



Capturing cultivar differences in water-limited yield potential of potato in the Netherlands using experimentation and modelling

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Background

In recent years, potato production in the Netherlands suffered, particularly on sandy soils. Farmers could benefit from decision-support for crop management and adaptation to climate change and variability. In this research we calibrate and evaluate water-limited potential yields of modern potato cultivars using the model WOFOST.

Field work

During a period of two years two experimental fields were set up. One on sandy soil near Vredepeel, and one on clayey soils near Lelystad, the Netherlands. We only focus on the results for Vredepeel here. The commercial potato cultivars 'Premiere', 'Fontane', and 'Festien' were used, differing in cultivar lateness. Two irrigation treatments were used to allow for assessment of both a potential (W2, goal pF of 2.4) and water-limited production situation (W1, goal pF of 3.2) (Table 1).

Table 1: Rainfall and irrigation data per irrigation treatment for both years.

Year	Rainfall (mm)	Irrigation W2 (mm)	Irrigation W1 (mm)
2019	197	329	181
2020	212	302	163

Results calibration: 2020

Table 3: Observed (Field) and pre and post calibration yields and relative yield gaps (difference between full irrigation and partial irrigation) of the year 2020.

Cultivar	W2 Yield (t.ha ⁻¹)		W1 Yield (t.ha ⁻¹)			W1 Yield reduction(%)		
	Field	Post	Field	Pre	Post	Field	Pre	Post
Premiere	18.3	17.0	12.8	16.6	13.2	30.1	4.0	23.6
Fontane	19.1	18.4	15.4	17.0	15.2	19.5	3.4	13.4
Festien	18.0	17.7	15.5	16.0	14.3	13.8	3.5	13.6

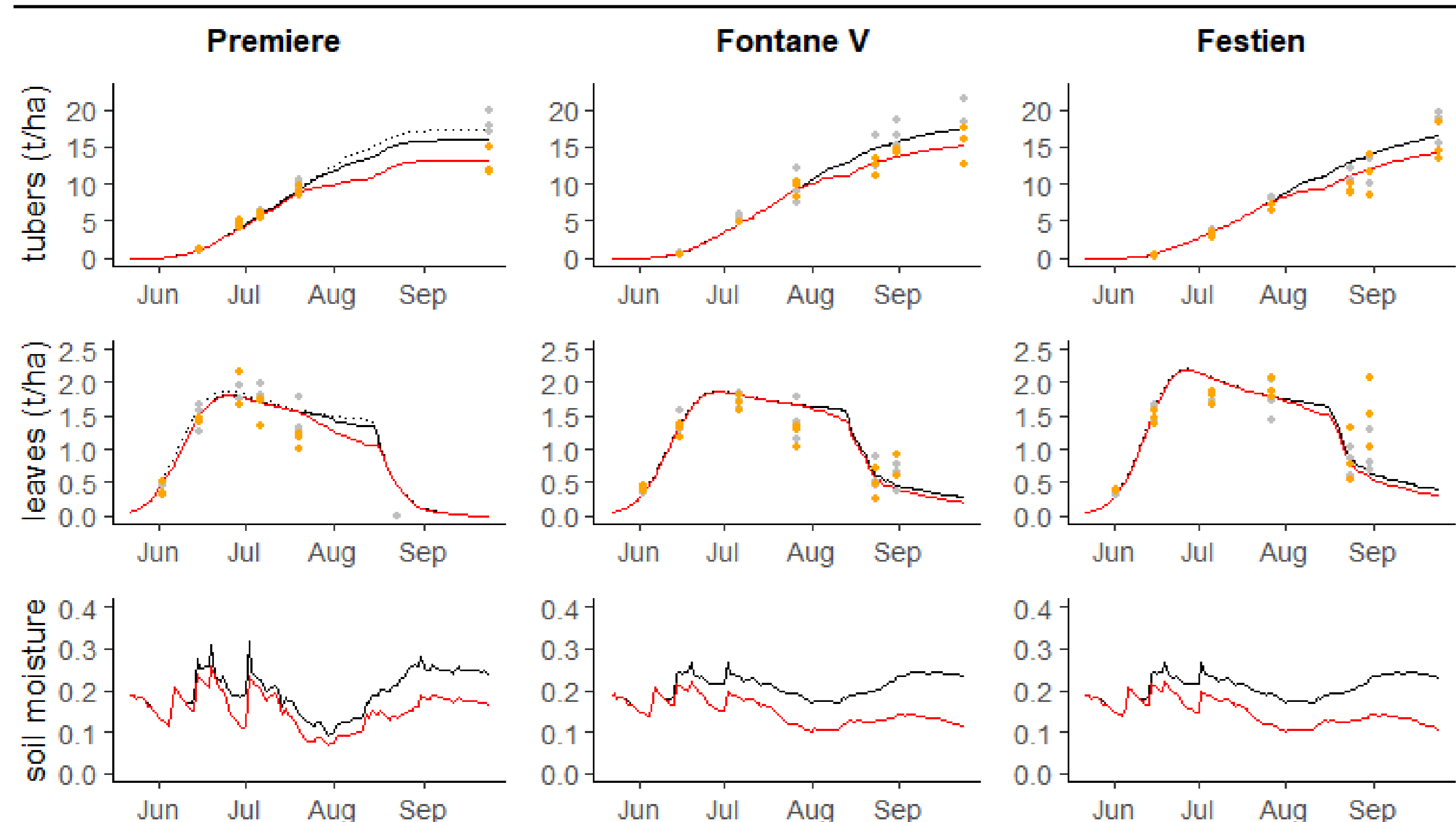


Figure 1: Simulations per cultivar during 2020. The black lines are water limited simulations of the W2 treatment. Black dots are observations from W2 plots. The red lines are water limited simulations with data from the W1 treatment. Orange dots are observations from W1 plots. The dotted line is a potential yield simulation.

Modeling approach

Data collected from the 2020 field season was used for model calibration while data from 2019 was used for a first model evaluation. As a starting point crop parameters for potential yield from ten Den et al. (2022) were used, supplemented with relevant location specific rainfall and soil data.

Relevant crop and soil parameters of WOFOST were identified using a sensitivity analysis. Crop parameters were adjusted based on experimental data if possible (RDI) and on literature (CFET) or via optimisation (RDMSOL and RDMCR) (Table 2).

Table 2: crop parameters changed.

Parameter	Defenition	Old value	New value	Unit
CFET	correction factor for evapotranspiration	1.0	1.1	-
RDI	initial rooting depth	10	15	cm
RDMSOL	soil-dependent maximum rooting depth	-	66	cm
RDMCR	crop-dependent maximum rooting depth	50	Premiere: 25 Others: 100	cm

Results evaluation: 2019

Table 4: Observed (Field) and pre and post calibration yields and relative yield gaps (difference between full irrigation and partial irrigation) of the year 2019.

Cultivar	W2 Yield (t.ha ⁻¹)		W1 Yield (t.ha ⁻¹)			W1 Yield reduction(%)		
	Field	Post	Field	Pre	Post	Field	Pre	Post
Premiere	15.3	15.9	11.3	17.7	15.3	26.5	0.1	13.9
Fontane	21.3	17.5	19.0	18.4	17.6	10.9	0.0	13.2
Festien	18.3	16.5	17.8	17.7	16.9	2.9	0.0	4.6

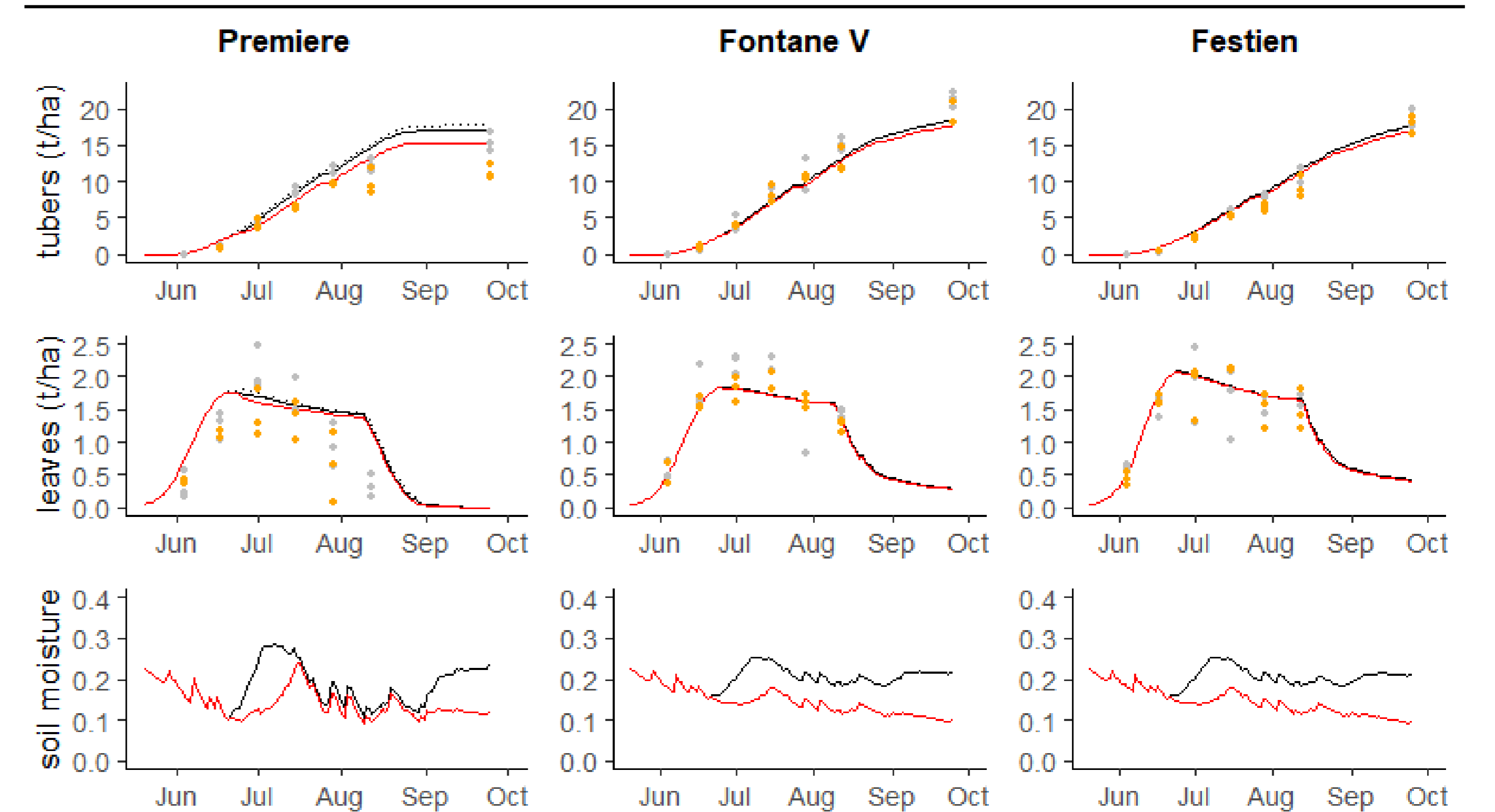


Figure 2: Simulations per cultivar during 2019. The black lines are water limited simulations of the W2 treatment. Black dots are observations from W2 plots. The red lines are water limited simulations with data from the W1 treatment. Orange dots are observations from W1 plots. The dotted line is a potential yield simulation.

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References

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Conclusion

The updated parameter sets performed well in Vredepeel. During evaluation the model underestimated the yield gap of Premiere, possibly caused by an overestimation of the potential yield (without any water limitation). Simulated yield gaps were within 6% of the measured yield gap for Fontane and Festien. Next, we will also use a model with a more sophisticated soil water module.

