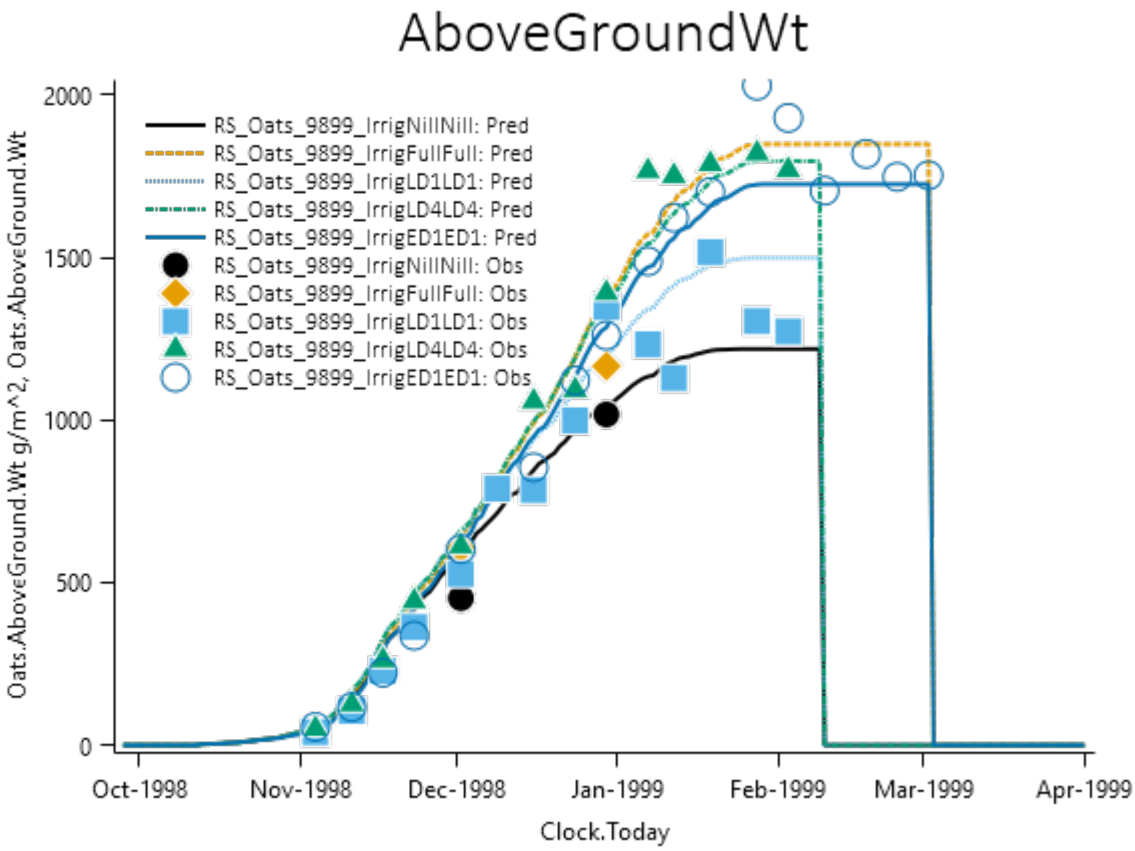
### 4.3.1 RS_Oats_9899

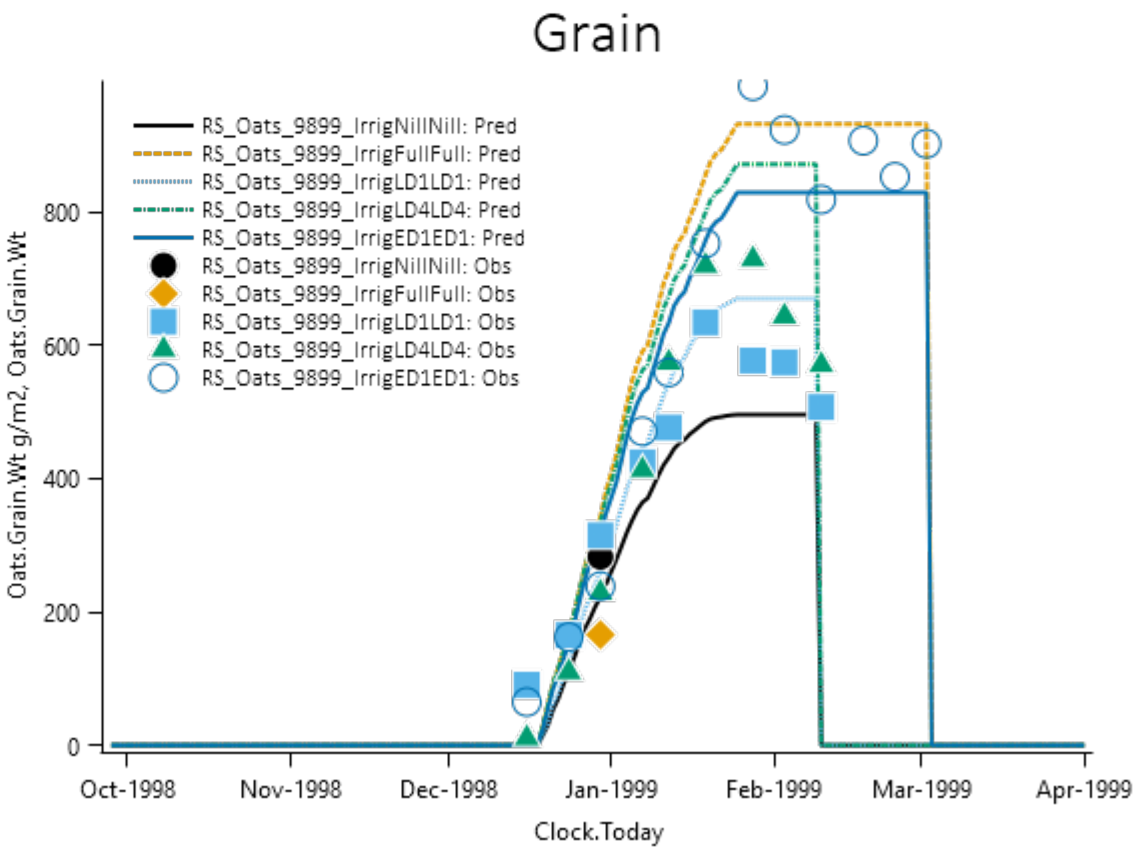
Data from:

Martin et al., 2001

```
The response of oats (Avena sativa L.) to timing and intensity of drought was determined in
```

rainshelter, which excluded rainfall during crop growth. Ten irrigation treatments subjected the crops to drought of varying duration at different stages during plant growth; the crops were otherwise fully irrigated. Oat grain yield generally increased linearly with cumulative water use, and decreased linearly as the maximum potential soil moisture deficit experienced during crop growth increased, regardless of the timing of drought. The exception to this was the no drought (fully irrigated) treatment, where lodging reduced panicle number and grain weight compared to early drought treatments. Drought affected yield mainly by reducing panicle and grain number, effects on grain weight were small. . Relieving early drought through late irrigation led to more late tillers, more panicles, heavier grains, and later maturity. Full and late drought increased screenings.





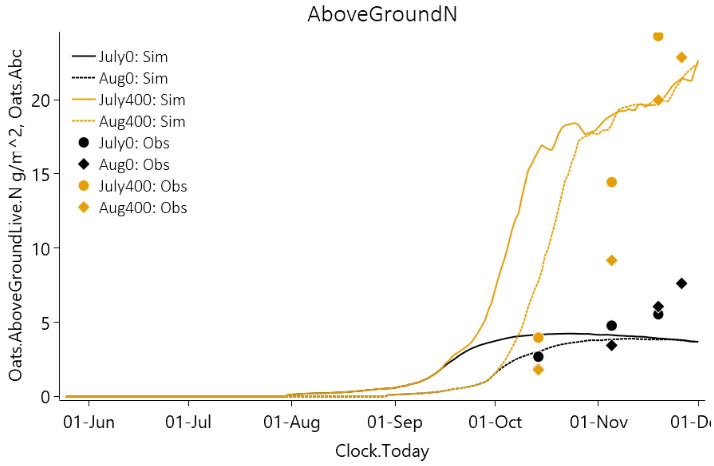

### 4.3.2 WinterSowing2015

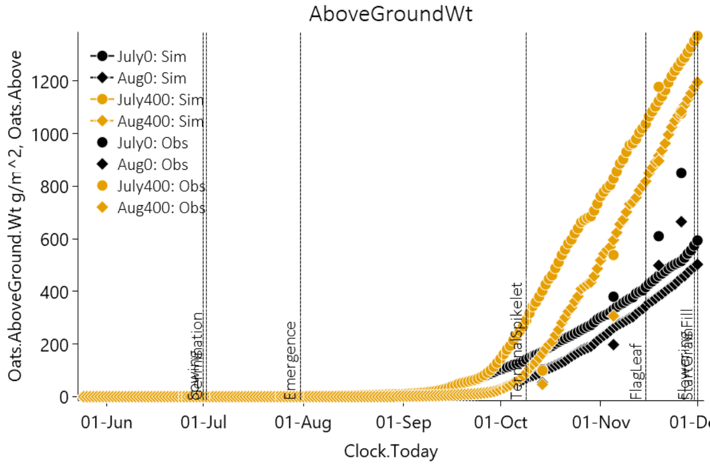
FRNL Experiment: Data from Malcolm et al., 2016

Note: the 2015 version of this experiment established inconsistently and data is not of the same quality as that generated in 2016.

Grazing winter forage crops is an important management strategy for profitable livestock production in many New Zealand regions where there is commonly a pasture feed deficit during this period. However, the high stocking densities that are often associated with these systems can have negative environmental effects, such as nitrogen (N) leaching losses to groundwater. This field study investigated the potential biomass production and reduced risk of N leaching from establishing oats (Avena sativa L.) as a green-chop catch crop after winter-grazed forage kale (Brassica oleracea var. acephala L.) in Canterbury, New Zealand. Oat crops were direct-drilled on two sowing dates (early: 1 July 2015 and late: 1 August 2015) and were managed under high (400 kg N/ha) and low (0 kg N/ha) N load conditions, representing urine-patch and inter urine-patch areas. For the early-sown crops yields were 6.1 (low N) and 11.8 t DM/ha (high N) at final harvest (50% ear emergence) on 19 November 2015. For the late-sown crops yields were 6.7 (low N) and 10.1 t DM/ha (high N) at the same development stage (26 November 2015). By establishing oats as a catch crop in winter soil profile mineral-N (0-120 cm depth) was reduced by up to 86% (early) and 80% (late) in the high N (simulated urine-patch) treatments compared with the respective fallow treatment. These results indicated the technical feasibility of direct drilling oats as catch crops immediately after winter forage grazing, with likely production and environmental benefits such as the reduced risk of N leaching losses.

#### 4.3.2.1 Graphs



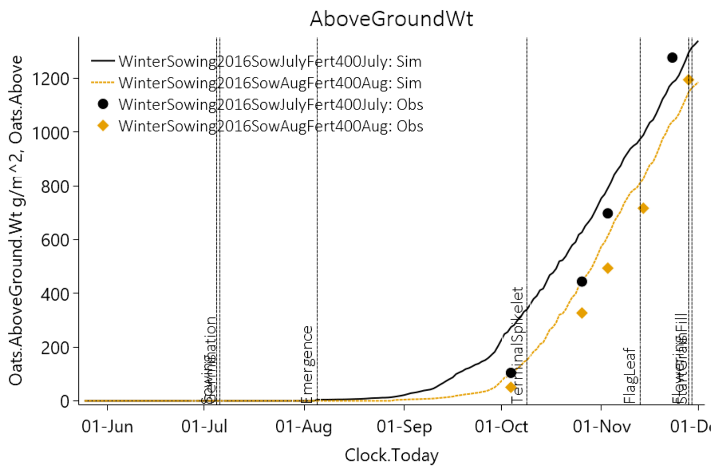



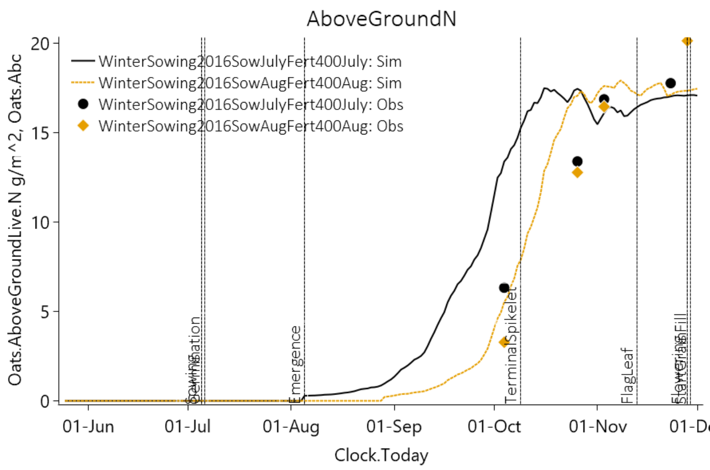

### 4.3.3 WinterSowing2016

FRNL Experiment: Data from Malcolm et al., 2016

Grazing winter forage crops is an important management strategy for profitable livestock production in many New Zealand regions where there is commonly a pasture feed deficit during this period. However, the high stocking densities that are often associated with these systems can have negative environmental effects, such as nitrogen (N) leaching losses to groundwater. This field study investigated the potential biomass production and reduced risk of N leaching from establishing oats (Avena sativa L.) as a green-chop catch crop after winter-grazed forage kale (Brassica oleracea var. acephala L.) in Canterbury, New Zealand. Oat crops were direct-drilled on two sowing dates (early: 1 July 2015 and late: 1 August 2015) and were managed under high (400 kg N/ha) and low (0 kg N/ha) N load conditions, representing urine-patch and inter urine-patch areas. For the early-sown crops yields were 6.1 (low N) and 11.8 t DM/ha (high N) at final harvest (50% ear emergence) on 19 November 2015. For the late-sown crops yields were 6.7 (low N) and 10.1 t DM/ha (high N) at the same development stage (26 November 2015). By establishing oats as a catch crop in winter soil profile mineral-N (0-120 cm depth) was reduced by up to 86% (early) and 80% (late) in the high N (simulated urine-patch) treatments compared with the respective fallow treatment. These results indicated the technical feasibility of direct drilling oats as catch crops immediately after winter forage grazing, with likely production and environmental benefits such as the reduced risk of N leaching losses.

#### 4.3.3.1 Graphs

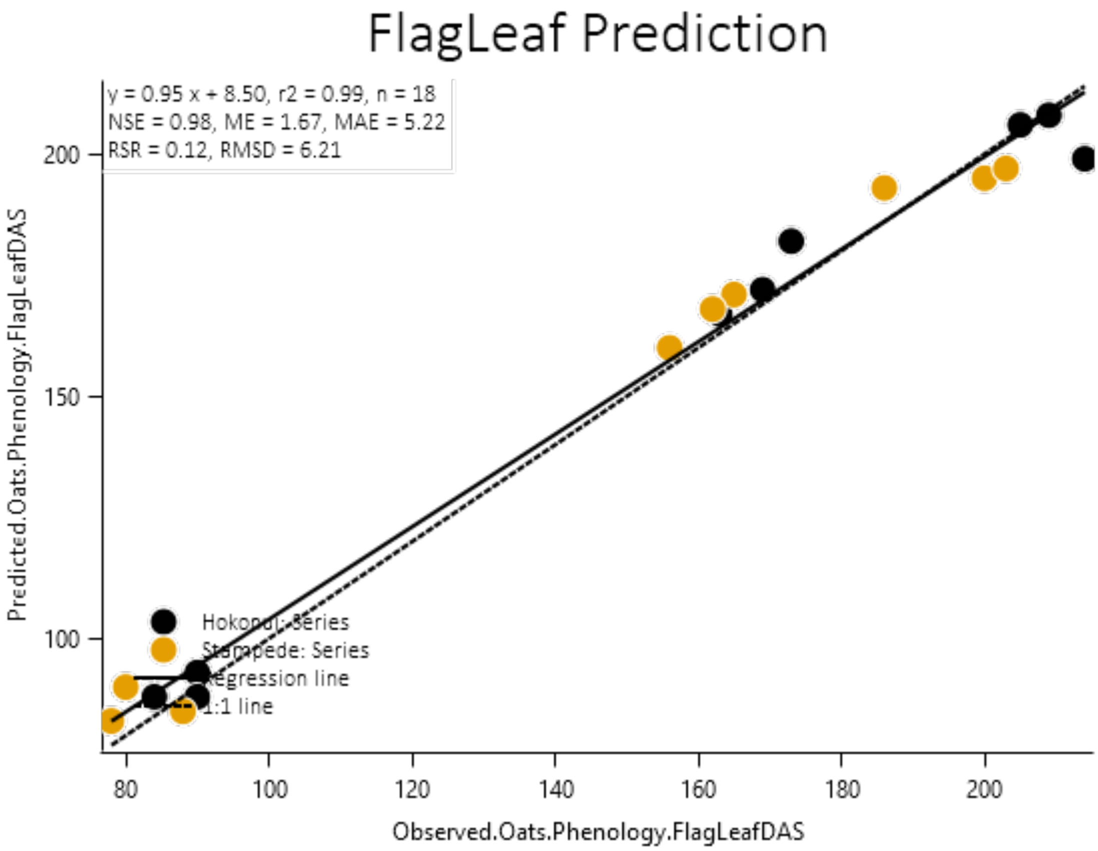


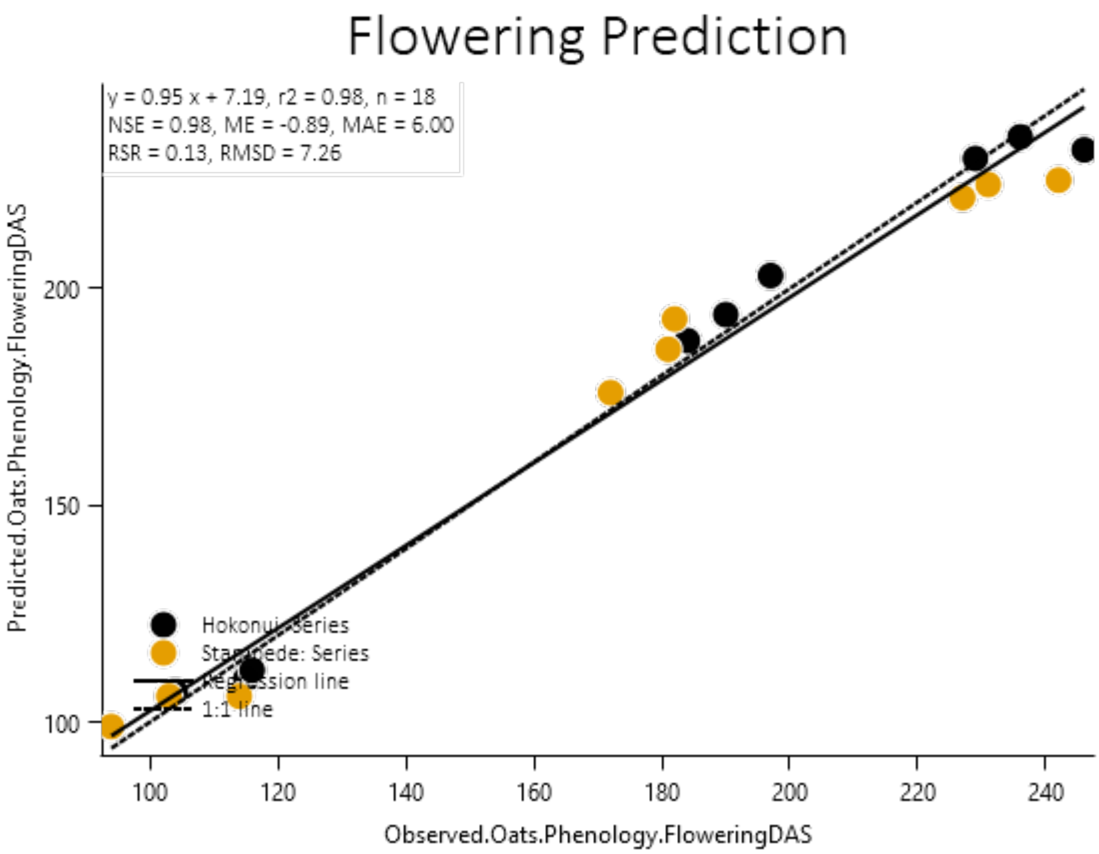




### 4.3.4 CPT

Jamieson, P. D. and C. A. Munro (1999). A simple method for the phenological evaluation of new cereal cultivars. Agronomy Society of New Zealand - Proceedings, Twenty-Ninth Annual Conference, 1999. J. G. Hampton and K. M. Pollock. 29: 63-68.

This experiment is part of the ongoing Cultivar Prediction Trial at Plant & Food Lincoln wher a Cultivar is planted at 3 sowing dates throughout the year and the time of flowering, Final leaf number and Flag leaf are recorded.




### 4.3.5 RS_Oats_1718

#### 4.3.5.1 Introduction

This is a simulation of Oats in a crop rotation consisting of a forage species, fodder beet, grown over spring/summer and harvested in autumn, followed by the catch crop, oats. The actual experiment was done in two parts in the rain shelter facility of Plant and Food Research, Lincoln, NZ. The experiments were designed to help develop the model for the respective plants and here they are used to further demonstrate that ApsimX can simulate water and nitrogen cycling in the field and then to examine whether catch crops are a good option for mitigating N leaching from forages.

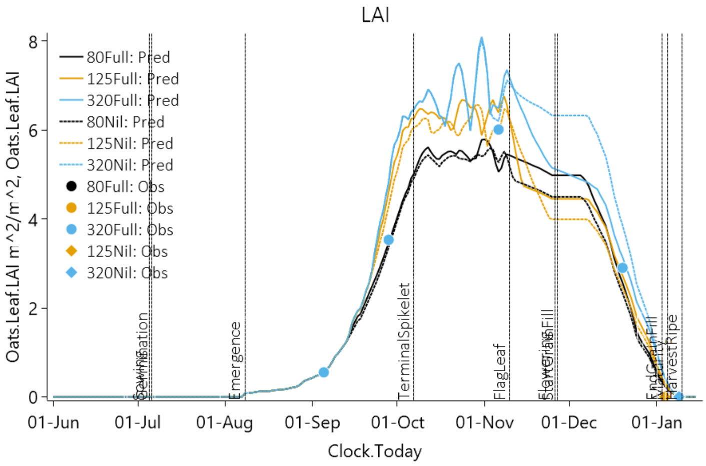
Part 1: Co-limitation of water and nitrogen on fodder beet physiology (no detail supplied for this experiment as it is not simulated herein)

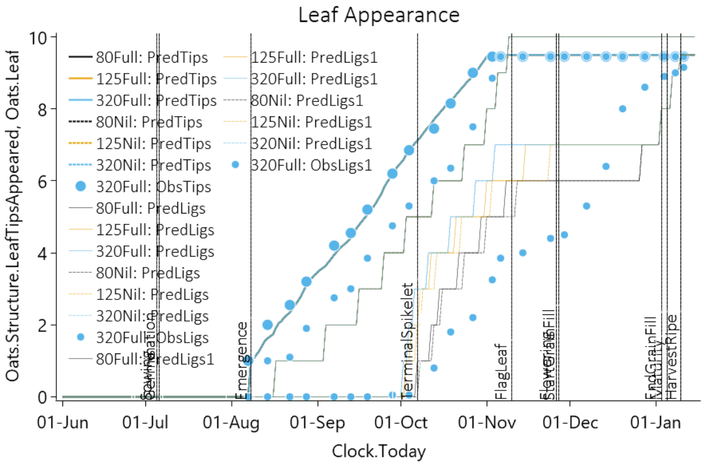
Part 2: Ability of oats to act as catch-crops over winter/spring
- Irrigation: 2 treatments, low (enough to keep plants growing) or full irrigation (to match PET) - Nitrogen: 3 treatments, 80 kg N/ha, 125 kg N/ha & 320 kg N/ha at sowing (urea applied at sowing)

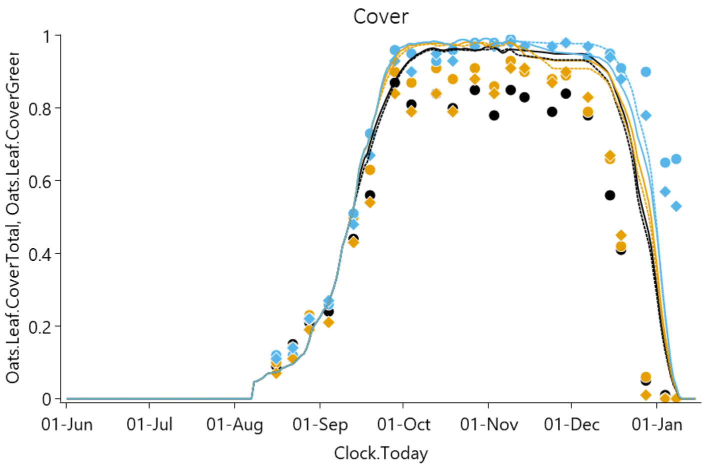
Oats Experiment Management:
- Cultivar: Milton
- Sowing density: 300 plants/m2
row spacing: 15 cm
depth: 45 mm

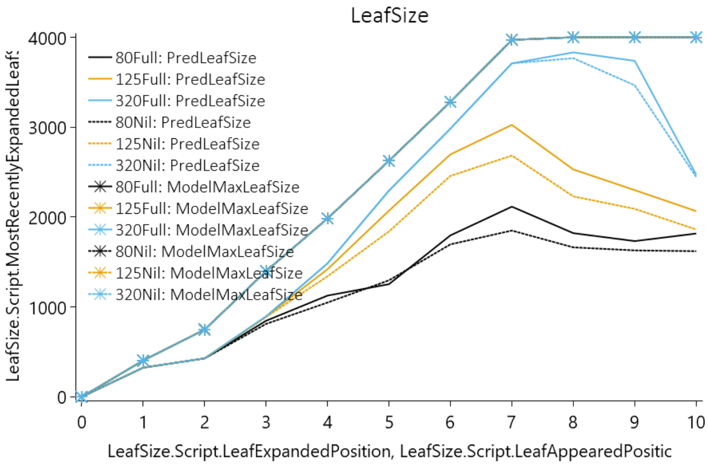
```
General actions:
    05/07/2017 - Sowing
    05/07/2017 -
 Fertiliser application (400kg/ha Potash, Urea: treat4=80kgN/ha, treat5=125kgN/ha, treat6=32
    24/07/2017 - Plants started to emerge
    11/09/2017 - Irrigation started in treatements 4, 5, and 6
    06/11/2017 - Irrigation extended to all plots
    04-09/01/2018 - Plots harvested
```

#### 4.3.5.2 Canopy

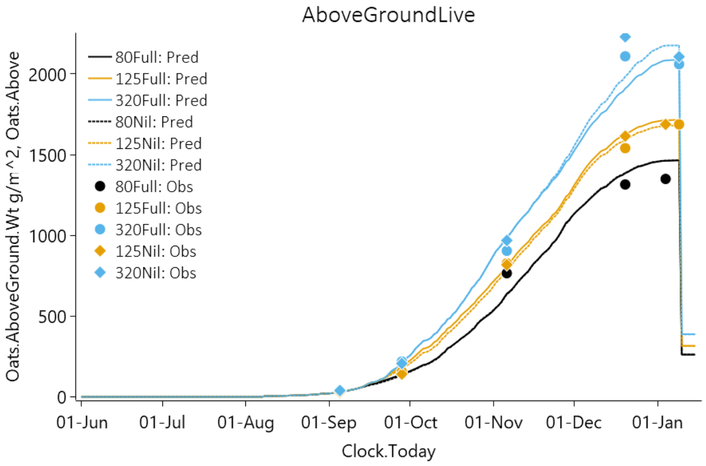


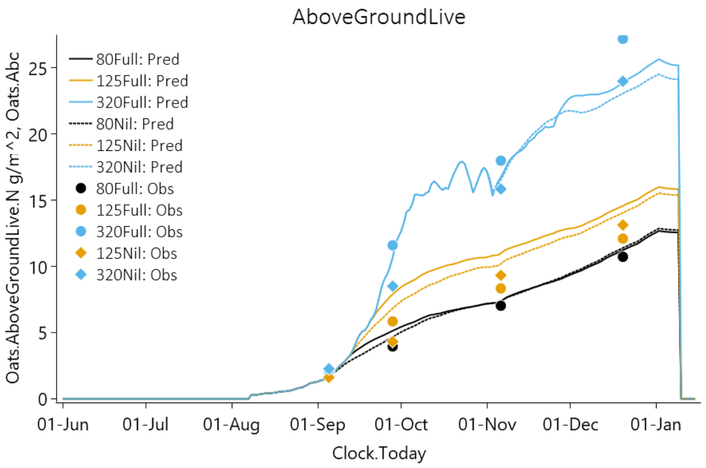






#### 4.3.5.3 Biomass




#### 4.3.5.4 Nitrogen




## 4.4 Australia

The Oats model construction for Australian varieties was based primarily around the experiment at Gatton in 2007. Supporting phenology data was collected at the Leslie Research Centre (LRC) and Wellcamp Research Station for northern varieties, data kindly supplied by Bruce Winter, Oats Breeder with DAFQ. The model was then extended to data sets at Roma in QLD, and also sites in South Australia (Tarlee, Pinery) where additional adjustments were made to the relevant varieties.

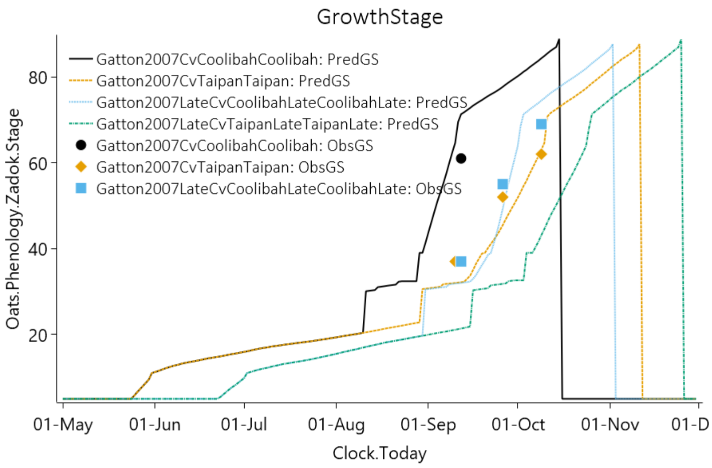
The Gatton, Roma, Tarlee, and Pinery experiments were used to construct the original APSIM Oats model and published at the Australian Agronomy Conference in 2008.

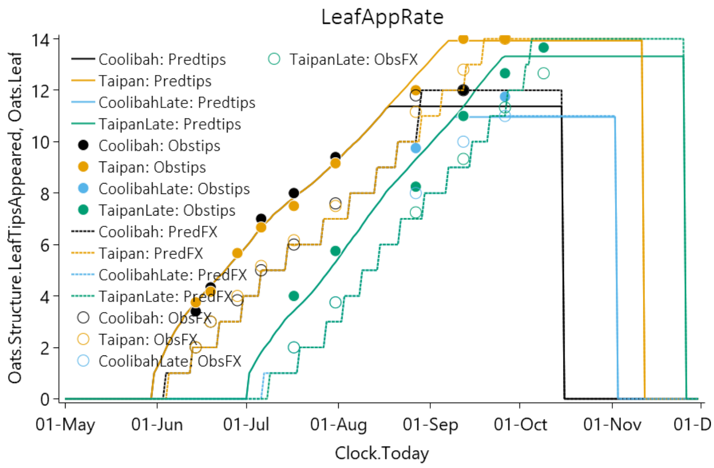
Peake A, Whitbread A, Davoren B, Braun J and Limpus, S. (2008). The development of a model in APSIM for the simulation of grazing oats and oaten hay. In: Global Issues, Paddock Action. Proceedings of the 14th ASA Conference, 21-25 September 2008, Adelaide, South Australia.

### 4.4.1 Gatton2007

This experiment comprised an early and late sowing date, but full growth and soil water data was only collected for the early sowing date. The late sowing date was comprised of observation plots for phenology data collection only.

Extinction coefficient and 'kl' values were measured on the early sowing date in addition to partitioned biomass data. Note that the kl values measured and used to simulated this irrigated trial were high, and may not apply to many dryland situations. Other simulations in the Australian validation data sets used the traditional wheat kl values for dryland situations.

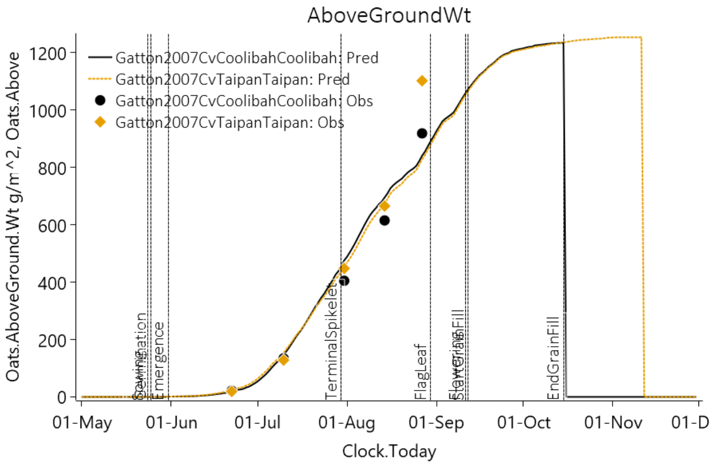


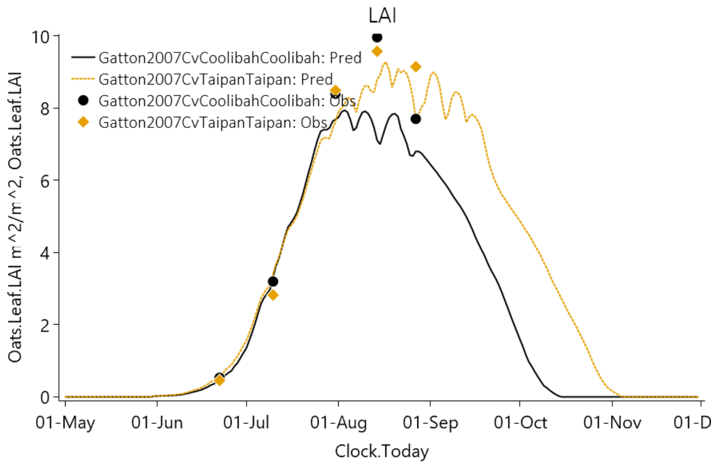



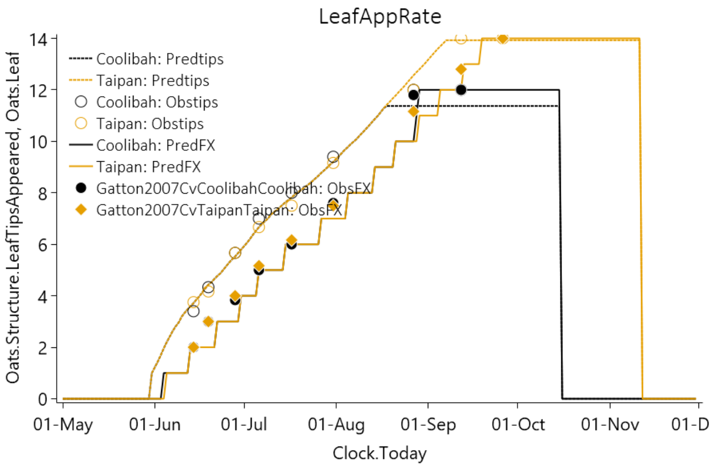

#### 4.4.1.1 Gatton2007early

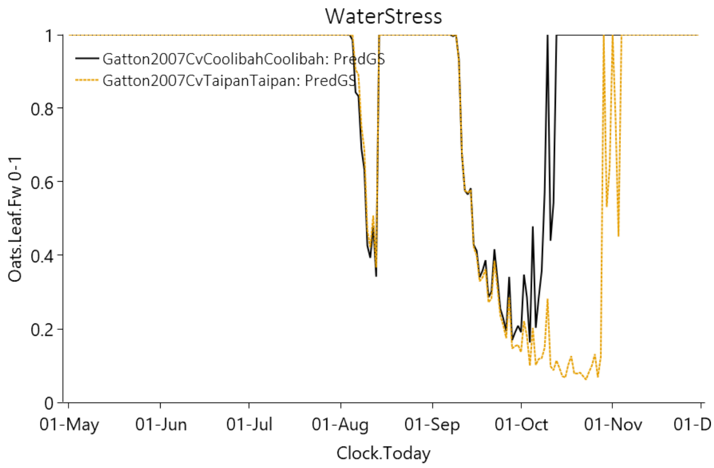
**List of experiments.**

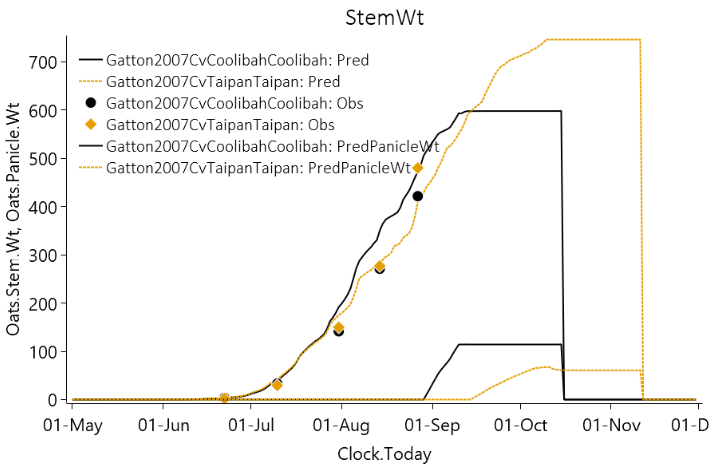
| Experiment Name | Design (Number of Treatments) |
|---|---|
| Gatton2007 | Cv (2) |

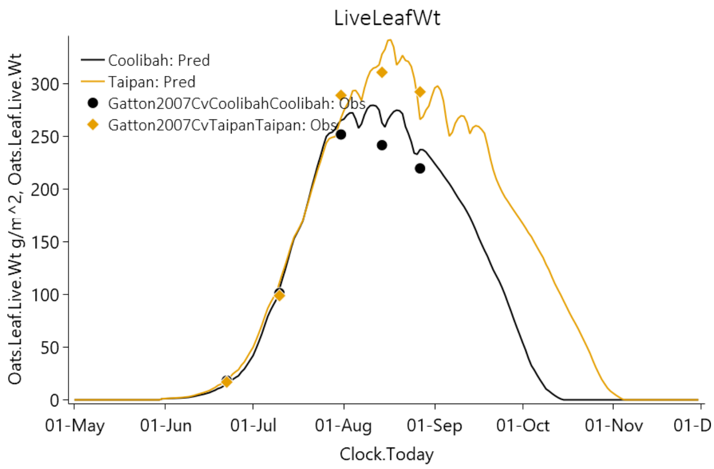

AboveGroundWt
Gatton2007CvCoolibahCoolibah: Pred
Gatton2007CvTaipanTaipan: Pred
Gatton2007CvCoolibahCoolibah: Obs
Gatton2007CvTaipanTaipan: Obs
Oats.AboveGround.Wt g/m^2, Oats.Above
Sowing
Germination
Emergence
TerminalSpikelet
FlagLeaf
Flowering
StartGrainFill
EndGrainFill
0
200
400
600
800
1000
1200
01-May
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
01-D
Clock.Today

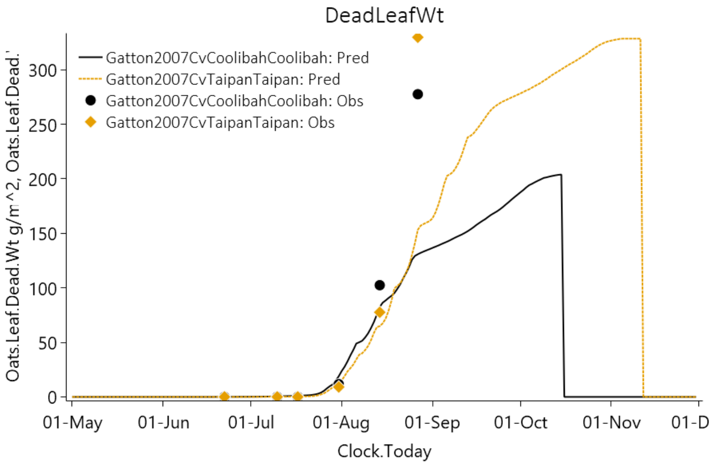

LAI
Gatton2007CvCoolibahCoolibah: Pred
Gatton2007CvTaipanTaipan: Pred
Gatton2007CvCoolibahCoolibah: Obs
Gatton2007CvTaipanTaipan: Obs
Oats.Leaf.LAI m^2/m^2, Oats.Leaf.LAI
0
2
4
6
8
10
01-May
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
01-D
Clock.Today

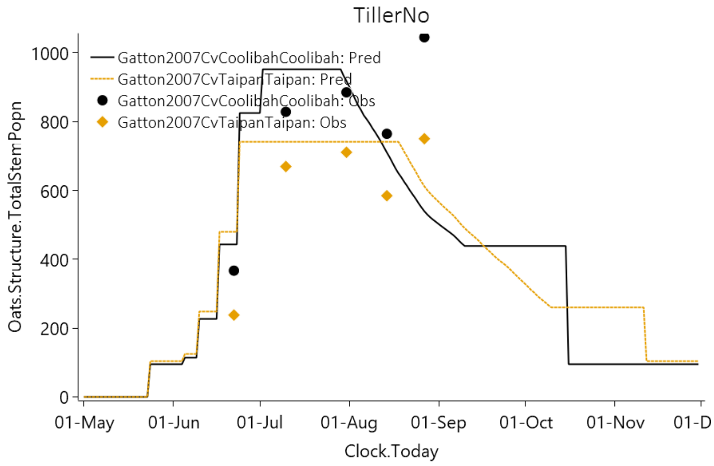

LeafAppRate
Coolibah: Predtips
Taipan: Predtips
Coolibah: Obstips
Taipan: Obstips
Coolibah: PredFX
Taipan: PredFX
Gatton2007CvCoolibahCoolibah: ObsFX
Gatton2007CvTaipanTaipan: ObsFX
Oats.Structure.LeafTipsAppeared, Oats.Leaf
0
2
4
6
8
10
12
14
01-May
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
01-D
Clock.Today

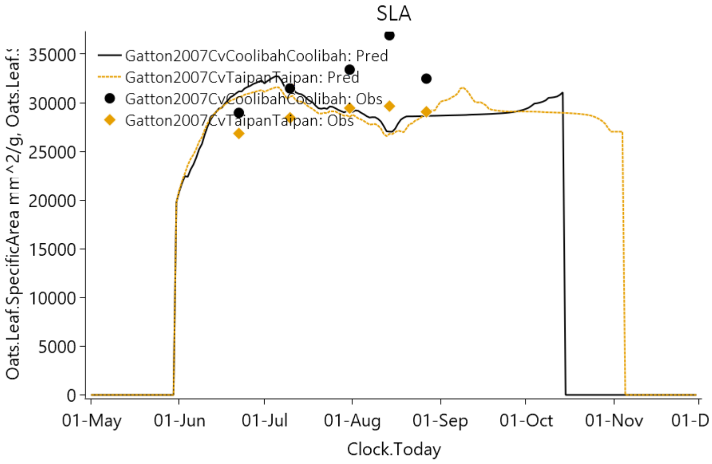

WaterStress
Gatton2007CvCoolibahCoolibah: PredGS
Gatton2007CvTaipanTaipan: PredGS
Oats.Leaf.Fw 0-1
0
0.2
0.4
0.6
0.8
1
01-May
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
01-D
Clock.Today

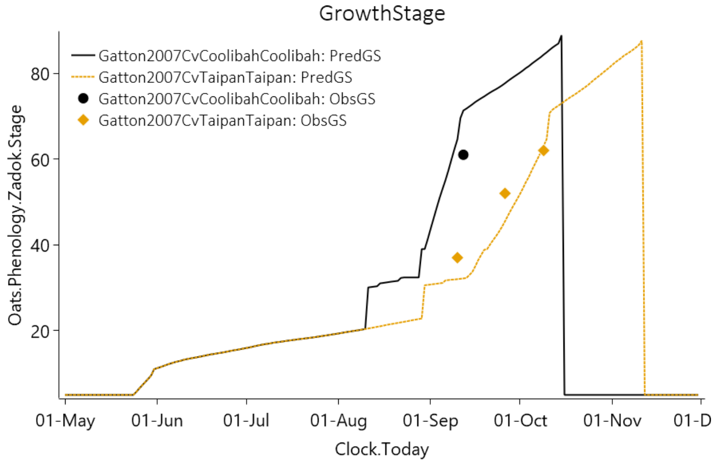

StemWt
Gatton2007CvCoolibahCoolibah: Pred
Gatton2007CvTaipanTaipan: Pred
Gatton2007CvCoolibahCoolibah: Obs
Gatton2007CvTaipanTaipan: Obs
Gatton2007CvCoolibahCoolibah: PredPanicleWt
Gatton2007CvTaipanTaipan: PredPanicleWt
Oats.Stem.Wt, Oats.Panicle.Wt
0
100
200
300
400
500
600
700
01-May
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
01-D
Clock.Today

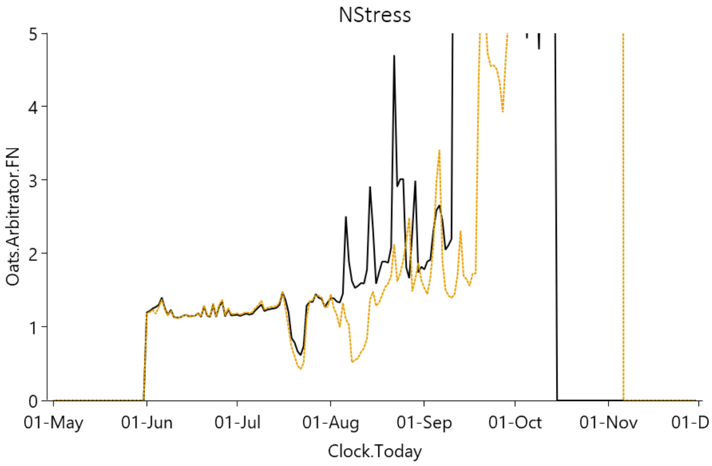

LiveLeafWt
Coolibah: Pred
Taipan: Pred
Gatton2007CvCoolibahCoolibah: Obs
Gatton2007CvTaipanTaipan: Obs
Oats.Leaf.Live.Wt g/m^2, Oats.Leaf.Live.Wt
0
50
100
150
200
250
300
01-May
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
01-D
Clock.Today

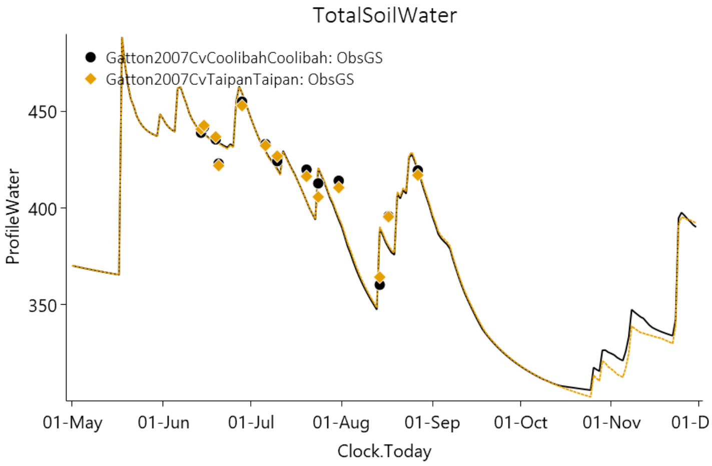

DeadLeafWt
Gatton2007CvCoolibahCoolibah: Pred
Gatton2007CvTaipanTaipan: Pred
Gatton2007CvCoolibahCoolibah: Obs
Gatton2007CvTaipanTaipan: Obs
Oats.Leaf.Dead.Wt g/m^2, Oats.Leaf.Dead.
Clock.Today

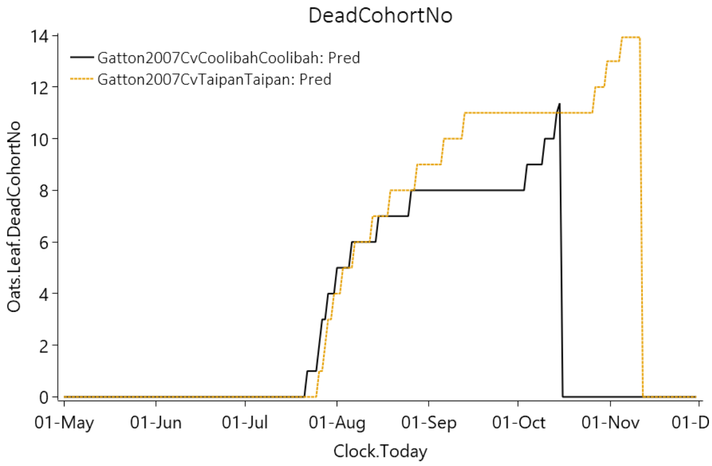

TillerNo
Gatton2007CvCoolibahCoolibah: Pred
Gatton2007CvTaipanTaipan: Pred
Gatton2007CvCoolibahCoolibah: Obs
Gatton2007CvTaipanTaipan: Obs
Oats.Structure.TotalStemPopn
Clock.Today

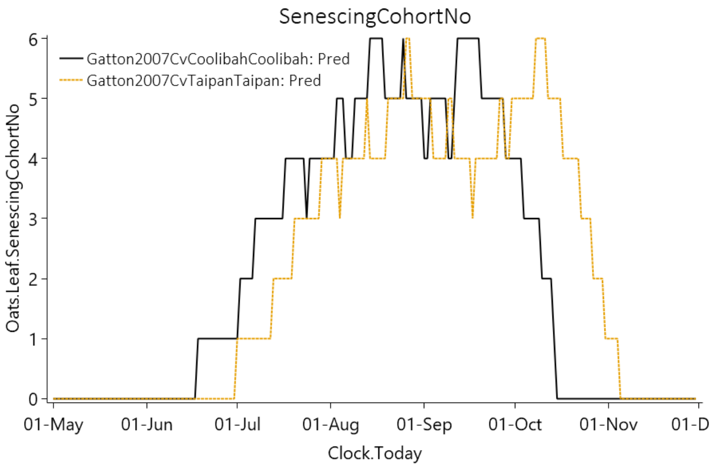

SLA
Gatton2007CvCoolibahCoolibah: Pred
Gatton2007CvTaipanTaipan: Pred
Gatton2007CvCoolibahCoolibah: Obs
Gatton2007CvTaipanTaipan: Obs
Oats.Leaf.SpecificArea mm^2/g, Oats.Leaf.
Clock.Today

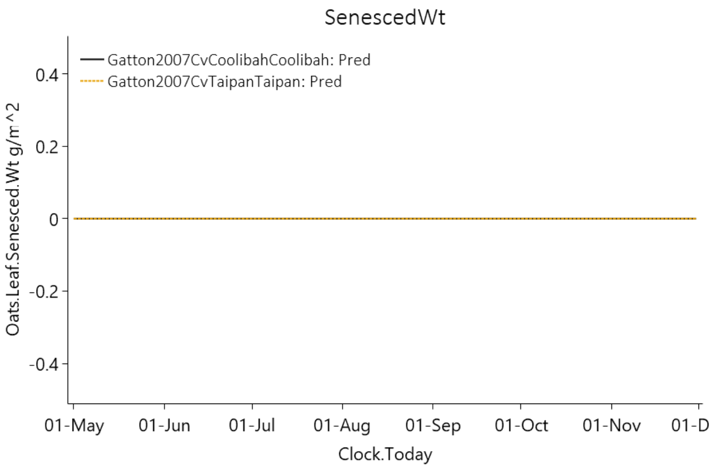

GrowthStage
Gatton2007CvCoolibahCoolibah: PredGS
Gatton2007CvTaipanTaipan: PredGS
Gatton2007CvCoolibahCoolibah: ObsGS
Gatton2007CvTaipanTaipan: ObsGS
Oats.Phenology.Zadok.Stage
Clock.Today


NStress
Oats.Arbitrator.FN
Clock.Today

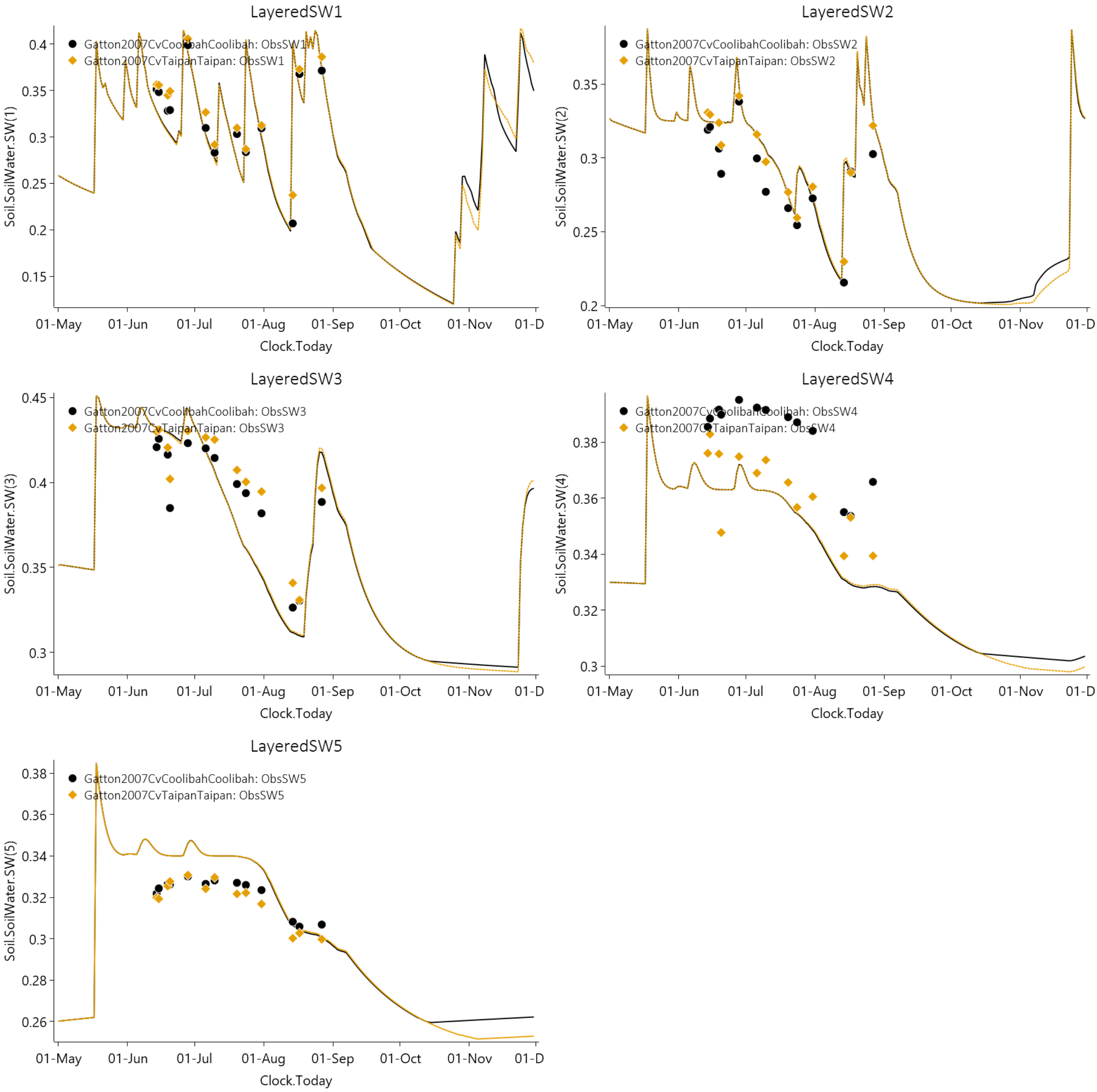

TotalSoilWater
Gatton2007CvCoolibahCoolibah: ObsGS
Gatton2007CvTaipanTaipan: ObsGS
ProfileWater
Clock.Today


DeadCohortNo
Gatton2007CvCoolibahCoolibah: Pred
Gatton2007CvTaipanTaipan: Pred
Oats.Leaf.DeadCohortNo
Clock.Today


SenescingCohortNo
Gatton2007CvCoolibahCoolibah: Pred
Gatton2007CvTaipanTaipan: Pred
Oats.Leaf.SenescingCohortNo
Clock.Today


SenescedWt
Gatton2007CvCoolibahCoolibah: Pred
Gatton2007CvTaipanTaipan: Pred
Oats.Leaf.Senesced.Wt g/m^2
Clock.Today

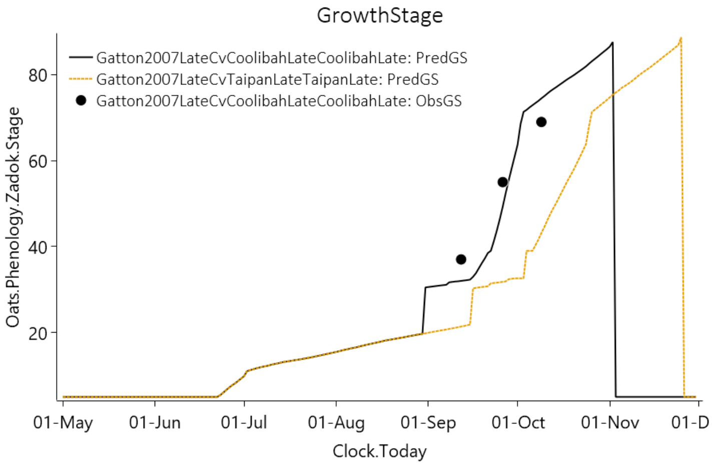
#### 4.4.1.1.1 Layered SW

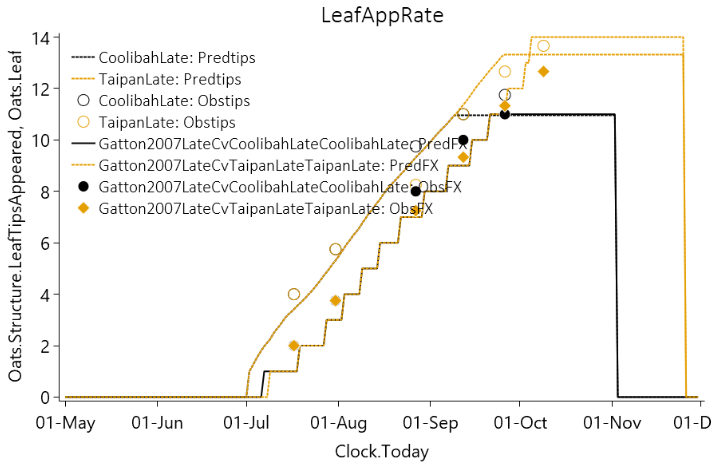



### 4.4.1.2 Gatton2007LATEsown

### List of experiments.

| Experiment Name | Design (Number of Treatments) |
|---|---|
| Gatton2007Late | Cv (2) |




#### 4.4.1.2.1 Gatton2007Late

The late sown experiment at Gatton in 2007 was comprised of observation plots of the two varieties used in the early sowing date. 4 plants were monitored for phenology (Leaf Appearance Rate and Zadoks stage) from each observation plot.

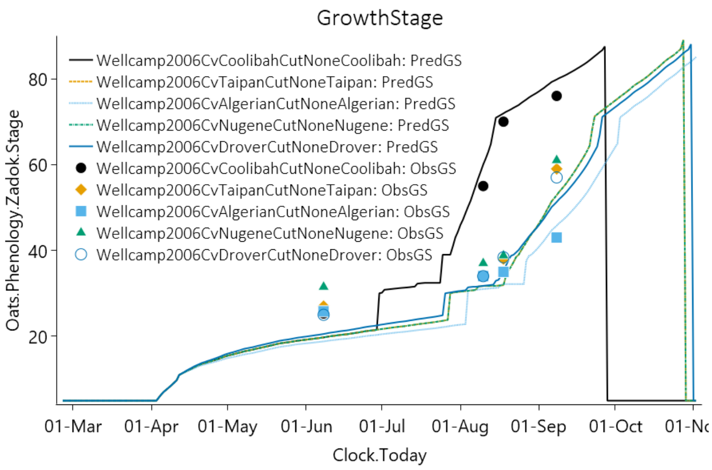
### 4.4.2 Wellcamp2006

This experiment was run at DPI Wellcamp Research Station, Queensland in 2006. Phenology data (Zadok stage) was the only data collected.

This experiment was a phenology experiment based on small and narrow observation plots (4 rows) in conjunction with a QDAF Oats breeing trial. The decision was taken to use a nearby SILO met-data set rather than the onsite weather station, due to the possibility that the onsite met station had not been calibrated for some time.

**List of experiments.**

| Experiment Name | Design (Number of Treatments) |
|---:|---:|
| Wellcamp2006 | (15) |




### 4.4.3 Roma2006

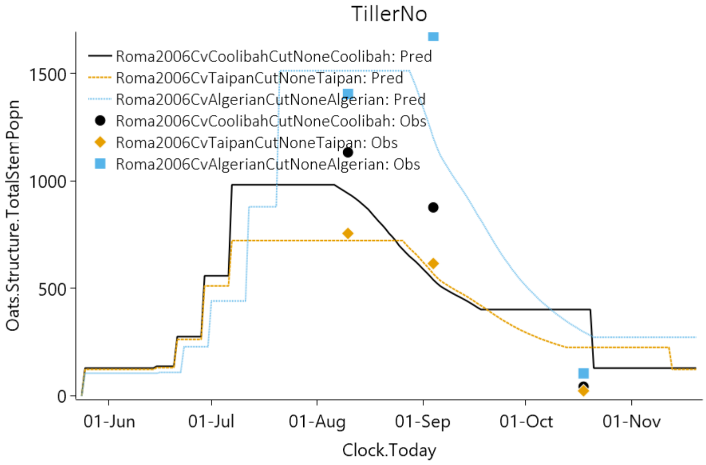
This experiment was run at Roma Research Station, Queensland in 2006. Two reps were used to generate cut and regrowth data (two cuts taken). The third rep was split in two, and one half was used to allow unlimited growth (no cutting), and the other half was only cut once. Soil water data for the ungrazed treatment was sourced exclusively from rep 3 except for the sowing PAW which was measured bulked across the experiment.

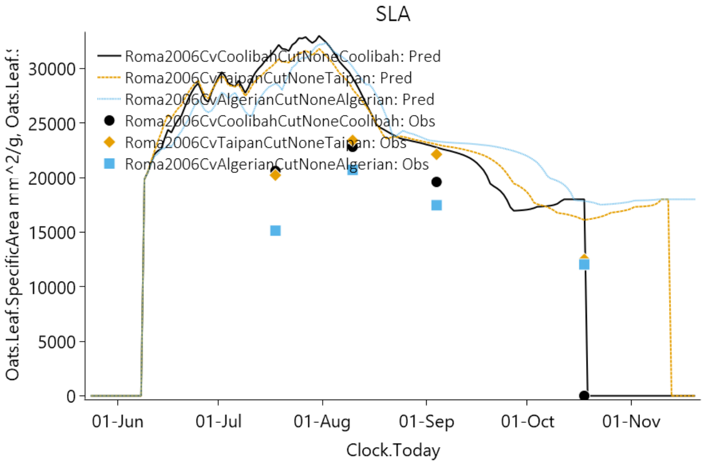
Inaccuracy in the prediction of SLA and LAI was probably due to measurement error. The trial was heavily water stressed and it was difficult to accurately measure leaf area of curled, drought stress leaves, particularly when they were stored overnight.

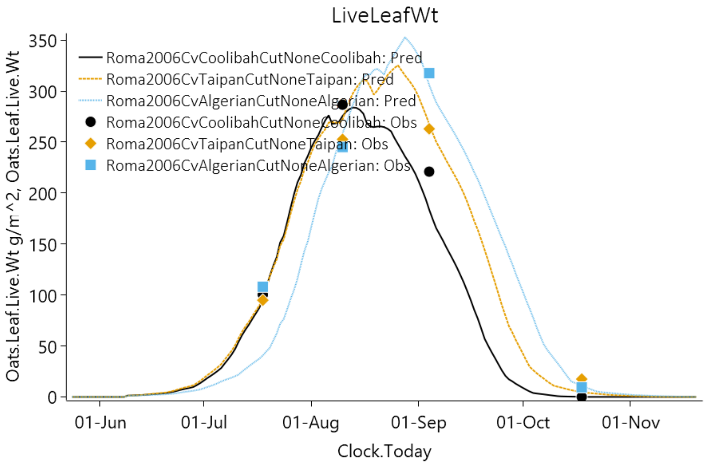
**List of experiments.**

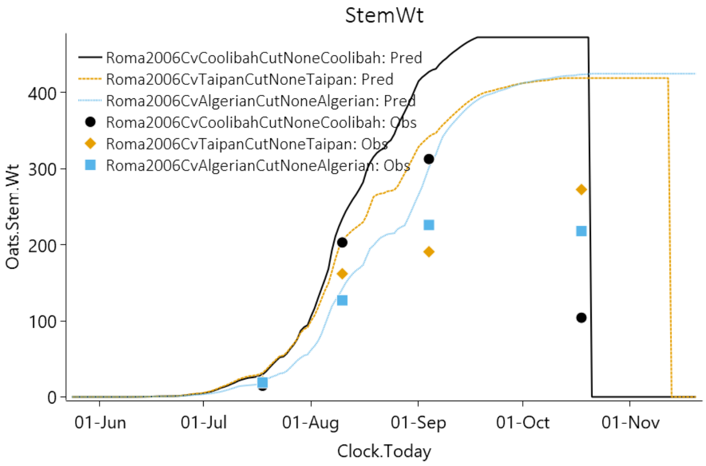
| Experiment Name | Design (Number of Treatments) |
|---:|---:|
| Roma2006 | (9) |

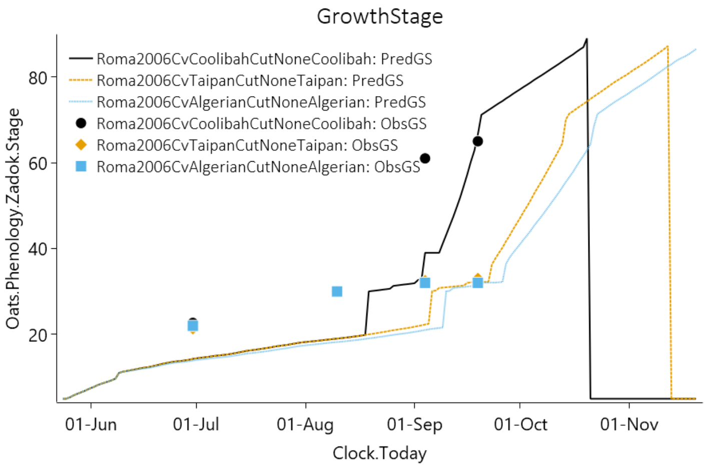
#### 4.4.3.1 UngrazedGraphs

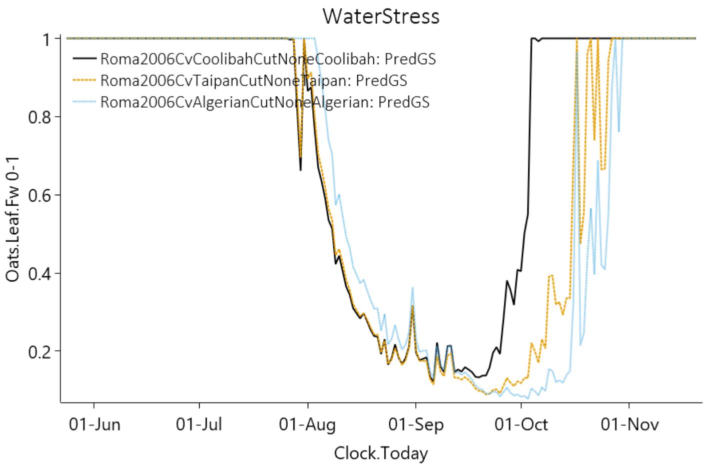


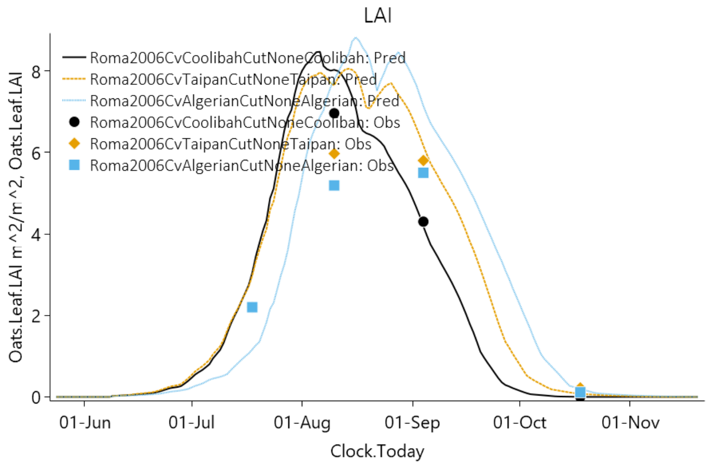



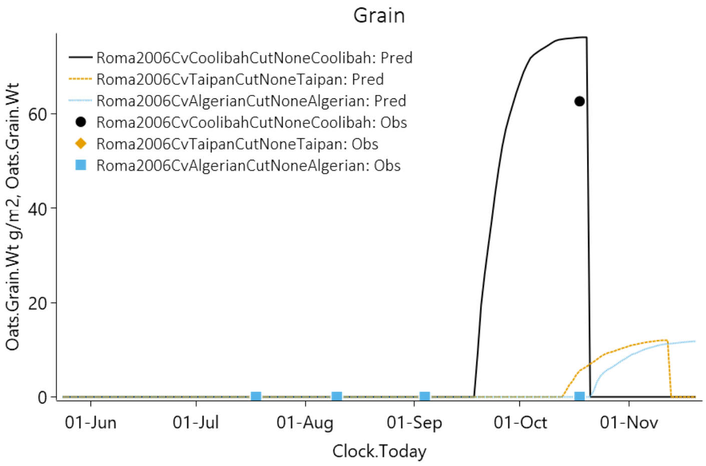



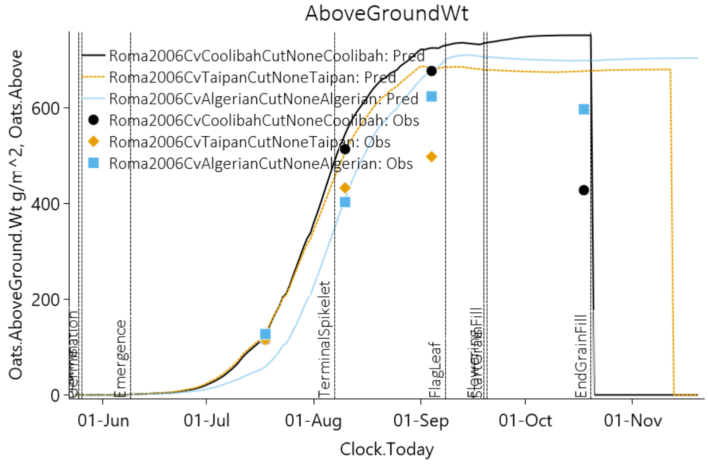



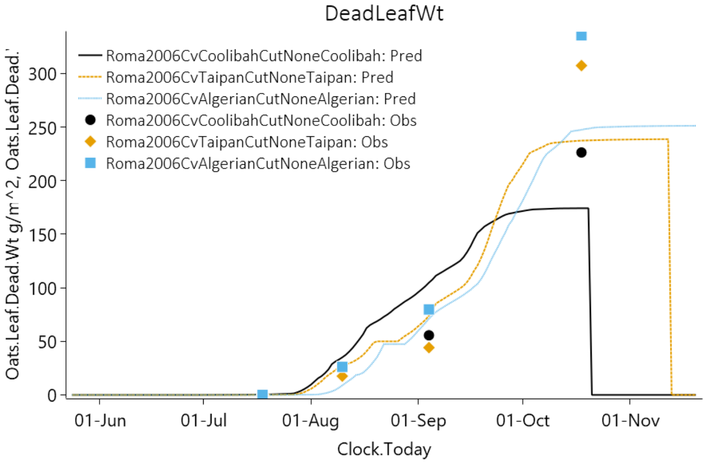



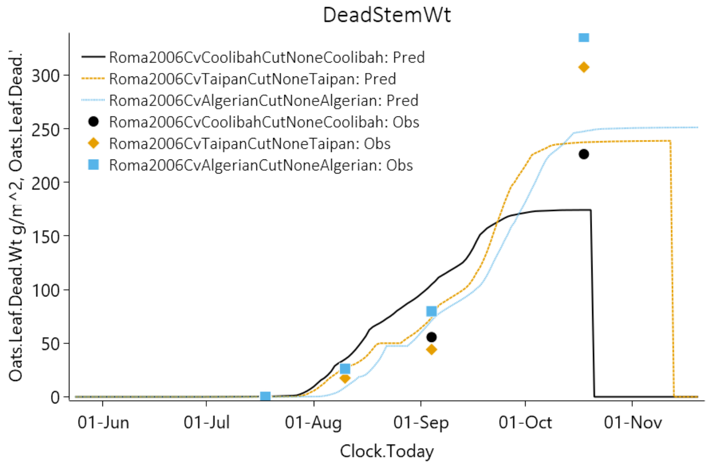



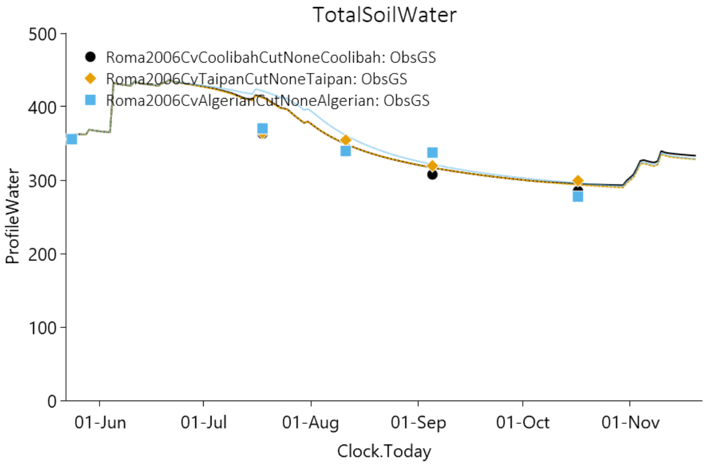

LAI
Roma2006CvCoolibahCutNoneCoolibah: Pred
Roma2006CvTaipanCutNoneTaipan: Pred
Roma2006CvAlgerianCutNoneAlgerian: Pred
Roma2006CvCoolibahCutNoneCoolibah: Obs
Roma2006CvTaipanCutNoneTaipan: Obs
Roma2006CvAlgerianCutNoneAlgerian: Obs
Oats.Leaf.LAI m^2/m^2, Oats.Leaf.LAI
0
2
4
6
8
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
Clock.Today


Grain
Roma2006CvCoolibahCutNoneCoolibah: Pred
Roma2006CvTaipanCutNoneTaipan: Pred
Roma2006CvAlgerianCutNoneAlgerian: Pred
Roma2006CvCoolibahCutNoneCoolibah: Obs
Roma2006CvTaipanCutNoneTaipan: Obs
Roma2006CvAlgerianCutNoneAlgerian: Obs
Oats.Grain.Wt g/m2, Oats.Grain.Wt
0
20
40
60
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
Clock.Today

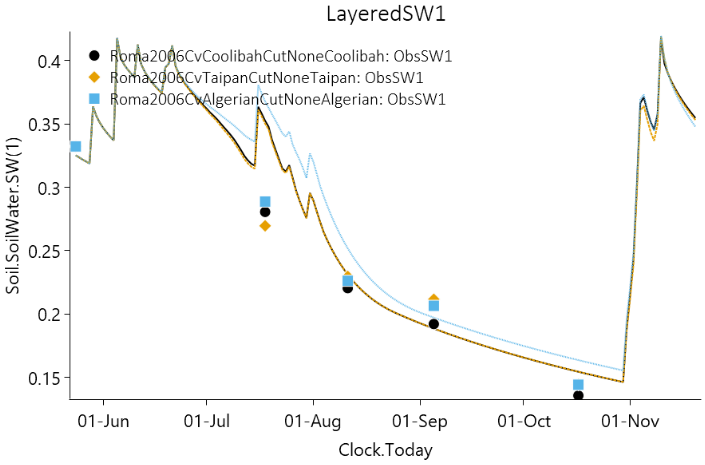

AboveGroundWt
Roma2006CvCoolibahCutNoneCoolibah: Pred
Roma2006CvTaipanCutNoneTaipan: Pred
Roma2006CvAlgerianCutNoneAlgerian: Pred
Roma2006CvCoolibahCutNoneCoolibah: Obs
Roma2006CvTaipanCutNoneTaipan: Obs
Roma2006CvAlgerianCutNoneAlgerian: Obs
Oats.AboveGround.Wt g/m^2, Oats.Above
Germination
Emergence
TerminalSpikelet
FlagLeaf
Flowering
StartGrainFill
EndGrainFill
0
200
400
600
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
Clock.Today

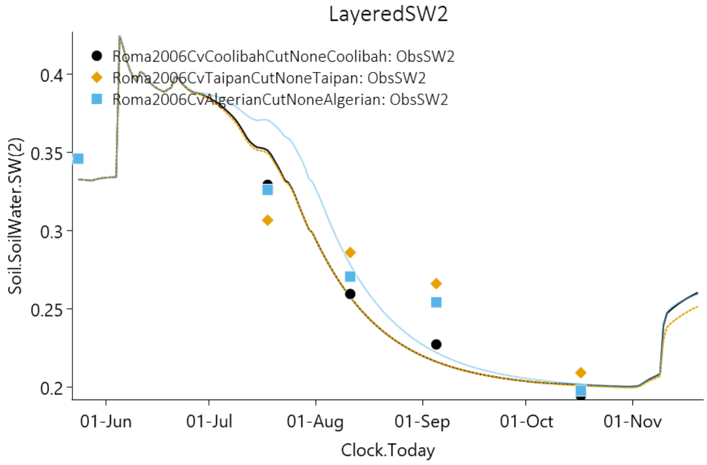

DeadLeafWt
Roma2006CvCoolibahCutNoneCoolibah: Pred
Roma2006CvTaipanCutNoneTaipan: Pred
Roma2006CvAlgerianCutNoneAlgerian: Pred
Roma2006CvCoolibahCutNoneCoolibah: Obs
Roma2006CvTaipanCutNoneTaipan: Obs
Roma2006CvAlgerianCutNoneAlgerian: Obs
Oats.Leaf.Dead.Wt g/m^2, Oats.Leaf.Dead.'
0
50
100
150
200
250
300
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
Clock.Today

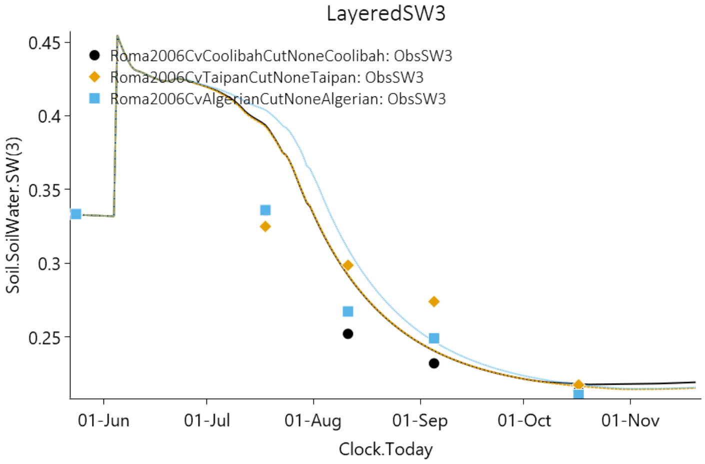

DeadStemWt
Roma2006CvCoolibahCutNoneCoolibah: Pred
Roma2006CvTaipanCutNoneTaipan: Pred
Roma2006CvAlgerianCutNoneAlgerian: Pred
Roma2006CvCoolibahCutNoneCoolibah: Obs
Roma2006CvTaipanCutNoneTaipan: Obs
Roma2006CvAlgerianCutNoneAlgerian: Obs
Oats.Leaf.Dead.Wt g/m^2, Oats.Leaf.Dead.'
0
50
100
150
200
250
300
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
Clock.Today

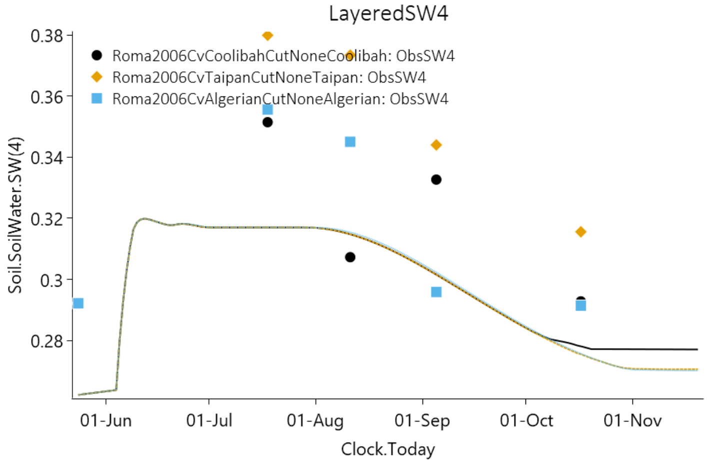

TotalSoilWater
Roma2006CvCoolibahCutNoneCoolibah: ObsGS
Roma2006CvTaipanCutNoneTaipan: ObsGS
Roma2006CvAlgerianCutNoneAlgerian: ObsGS
ProfileWater
0
100
200
300
400
500
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
Clock.Today

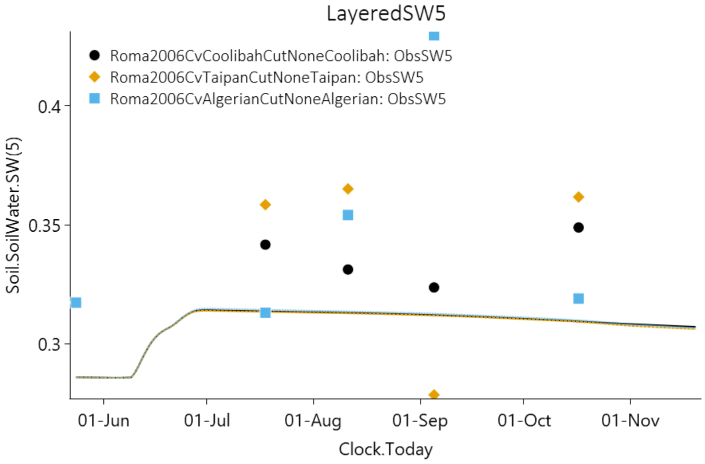
#### 4.4.3.2 LayeredSWUncut



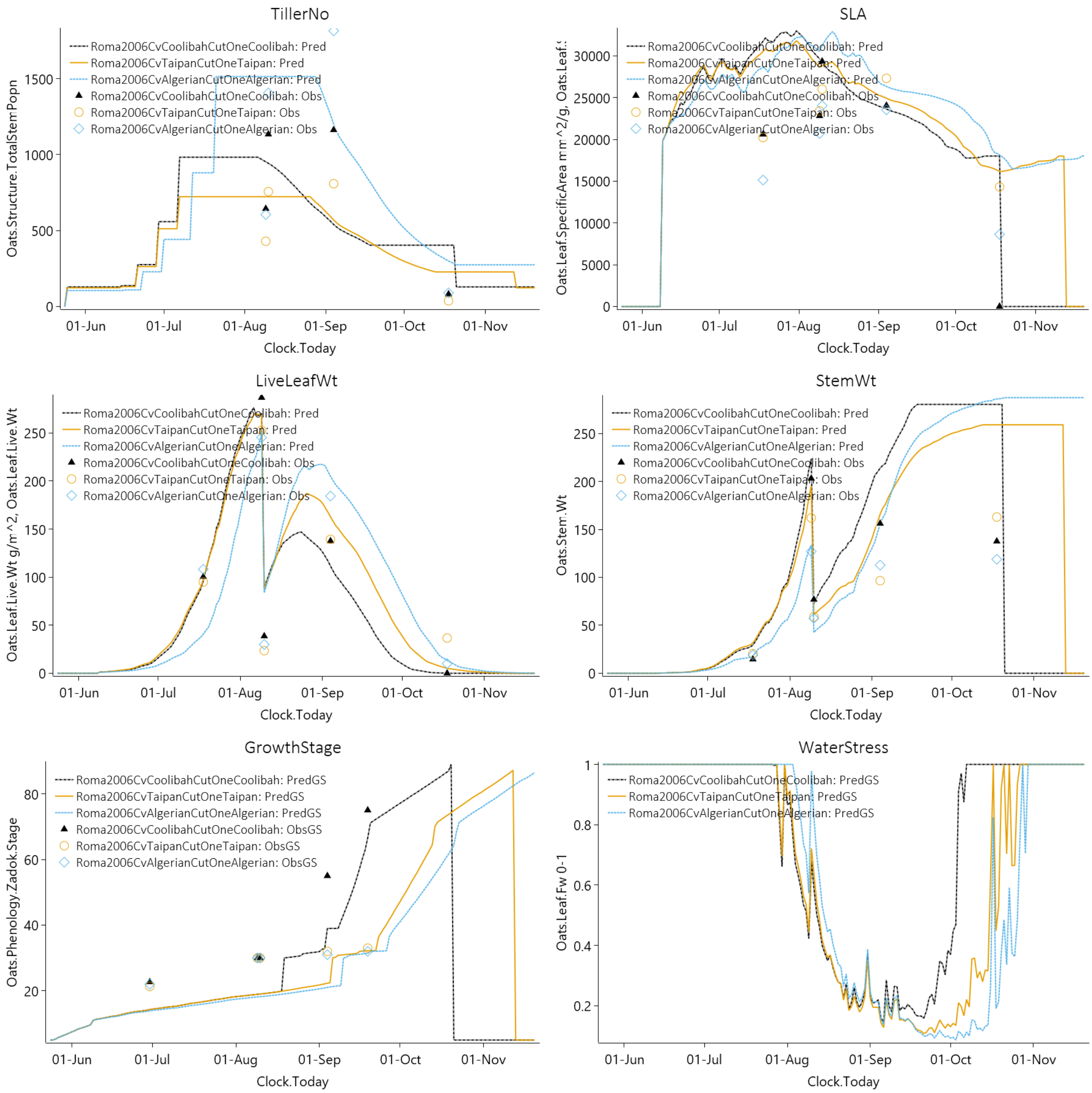



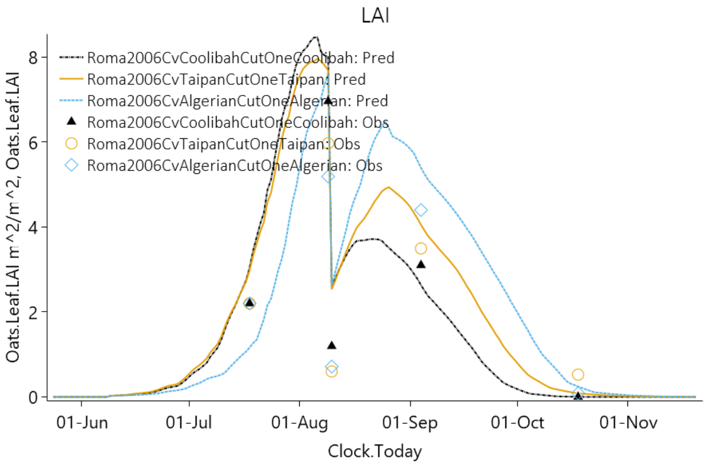



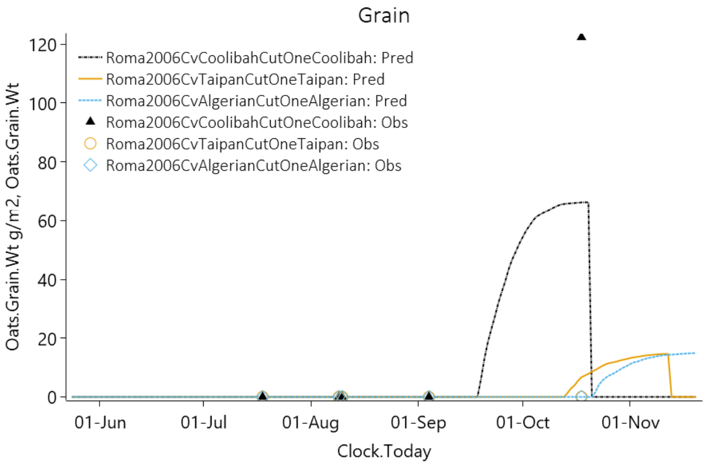



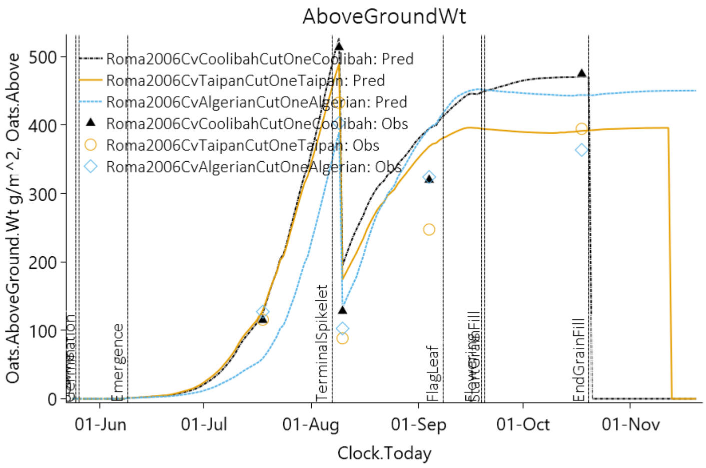



#### 4.4.3.3 OneCutGraphs

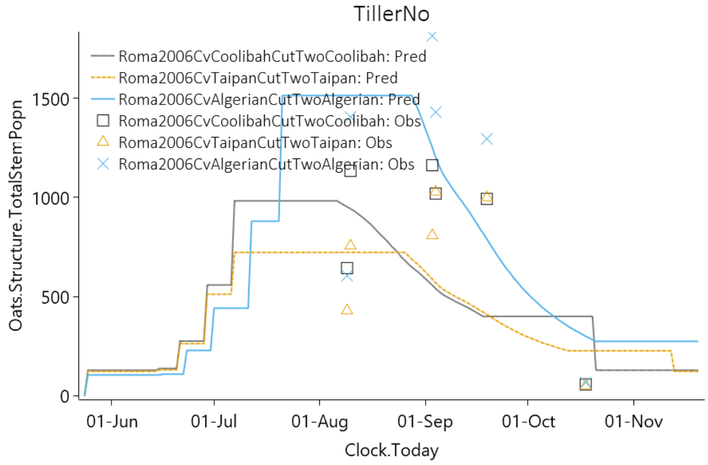


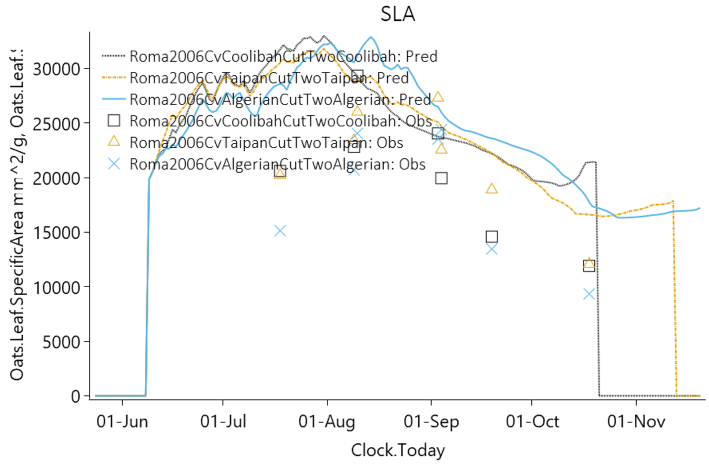

LAI
Roma2006CvCoolibahCutOneCoolibah: Pred
Roma2006CvTaipanCutOneTaipan: Pred
Roma2006CvAlgerianCutOneAlgerian: Pred
Roma2006CvCoolibahCutOneCoolibah: Obs
Roma2006CvTaipanCutOneTaipan: Obs
Roma2006CvAlgerianCutOneAlgerian: Obs
Oats.Leaf.LAI m^2/m^2, Oats.Leaf.LAI
8
6
4
2
0
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
Clock.Today

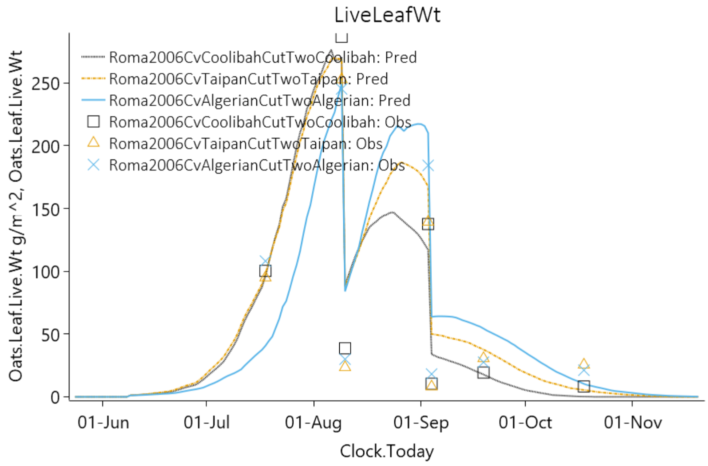

Grain
Roma2006CvCoolibahCutOneCoolibah: Pred
Roma2006CvTaipanCutOneTaipan: Pred
Roma2006CvAlgerianCutOneAlgerian: Pred
Roma2006CvCoolibahCutOneCoolibah: Obs
Roma2006CvTaipanCutOneTaipan: Obs
Roma2006CvAlgerianCutOneAlgerian: Obs
Oats.Grain.Wt g/m^2, Oats.Grain.Wt
120
100
80
60
40
20
0
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
Clock.Today

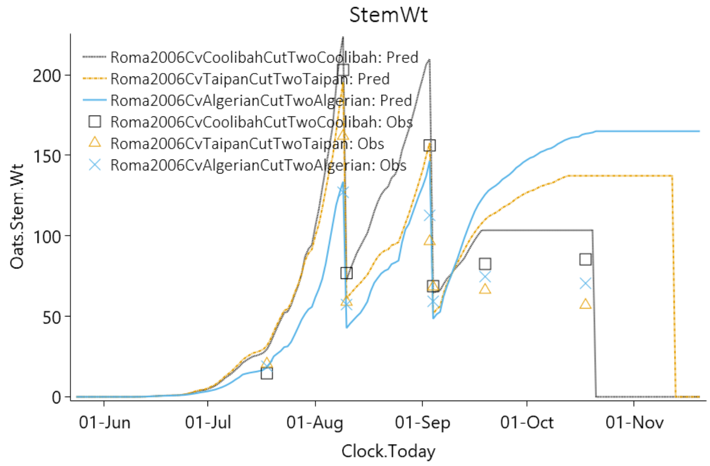

AboveGroundWt
Roma2006CvCoolibahCutOneCoolibah: Pred
Roma2006CvTaipanCutOneTaipan: Pred
Roma2006CvAlgerianCutOneAlgerian: Pred
Roma2006CvCoolibahCutOneCoolibah: Obs
Roma2006CvTaipanCutOneTaipan: Obs
Roma2006CvAlgerianCutOneAlgerian: Obs
Oats.AboveGround.Wt g/m^2, Oats.Above
500
400
300
200
100
0
Emergence
TerminalSpikelet
FlagLeaf
EndGrainFill
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
Clock.Today

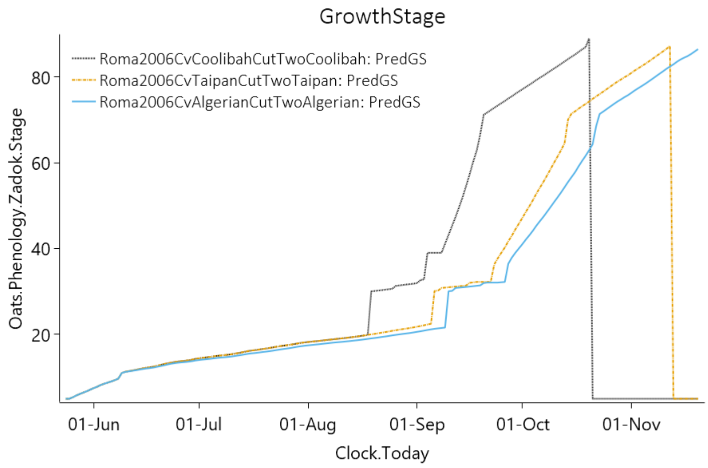
### 4.4.3.4 TwoCutGraphs

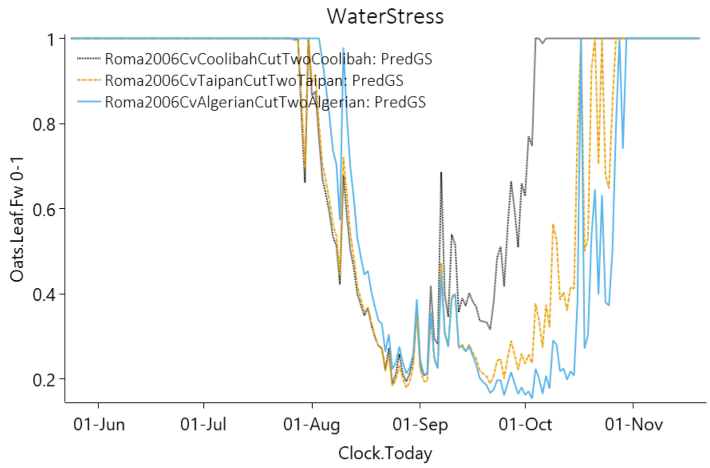


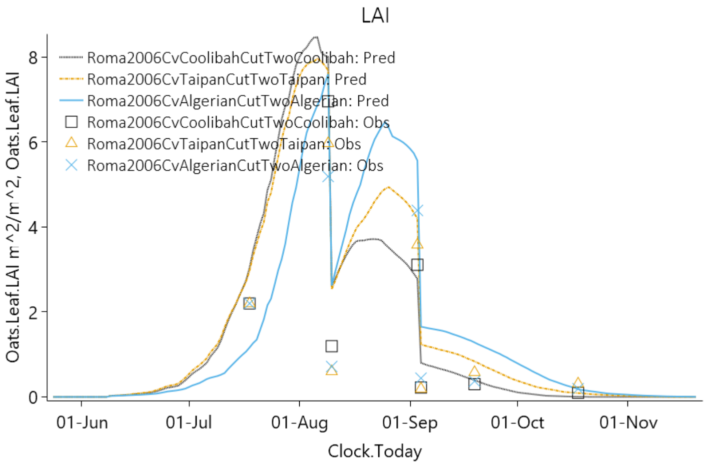



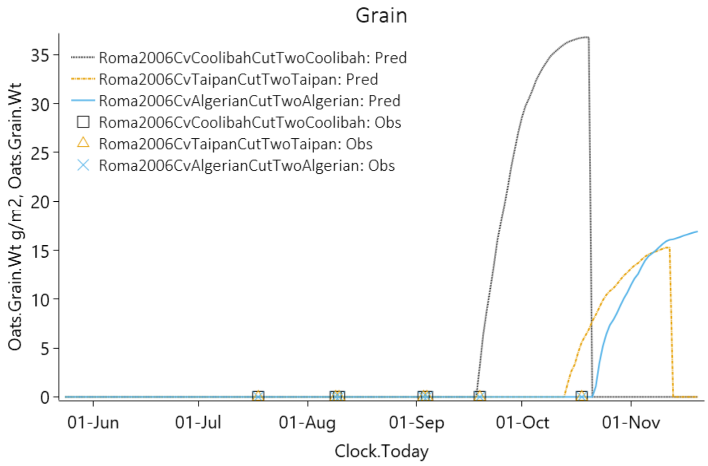



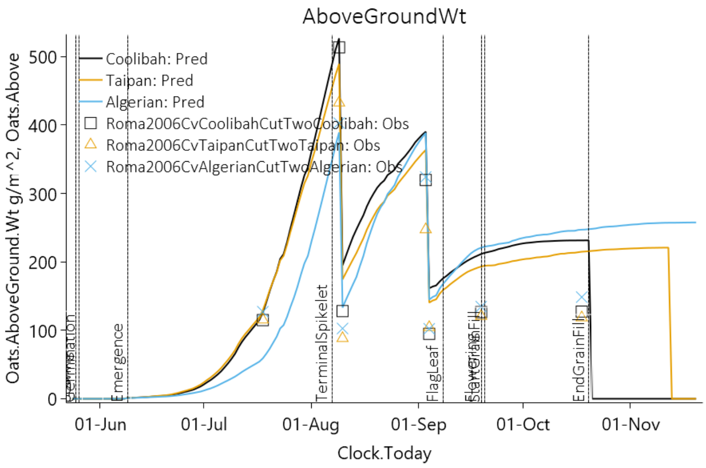





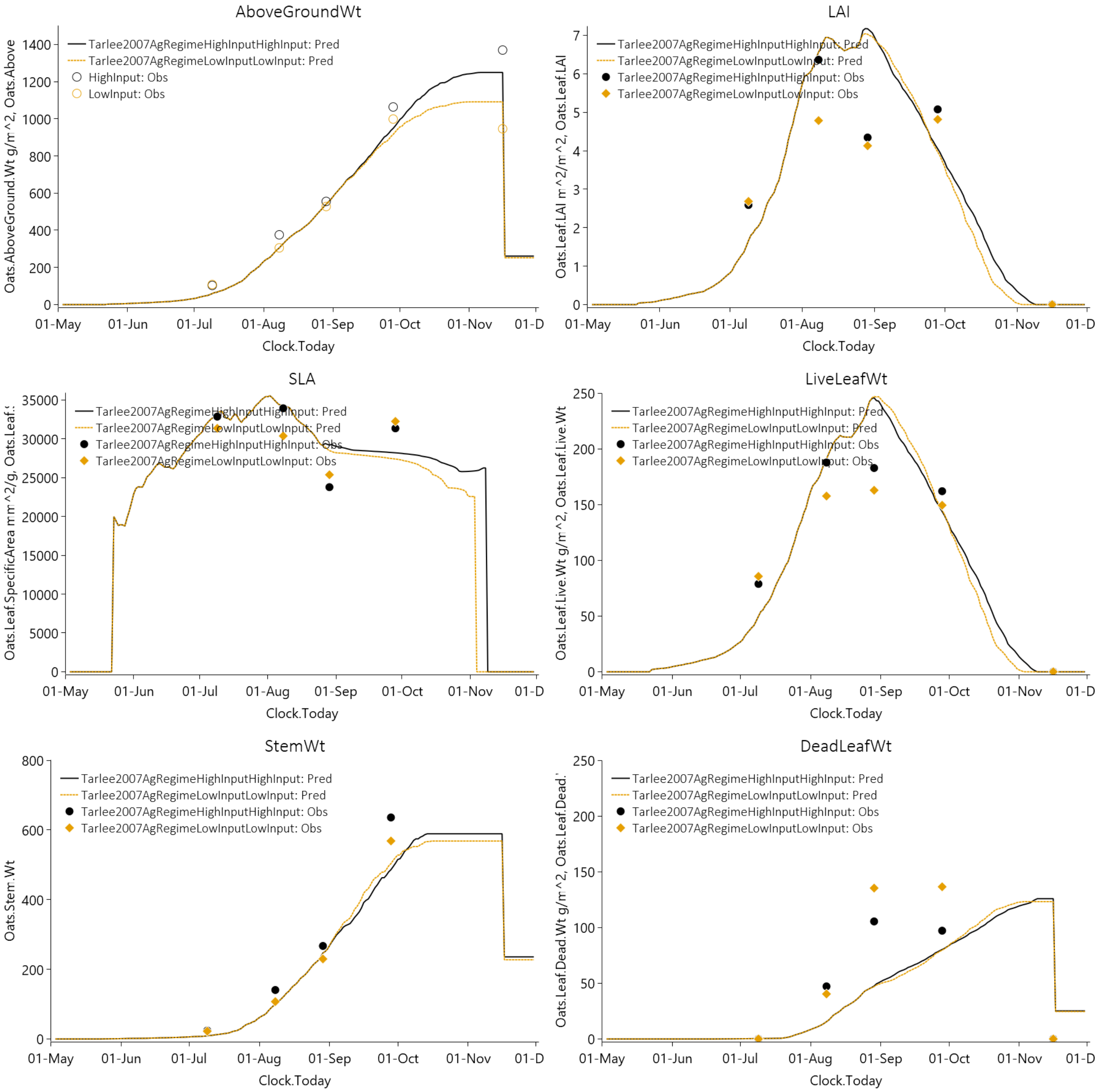




### 4.4.4 Tarlee2007

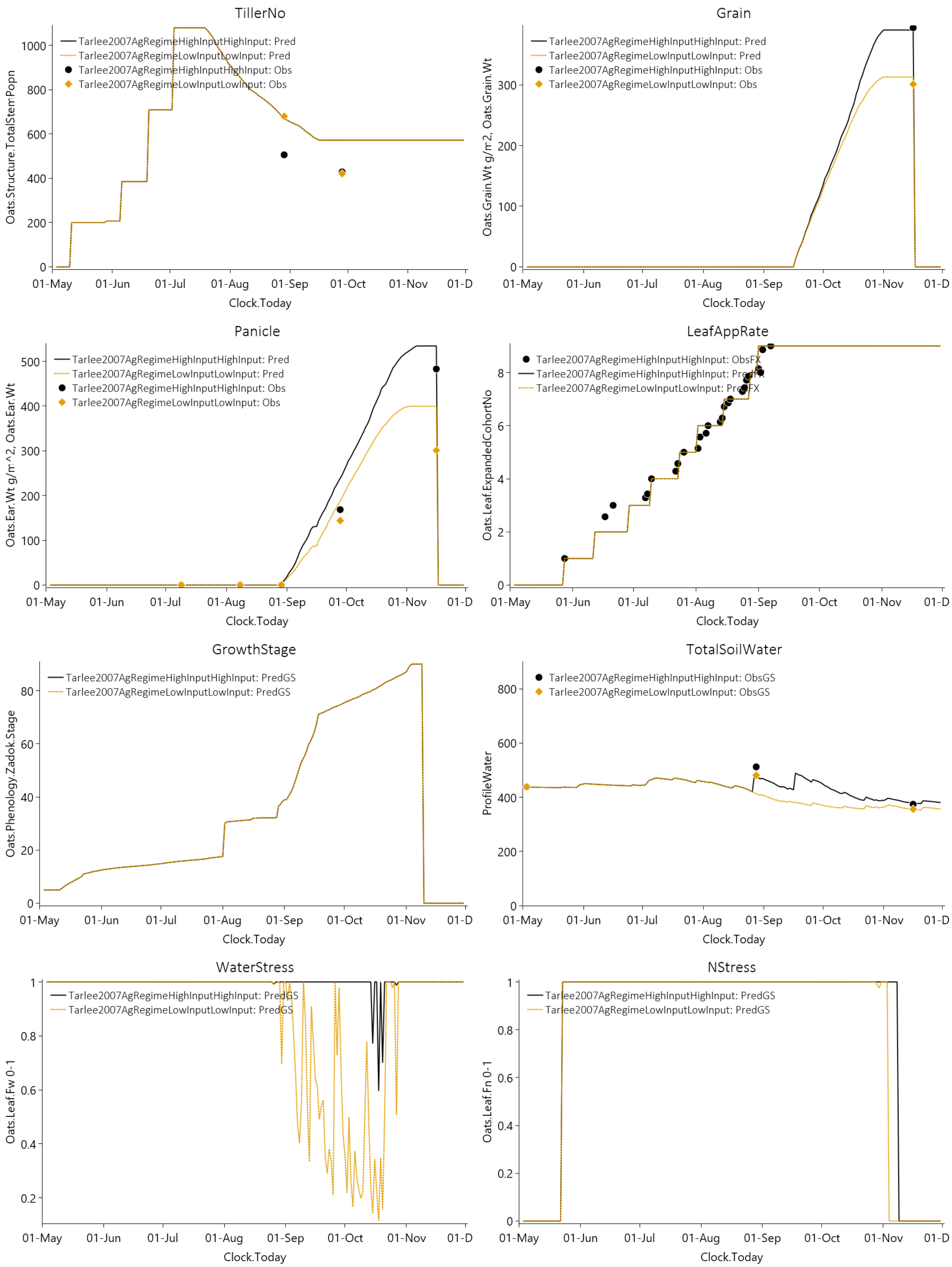
This experiment was run at Tarlee, South Australia, in 2007. Leaf disease (probably yellow spot) was observed to take hold in the latter stages of the experiment that may explain differences between observed and simulated LAI, leaf biomass and dead leaf biomass toward the end of the experiment.

**List of experiments.**

| Experiment Name | Design (Number of Treatments) |
|---:|---:|
| Tarlee2007 | AgRegime (2) |



AboveGroundWt
Tarlee2007AgRegimeHighInputHighInput: Pred
Tarlee2007AgRegimeLowInputLowInput: Pred
HighInput: Obs
LowInput: Obs
Oats.AboveGround.Wt g/m^2, Oats.Above
Clock.Today
LAI
Tarlee2007AgRegimeHighInputHighInput: Pred
Tarlee2007AgRegimeLowInputLowInput: Pred
Tarlee2007AgRegimeHighInputHighInput: Obs
Tarlee2007AgRegimeLowInputLowInput: Obs
Oats.Leaf.LAI m^2/m^2, Oats.Leaf.LAI
Clock.Today
SLA
Oats.Leaf.SpecificArea mm^2/g, Oats.Leaf.
Clock.Today
LiveLeafWt
Oats.Leaf.Live.Wt g/m^2, Oats.Leaf.Live.Wt
Clock.Today
StemWt
Oats.Stem.Wt
Clock.Today
DeadLeafWt
Oats.Leaf.Dead.Wt g/m^2, Oats.Leaf.Dead.
Clock.Today
01-May
01-Jun
01-Jul
01-Aug
01-Sep
01-Oct
01-Nov
01-D



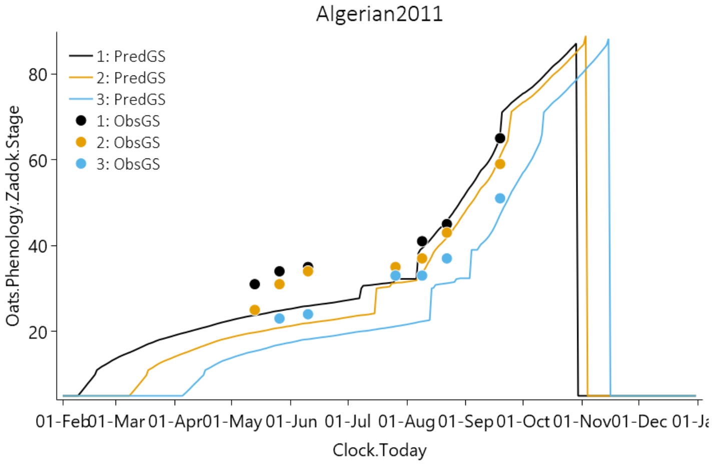

### 4.4.5 LRCphenology

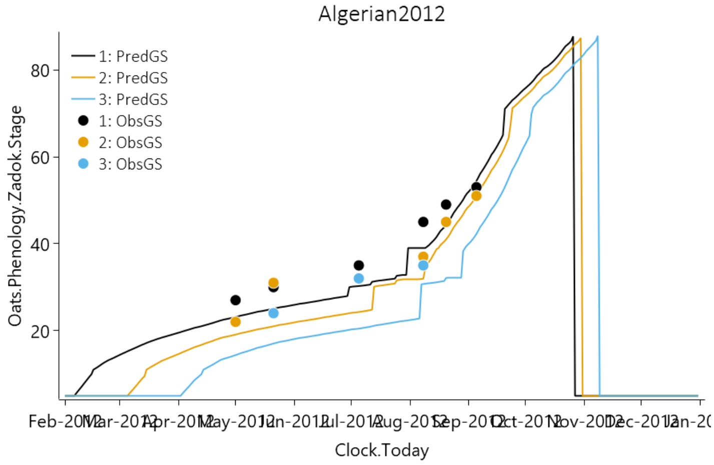
These simulations were used to develop phenology parameters for a range of cultivars used in northern Australia. Observed data was kindly supplied by Bruce Winter (Oats Breeder) and Richard Uebergang from experiments conducted at DAFQ Leslie Research Centre, Holberton St Toowoomba. SILO weather data from the nearby Toowoomba Airport was used. Approximated irrigation data and fertiliser regime was provided by LRC staff who managed the phenology screening trials to be non-water and N limiting.

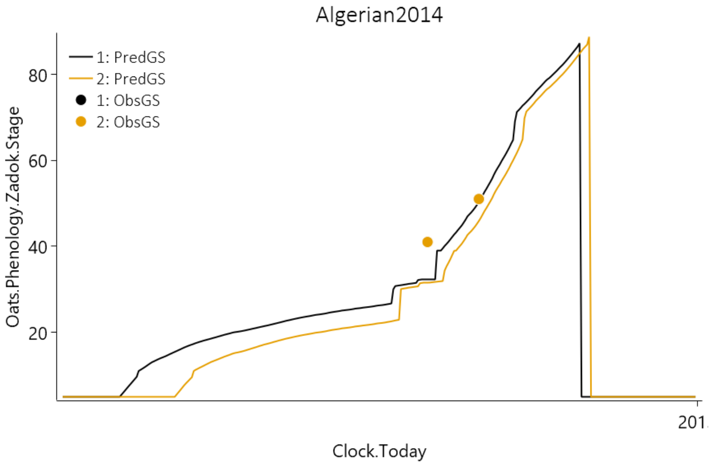
**List of experiments.**

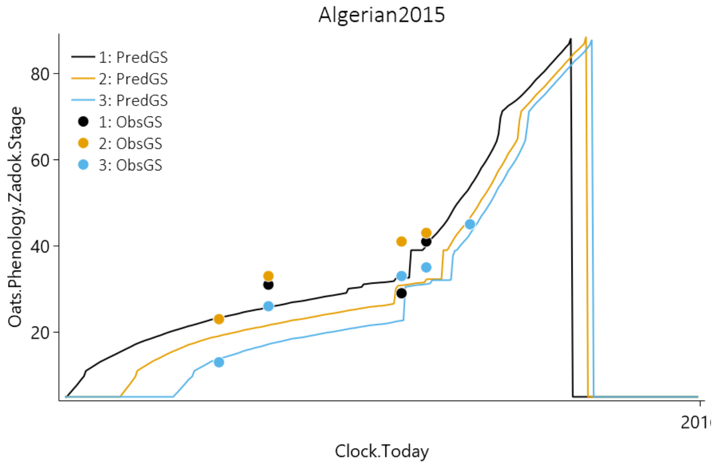
| Experiment Name | Design (Number of Treatments) |
|---:|---:|
| LRC2011 | (12) |
| LRC2012 | (15) |
| LRC2014 | (14) |
| LRC2015 | (21) |
| LRC2016 | (21) |
| LRC2017 | (21) |

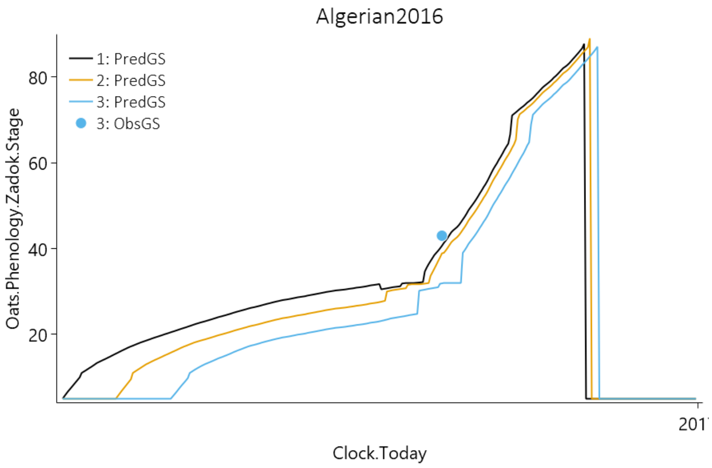
### 4.4.5.1 Algerian

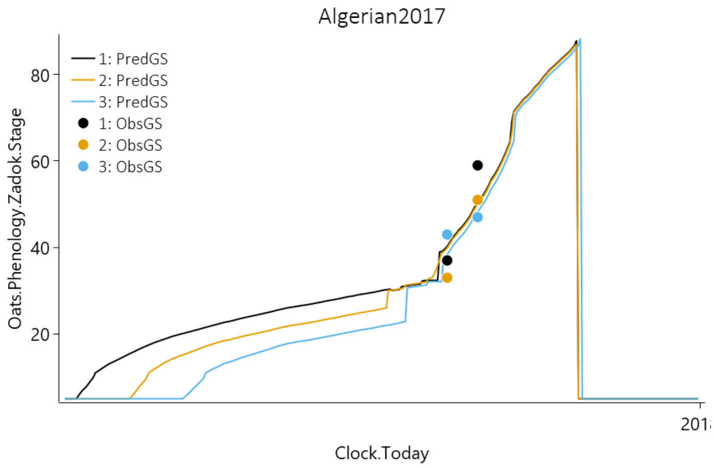


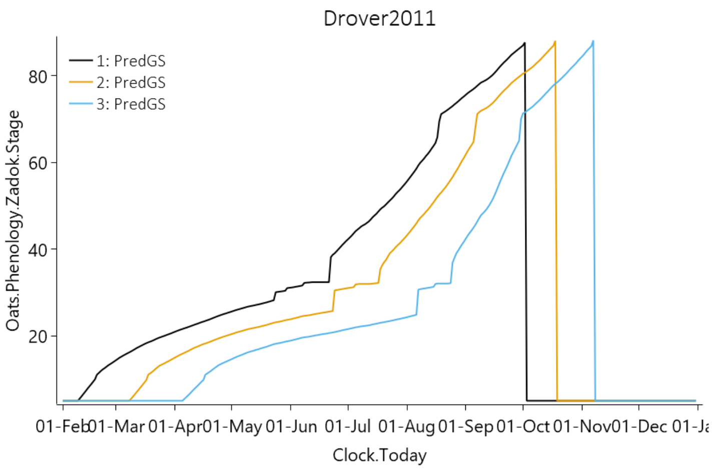



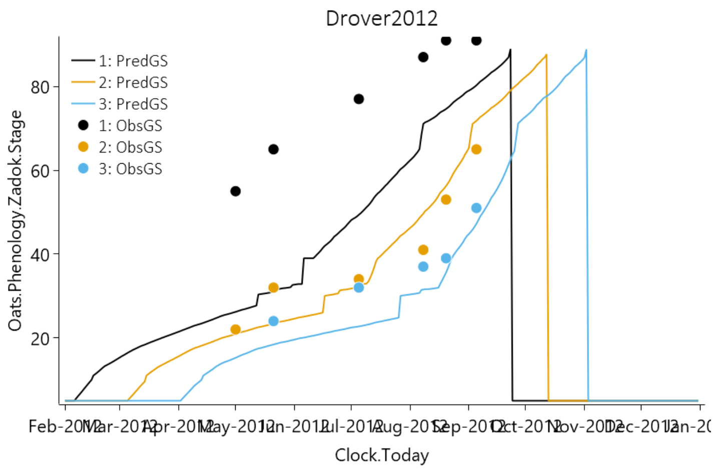



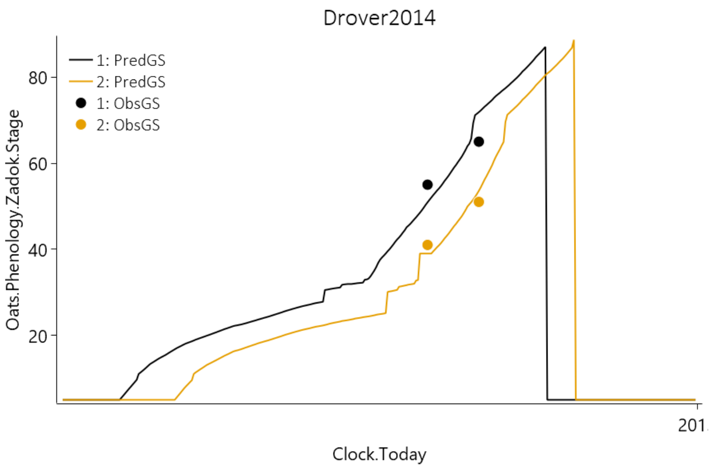
#### 4.4.5.2 Drover



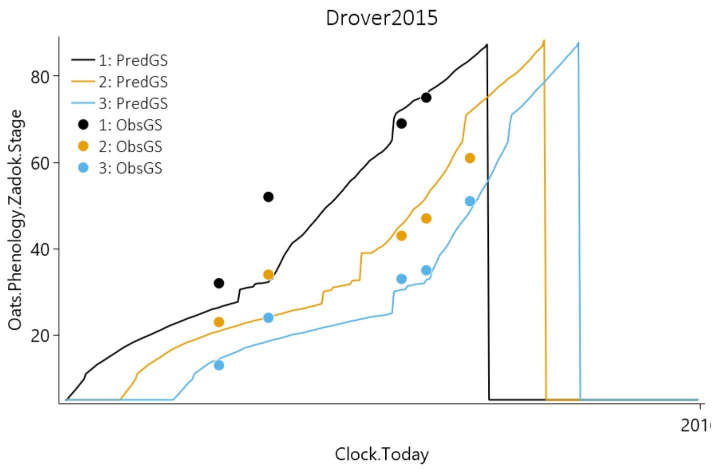
Drover2011
1: PredGS
2: PredGS
3: PredGS
Oats.Phenology.Zadok.Stage
Clock.Today

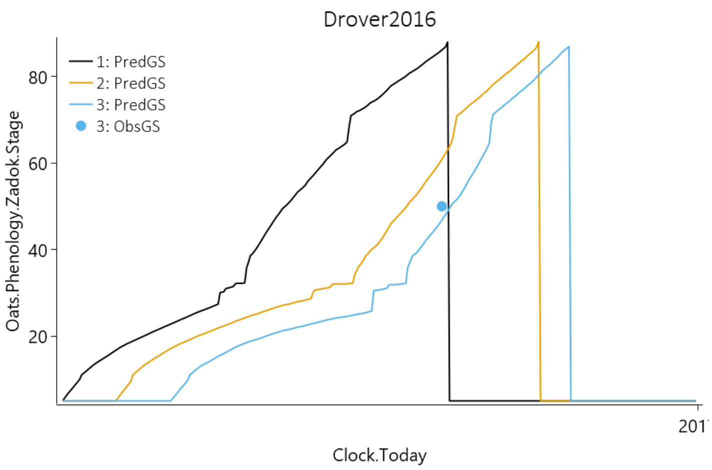
Drover2012
1: PredGS
2: PredGS
3: PredGS
1: ObsGS
2: ObsGS
3: ObsGS
Oats.Phenology.Zadok.Stage
Clock.Today

Drover2014
1: PredGS
2: PredGS
1: ObsGS
2: ObsGS
Oats.Phenology.Zadok.Stage
Clock.Today

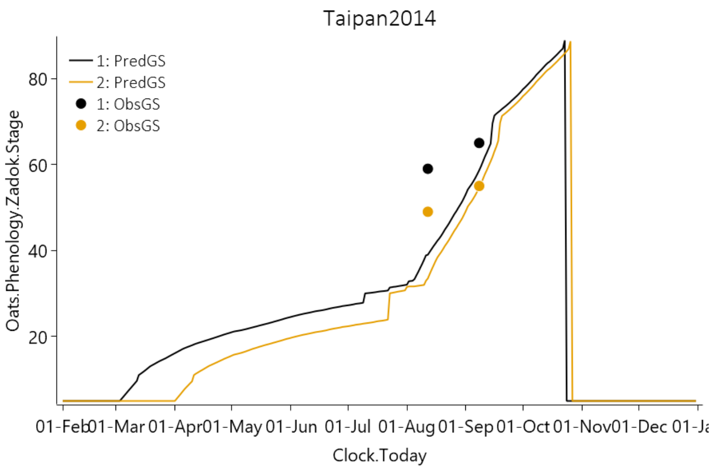



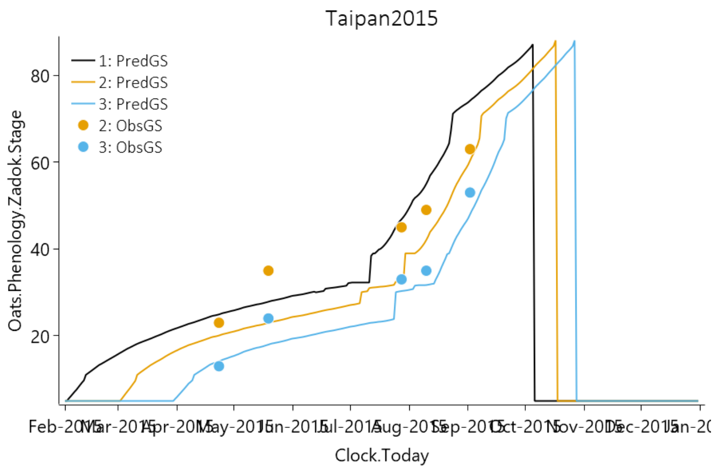
Drover2015
1: PredGS
2: PredGS
3: PredGS
1: ObsGS
2: ObsGS
3: ObsGS
Oats.Phenology.Zadok.Stage
Clock.Today

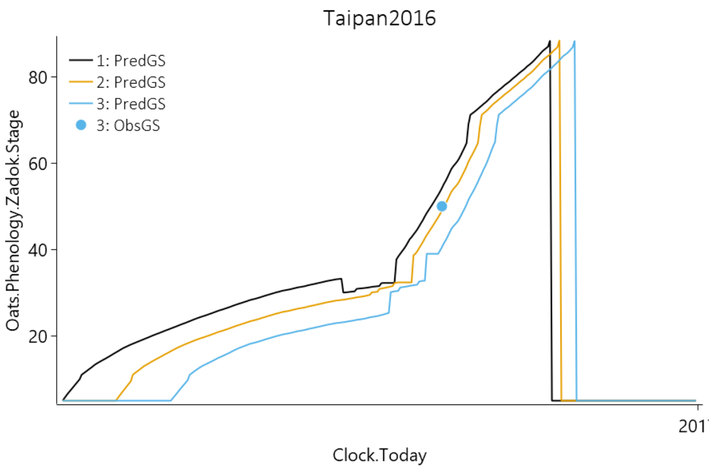



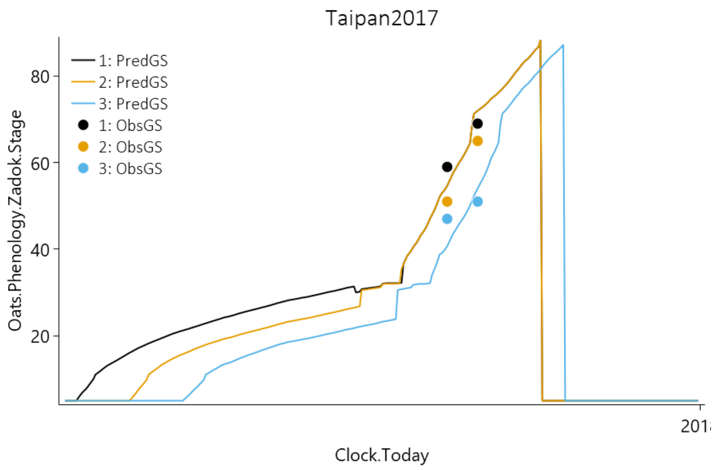
Drover2016
1: PredGS
2: PredGS
3: PredGS
3: ObsGS
Oats.Phenology.Zadok.Stage
Clock.Today

### 4.4.5.3 Taipan

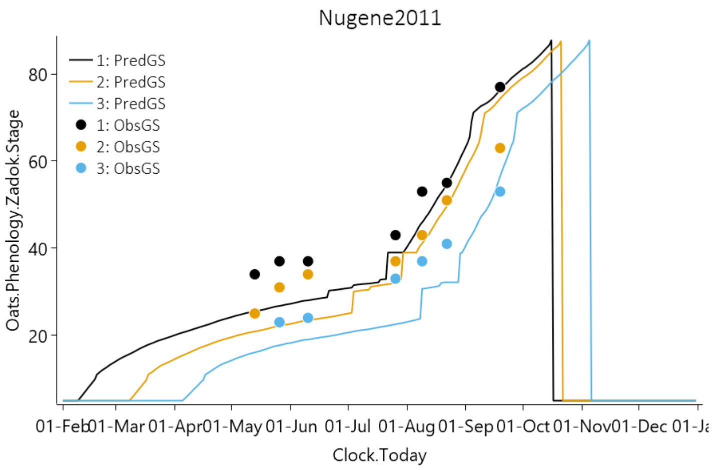


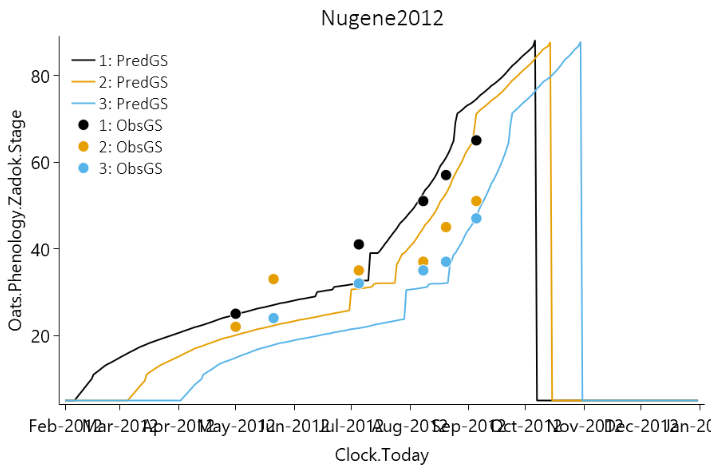



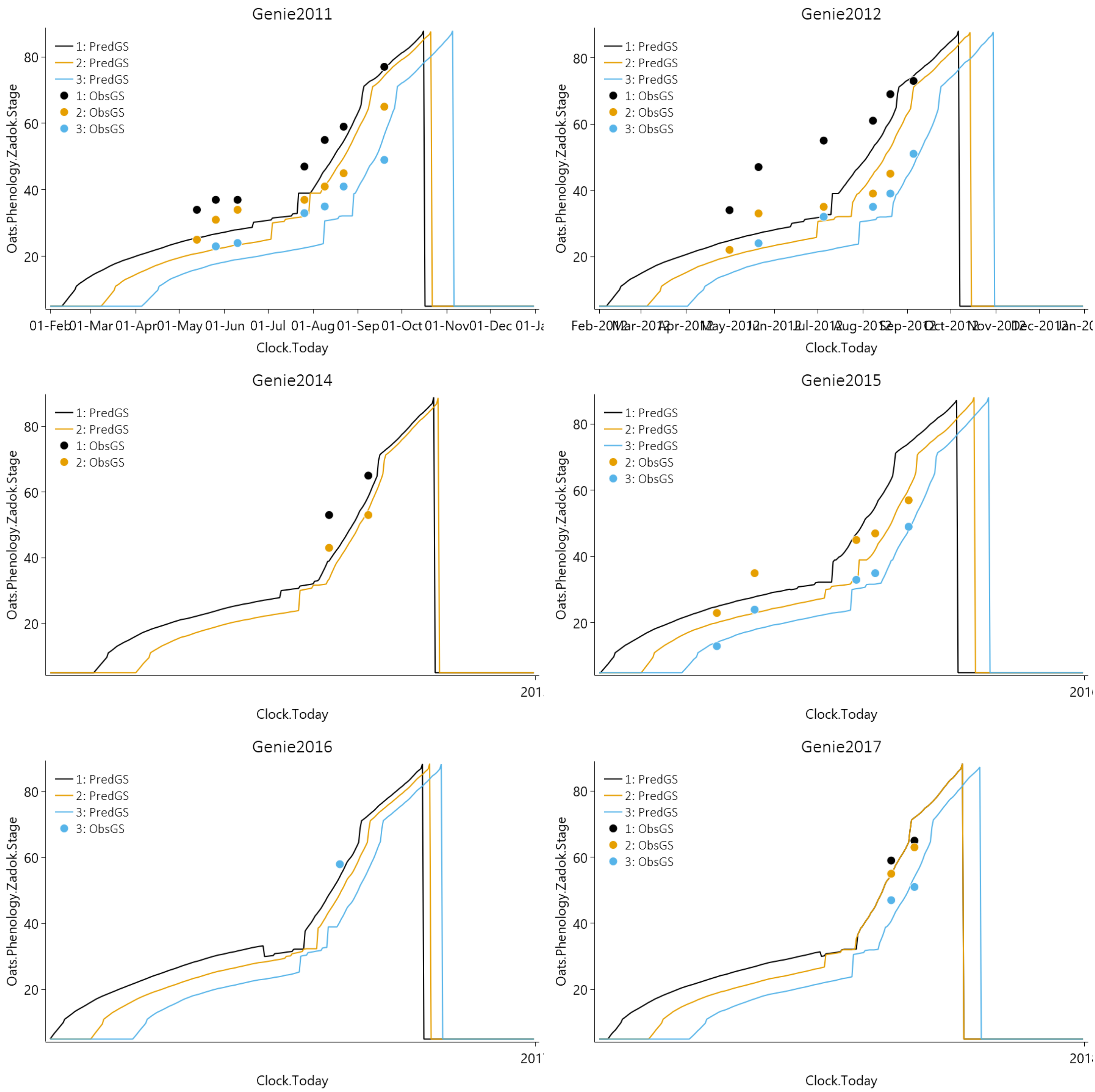




### 4.4.5.4 Nugene



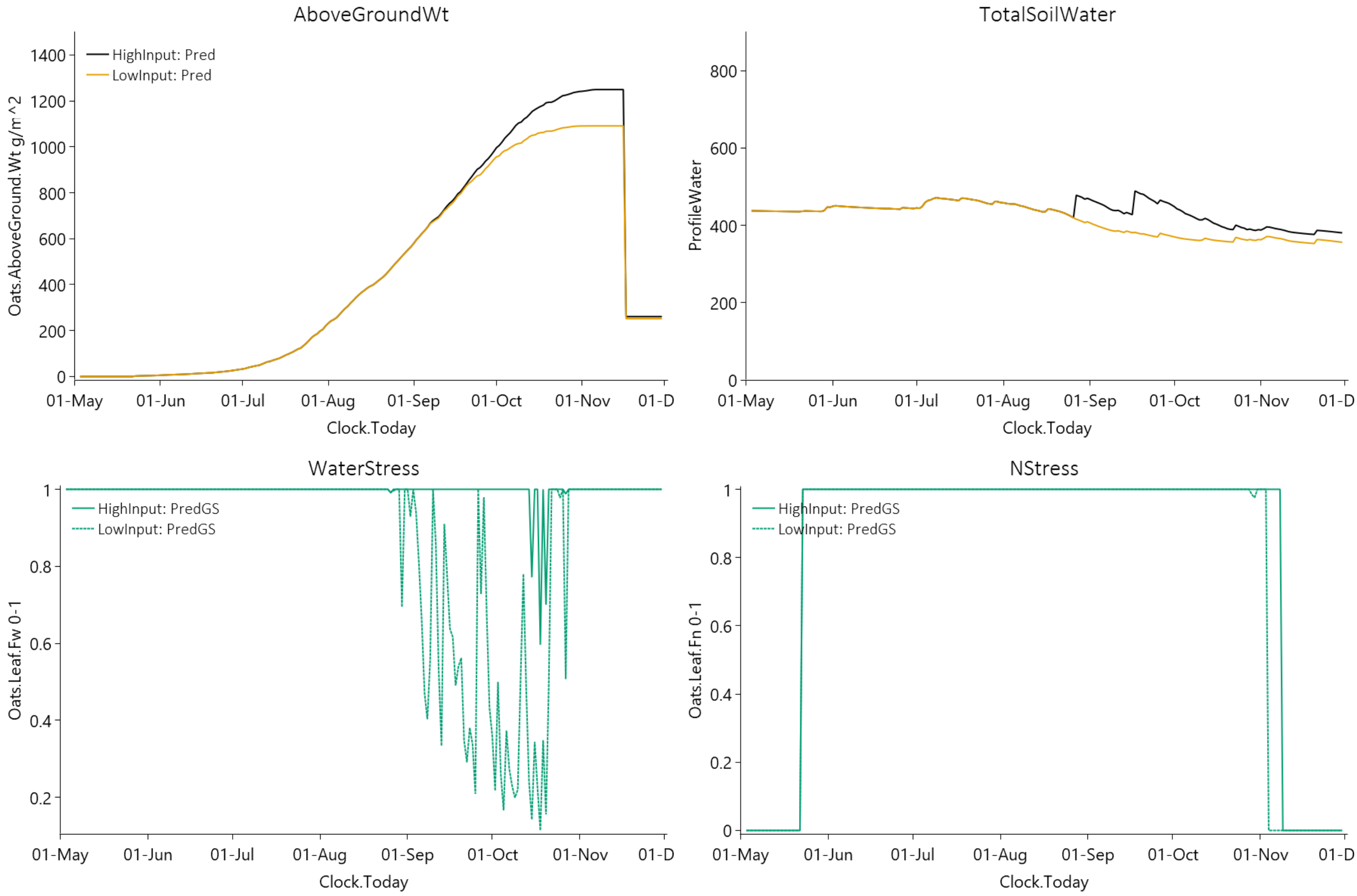
### 4.4.5.5 Genie




# 5 Sensibility

### List of experiments.

| Experiment Name | Design (Number of Treatments) |
|---|---|
| OatsExampleTarlee2007 | AgRegime (2) |




# 6 References


BA Keating, Commonwealth Scientific, H Meinke, ME Probert, NI Huth, IG Hills, 2001. NWheat: documentation and performance of a wheat module for APSIM. CSIRO Division of Agriculture Technical Memorandum, CSIRO Division of Tropical Agriculture, Brisbane.

Brown, Hamish E., Huth, Neil I., Holzworth, Dean P., Teixeira, Edmar I., Zyskowski, Rob F., Hargreaves, John N. G., Moot, Derrick J., 2014. Plant Modelling Framework: Software for building and running crop models on the APSIM platform. Environmental Modelling and Software 62, 385-398.

Holzworth, Dean P., Huth, Neil I., deVoil, Peter G., Zurcher, Eric J., Herrmann, Neville I., McLean, Greg, Chenu, Karine, van Oosterom, Erik J., Snow, Val, Murphy, Chris, Moore, Andrew D., Brown, Hamish, Whish, Jeremy P. M., Verrall, Shaun, Fainges, Justin, Bell, Lindsay W., Peake, Allan S., Poulton, Perry L., Hochman, Zvi, Thorburn, Peter J., Gaydon, Donald S., Dalgliesh, Neal P., Rodriguez, Daniel, Cox, Howard, Chapman, Scott, Doherty, Alastair, Teixeira, Edmar, Sharp, Joanna, Cichota, Rogerio, Vogeler, Iris, Li, Frank Y., Wang, Enli, Hammer, Graeme L., Robertson, Michael J., Dimes, John P., Whitbread, Anthony M., Hunt, James, van Rees, Harm, McClelland, Tim, Carberry, Peter S., Hargreaves, John N. G., MacLeod, Neil, McDonald, Cam, Harsdorf, Justin, Wedgwood, Sara, Keating, Brian A., 2014. APSIM – Evolution towards a new generation of agricultural systems simulation. Environmental Modelling and Software 62, 327-350.

Keating, B. A., Carberry, P. S., Hammer, G. L., Probert, M. E., Robertson, M. J., Holzworth, D., Huth, N. I., Hargreaves, J. N. G., Meinke, H., Hochman, Z., McLean, G., Verburg, K., Snow, V., Dimes, J. P., Silburn, M., Wang, E., Brown, S., Bristow, K. L., Asseng, S., Chapman, S., McCown, R. L., Freebairn, D. M., Smith, C. J., 2003. An overview of APSIM, a model designed for farming systems simulation. European Journal of Agronomy 18 (3-4), 267-288.

Malcolm, B, Teixeira, E, Johnstone, P, Maley, S, de Ruiter, J, Chakwizira, E, 2016. Catch crops after winter grazing for production and environmental benefits. Agronomy New Zealand 46, 99-108.

Martin, RJ, Jamieson, PD, Gillespie, RN, Maley, S, 2001. Effect of timing and intensity of drought on the yield of oats (Avena sativa L.). Screening 1 (5.0), 7-90.

McCown, R. L., Hammer, G. L., Hargreaves, J. N. G., Holzworth, D., Huth, N. I., 1995. APSIM: an agricultural production system simulation model for operational research. Mathematics and Computers in Simulation 39 (3-4), 225-231.

McCown, R. L., Hammer, G. L., Hargreaves, J. N. G., Holzworth, D. P., Freebairn, D. M., 1996. APSIM: a Novel Software System for Model Development, Model Testing and Simulation in Agricultural Systems Research. Agricultural Systems 50 (3), 255-271.

Peake, A., Whitbread, A., Davoren, B., Braun, J., Limpus, S., 2008. The development of a model in APSIM for the simulation of grazing oats and oaten hay. In: Global Issues, Paddock Action. Proceedings of the 14th ASA Conference, 21-25 September 2008, Adelaide, South Australia., Eds: Unkovich, M.

S Asseng, B.A Keating, I.R.P Fillery, P.J Gregory, J.W Bowden, N.C Turner, J.A Palta, D.G Abrecht, 1998. Performance of the APSIM-wheat model in Western Australia . Field Crops Research 57 (2), 163 - 179.

S Asseng, A Bar-Tal, J.W Bowden, B.A Keating, A Van Herwaarden, J.A Palta, N.I Huth, M.E Probert, 2002. Simulation of grain protein content with APSIM-Nwheat . European Journal of Agronomy 16 (1), 25 - 42.

Wang, E., Robertson, M. J., Hammer, G. L., Carberry, P. S., Holzworth, D., Meinke, H., Chapman, S. C., Hargreaves, J. N. G., Huth, N. I., McLean, G., 2002. Development of a generic crop model template in the cropping system model APSIM. European Journal of Agronomy 18 (1-2), 121-140.