SkleroPro

A field-level, epidemiological risk forecast model for sclerotinia in winter rapeseed in Germany

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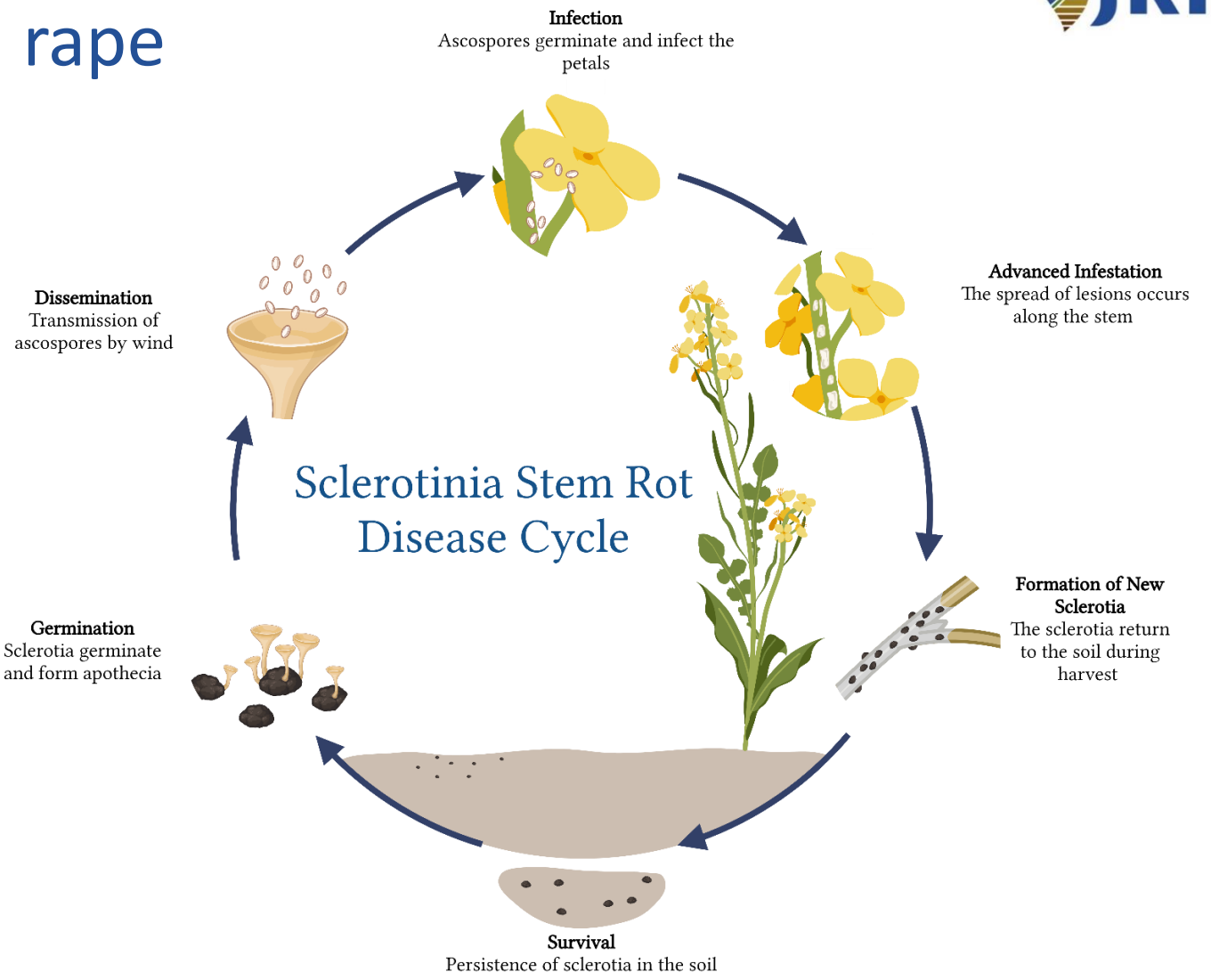
Project manager

Federal Office for Agriculture and Food

Sclerotinia stem rot in oilseed rape

- Sclerotinia sclerotiorum causes white stem rot in winter rapeseed (Brassica napus).
- This disease can lead to yield reductions of 20-30% in Germany.
- Decision Support Systems (DSS) help farmers to reduce pesticide use and optimize applications and minimize losses.
- Improve the currently used model for field-specific fungicide application recommendations during the flowering period.

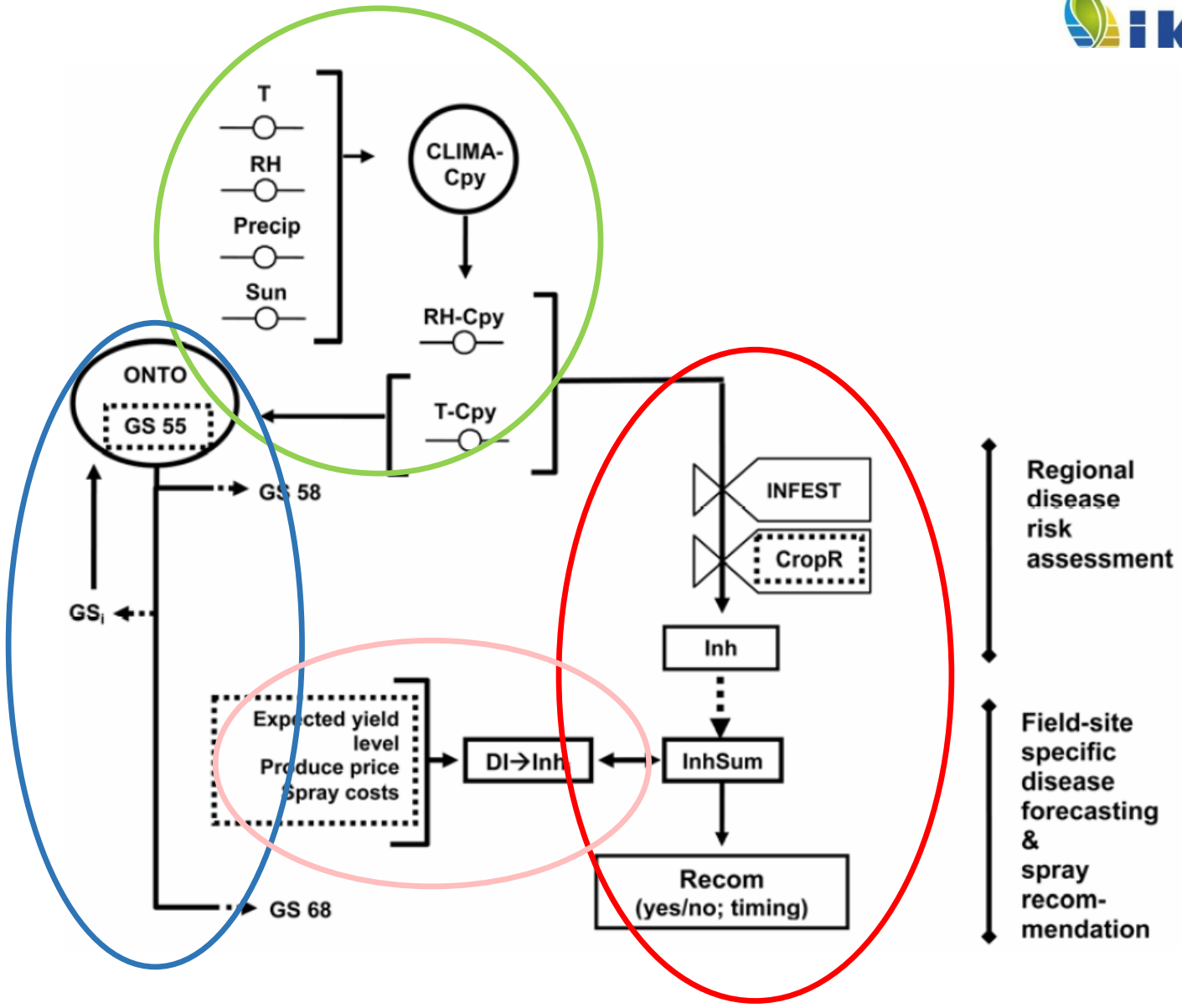


Sclerotinia Infection Cycle in Winter Rapeseed

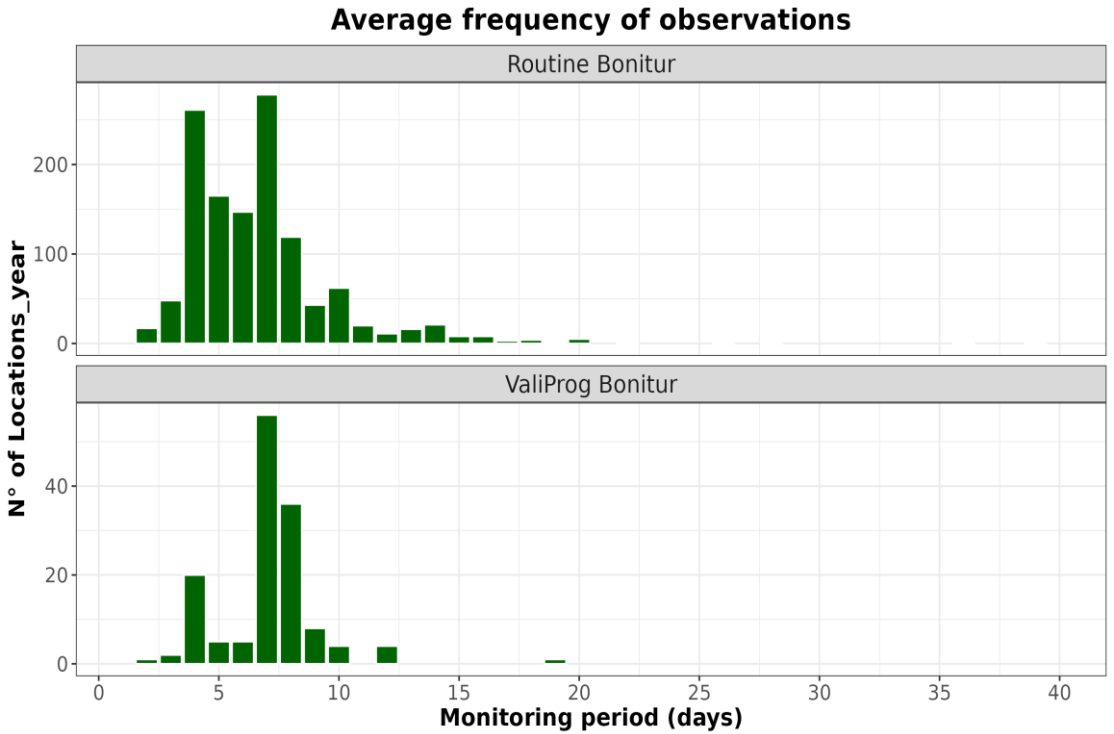
ScleroPro current version

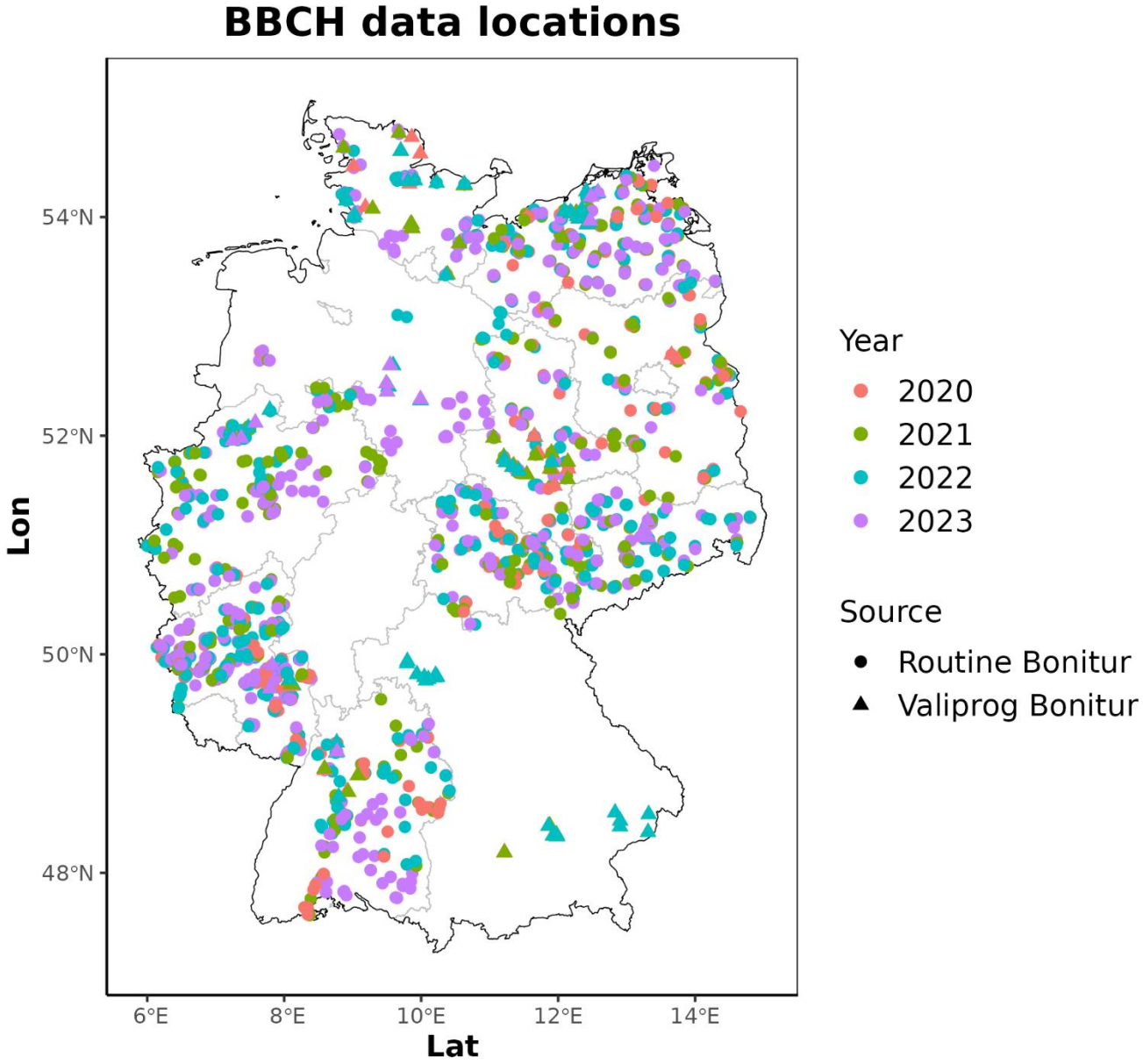
- Inputs: BBCH 55 Date
- Weather data
  - Hourly: T, RH, Prec.
  - Daily: Solar radiation
- Crop rotation

- Expected yield
- Spray costs
- Winter rapeseed price

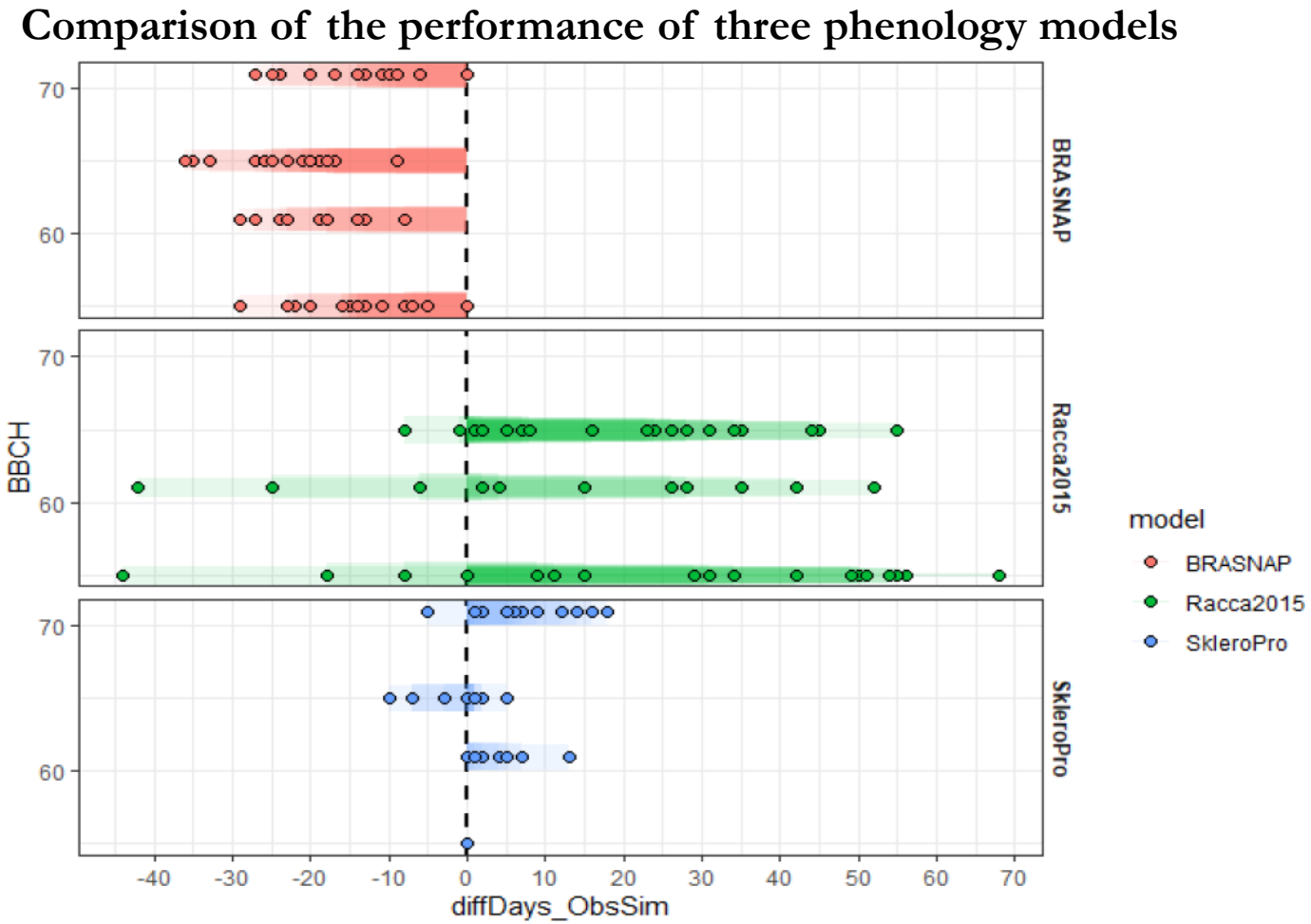


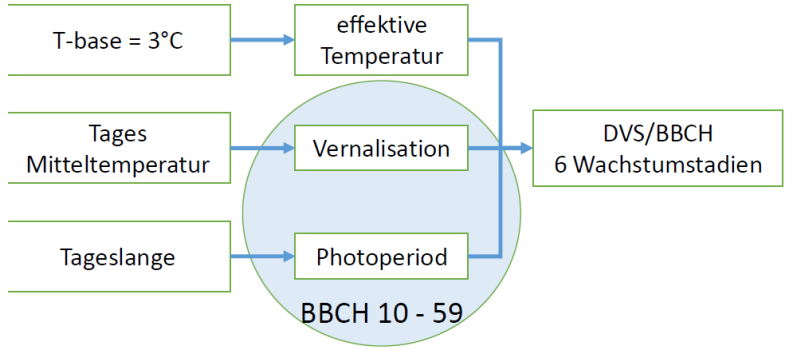
Phenology module - data





Phenology module – model comparison





BBCH = (f) RDR

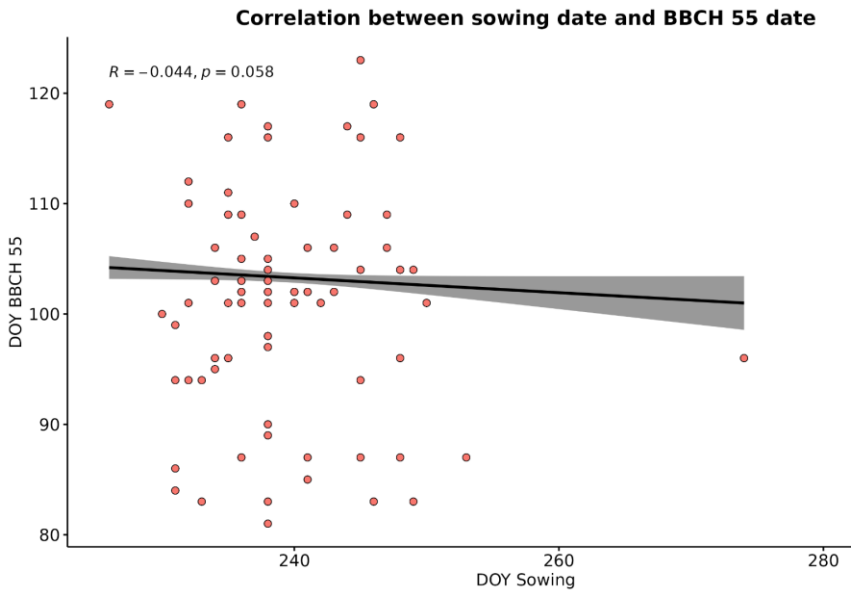
Wobei:
BBCH = Wachstumsstadium der Pflanze
RDR = Summe der Entwicklungsrate des Rapses von der Aussaat bis zum BBCH

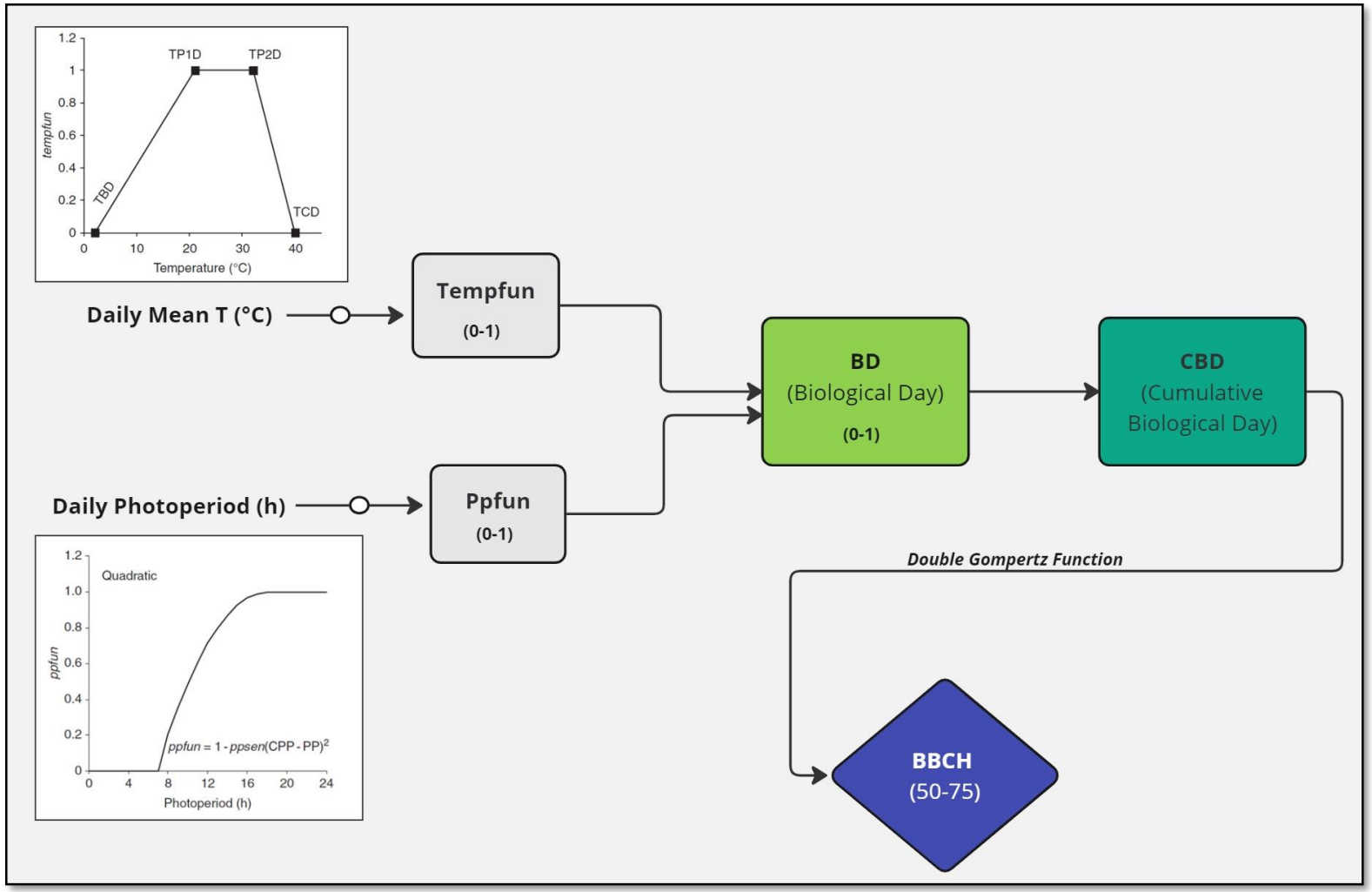
$$BBCH = p1 * e^{-e^{(-(p2+(p3*RDR)+(p4*RDR^2)+((p4^2)\frac{RDR^3}{3P3})}}$$

$$RDR = RDRopt * (((Tmean - Tmin)/(TOpt - TMin))^{(n*\frac{TMin-TOpt}{TOpt-TMax})} * \left(\frac{Tmax - Tmean}{TOpt - TMax}\right)^n)$$

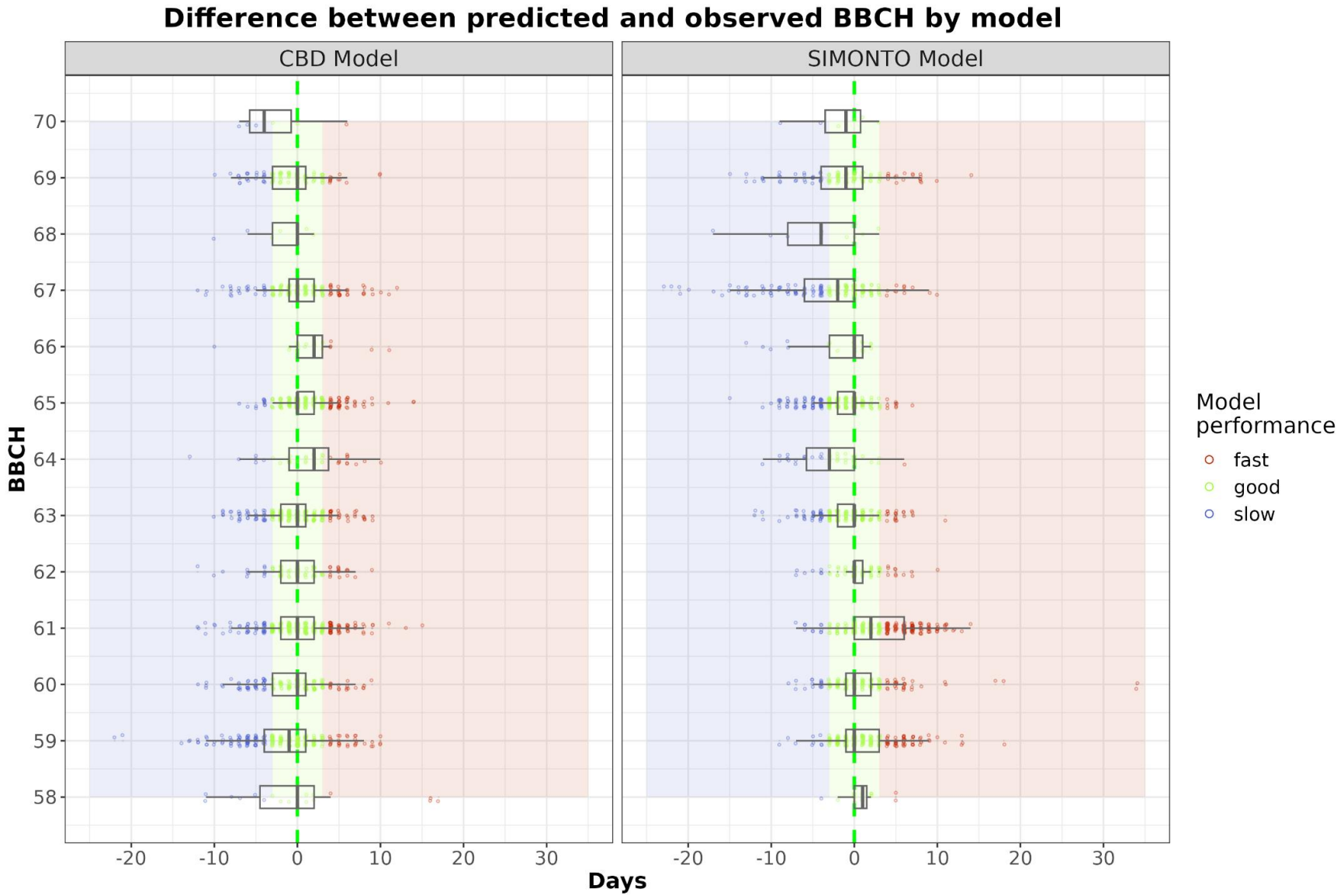
Phenology module – Cumulative Biological Module (CBD)

- Inputs: T + Pp
- Assumes no effect of sowing date on beginning of flowering
- Starts: 1. February





Phenology module – CBD vs current SkleroPro

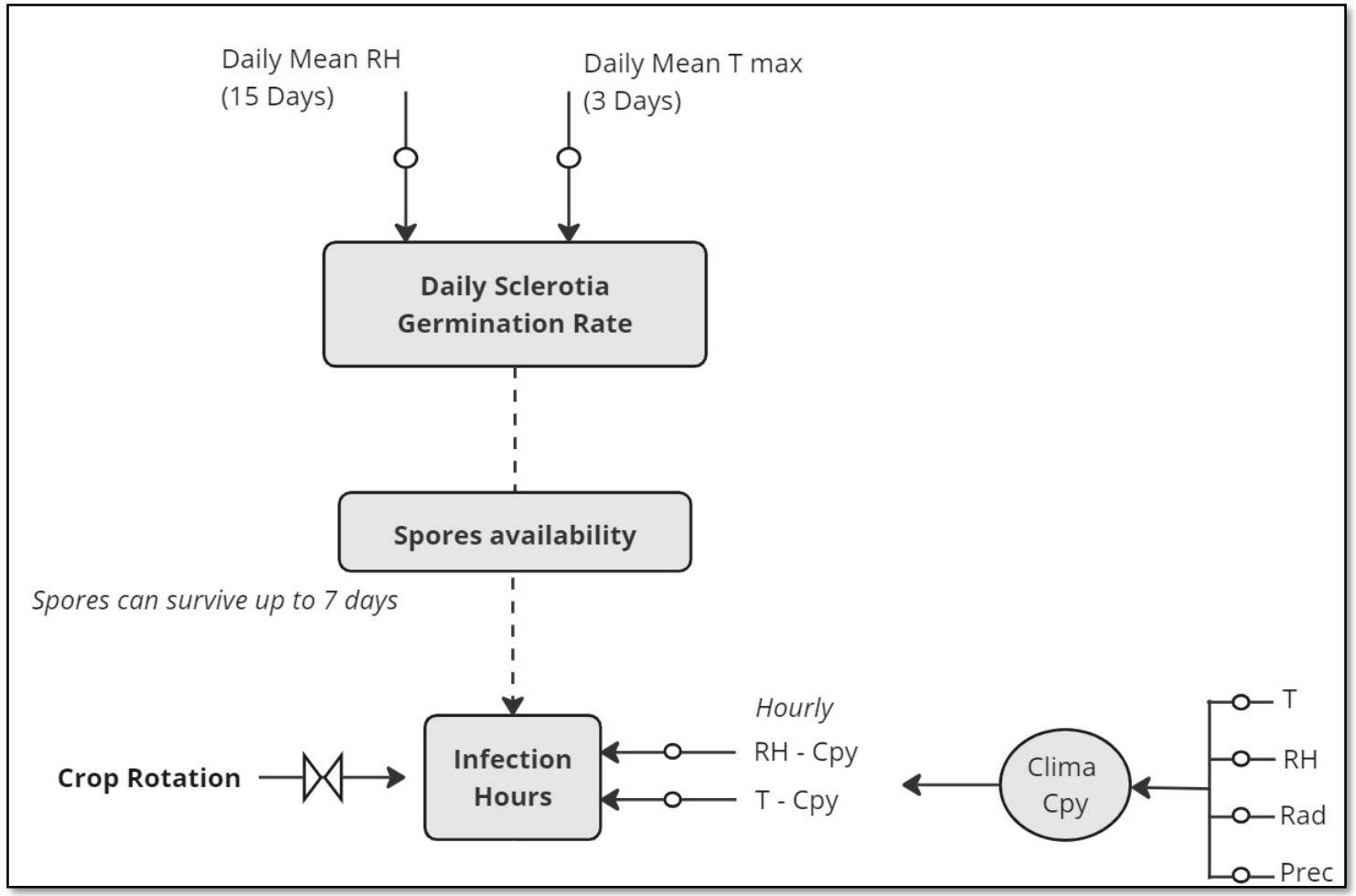


Model	RMSE (days)
Modified BRASNAP	± 6.13
Modified Racca	± 6.09
SIMONTO - WR	± 4.28
CBD	± 4.05

Disease development module

- Add Sklerotia germination submodule
- Add apothecium formation submodule

- Reevaluate crop rotation threshold
- Recalibrate economic thresholds



Disease development module - germination

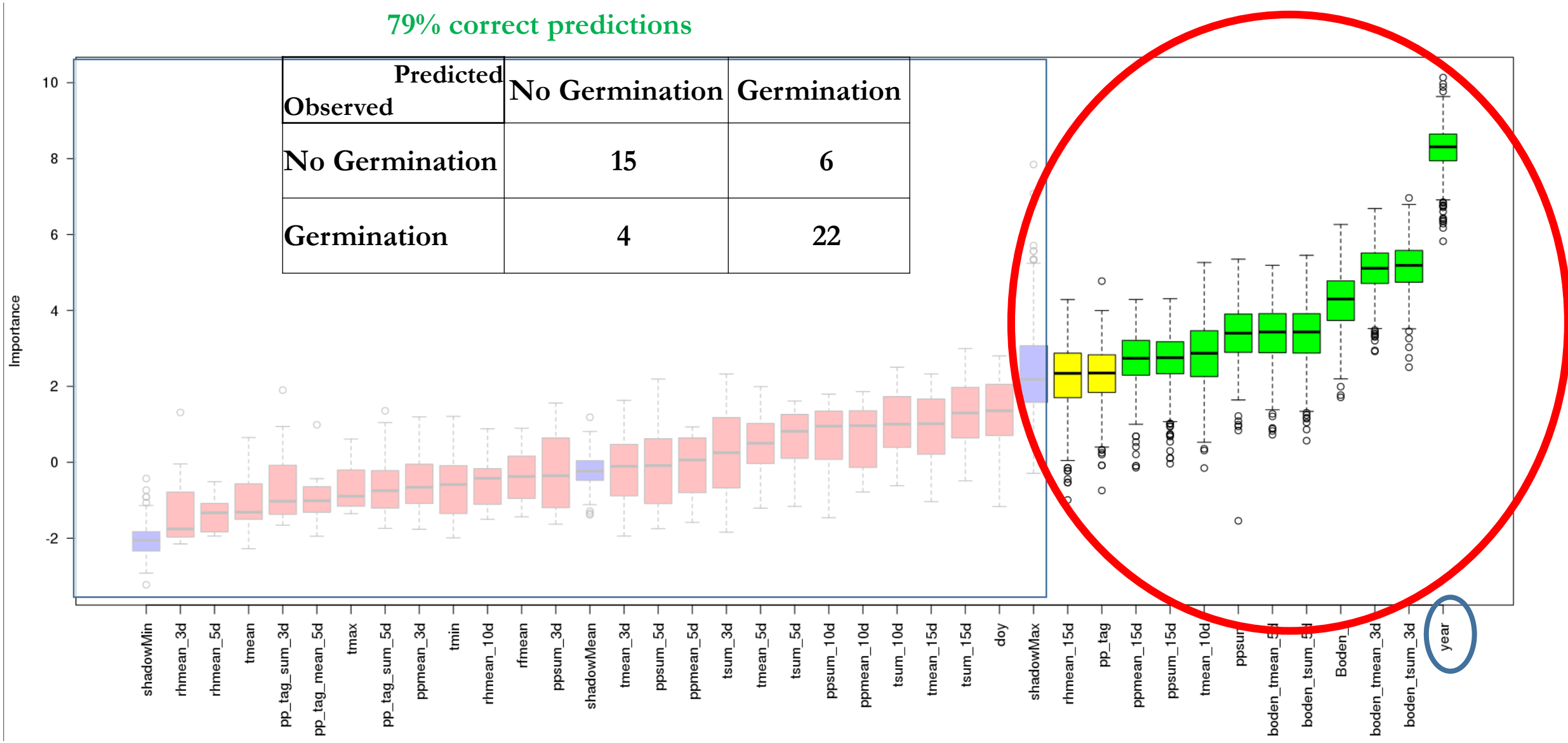
- Use of Sklerotia germination data on field (100 sclerotia, per depot; 4 depots)
- Weather Rolling Windows: ~ 40 variables of precipitation, temperature, and RH
- Boruta Forest feature selection (RF wrapper)
- Step-wise mixed-effect regression
- daily max temperature (average last 3 days) and daily relative humidity (average last 15 days)

Calculated for 1, 3, 5, 10 and 15 days	Other
Air T (°C)	DOY
Boden T (°C)	Year
Air T sum (base=5°C)	
Air T mean (°C)	
Boden T sum (base=5°C)	
Boden T mean (°C)	
Pp (mm)	
Pp TinyTag (mm)	
Pp sum (mm)	
Pp mean (mm)	
Pp sum from TinyTag (mm)	
Pp mean from TinyTag (mm)	
RH (%)	
RH mean (%)	
N° days > 5°C	
N° days > RH threshold	

Disease development module - germination

79% correct predictions

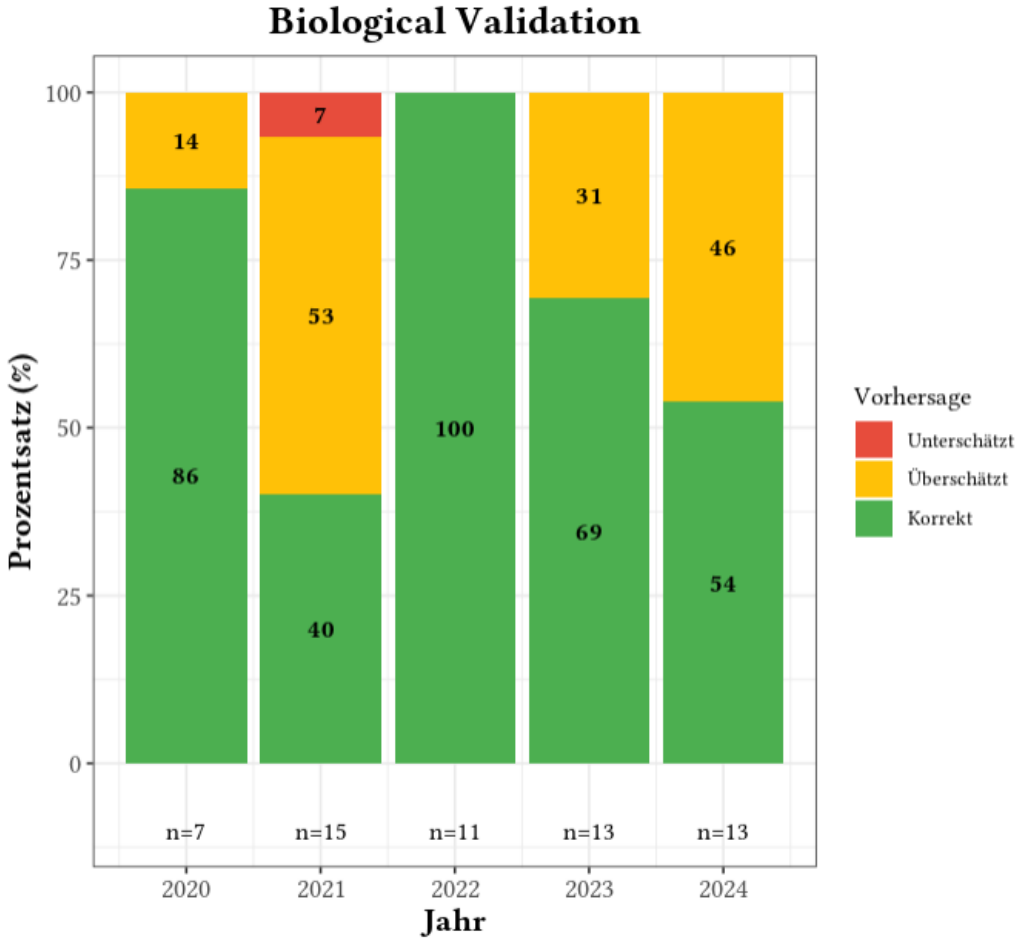
Observed \ Predicted	No Germination	Germination
No Germination	15	6
Germination	4	22



Disease development module – biological threshold

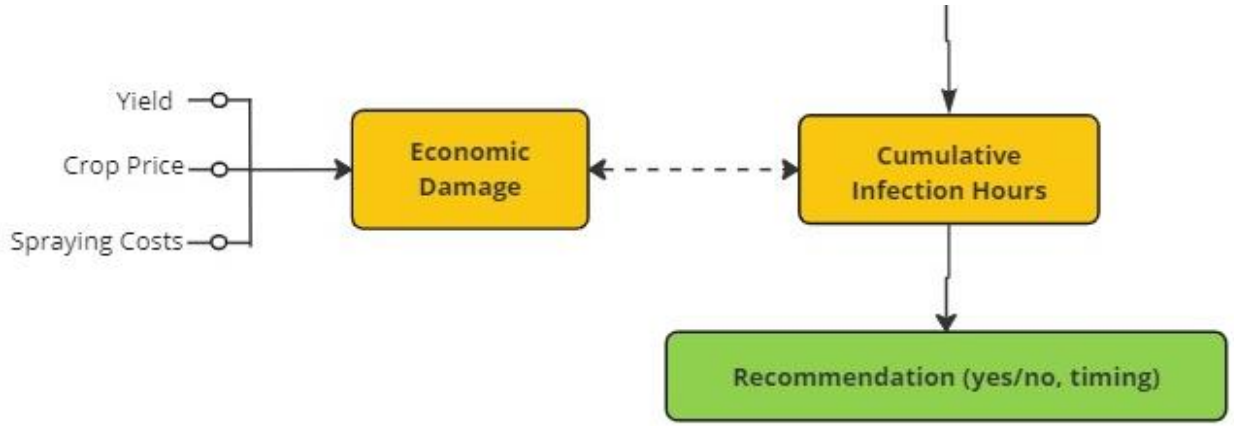
- The cumultive infection hours and crop rotation effects were recalibrated
- No significant improvements were found
- Assumes spores can survive up to 7 days under not adequate conditions
- Infection hours can start counting only when there are spores available that day

result_bio	n	percentage
Korrekt	39	66
Unterschätzt	1	2
Überschätzt	19	32

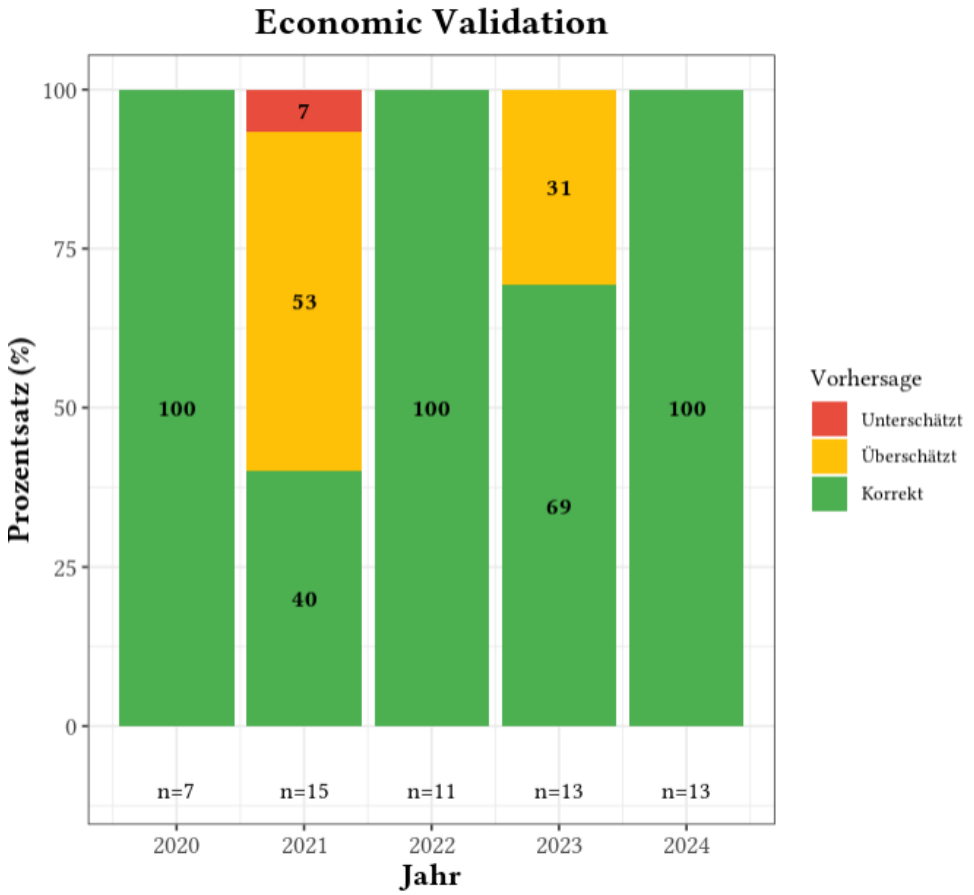


Disease development module – economic threshold

- No changes were made
- Effect of sprays on yield → unclear.



result_eco	n	percentage
Korrekt	46	78
Unterschätzt	1	2
Überschätzt	12	20



Thank you very much!

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Sources

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CBD Model

- **Biological day**: (daily) restriction of potential development due to T and P.
- BD=1 when T and Pp allow maximum development

$$BD = tempfun \times ppfun$$

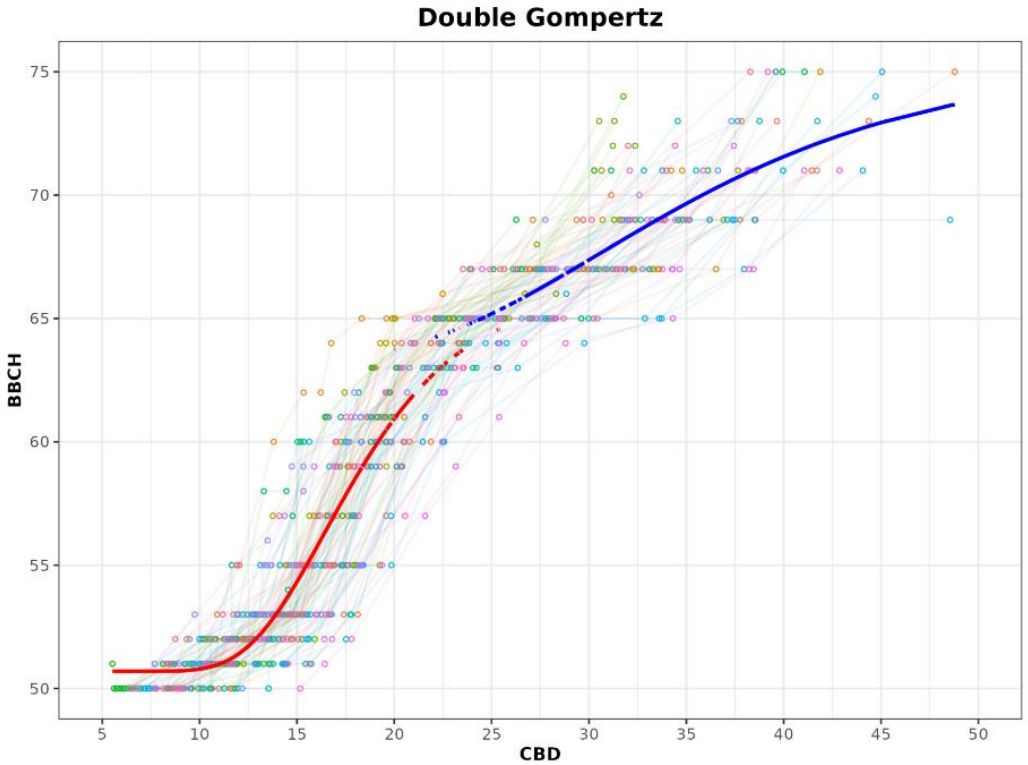
- **Cumulative BD**:

$$CBD_i = CBD_{i-1} + BD$$

CBD to BBCH using double Gompertz function

b_1= 0.2423258
c_1= 50.59107
d_1=66.18379
e_1= 16.2483

b_2= -0.1042211
c_2= 63.47196
d_2= 75.73487
e_2= 31.70237



Results (comparison of recalibrated models)

RMSE was calculated for BBCH 58 to 69.

This period is the target, as these are the days on which winter rapeseed is susceptible to sclerotinia infection.

Model	RMSE in days
Modified BRASNAP	± 6.13
Modified Racca	± 6.09
SIMONTO - WR	± 4.28
CBD	± 4.05

Other results from literarure

RMSE in days (flowering stages)	Source
± 7.45	Verocai et al., 2021
± 4.78	Hájková et al. 2021
± 1.4	Deligios et al. 2013 (For one year, one Sorte)
± 5	Robertson et al. 2016
± 6.38	Böttcher et al. 2016