cost
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Single-plant Modelling: towards a new weed management strategies

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Weed control

My aim in weed science:

reduction of environmental impact without reduction of the yield and enhancing biodiversity

Methods used:

- reduction of the amount of herbicide applied
- usage of decision support systems
- reduced soil disturbances
- precise application methods

Weed management

not specific

- 100% treatment
- Every weed plant is removed
- A large area is unnecessarily treated

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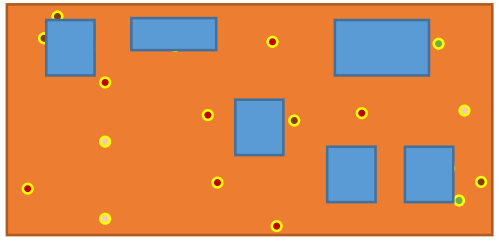
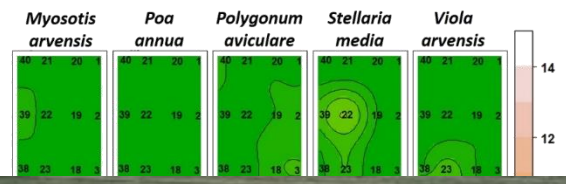
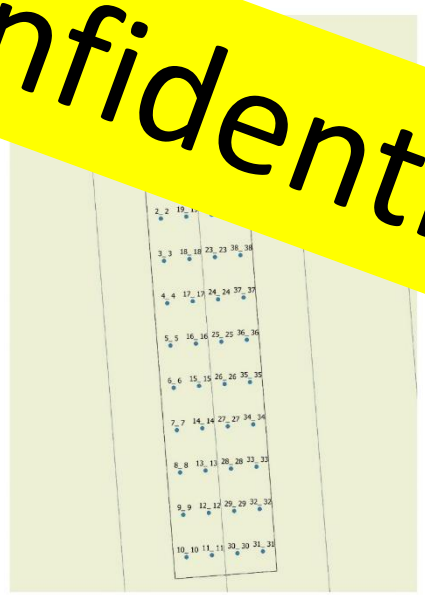
Site specific



- SSWM
- Some weed plants remain
- reduction of >90% possible
- Potential for biodiversity conservation



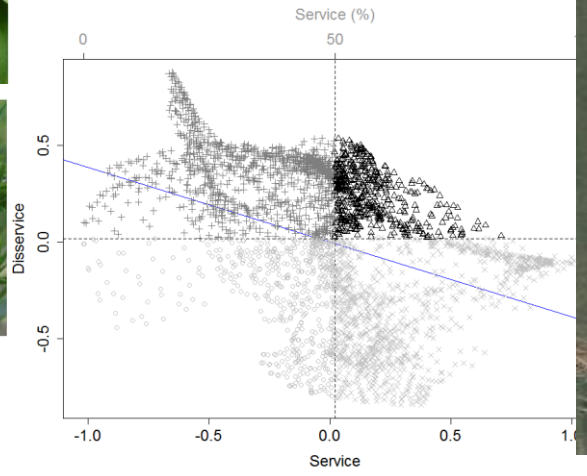


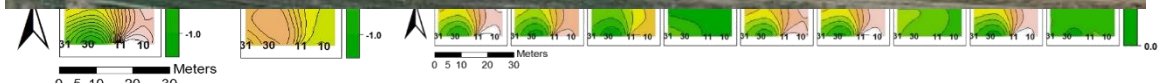
cific Leaf a	Plant height vegetative	Relative growth rate leaf (autumn)	Relative growth rate leaf (spring)	Pest species
4	0.63	0.54	0.64	0.00
0	0.00	0.65	0.74	1.00
0	0.64	0.53	0.74	0.28
0	0.63	1.00	1.00	0.16
3	1.00	0.00	0.00	0.13

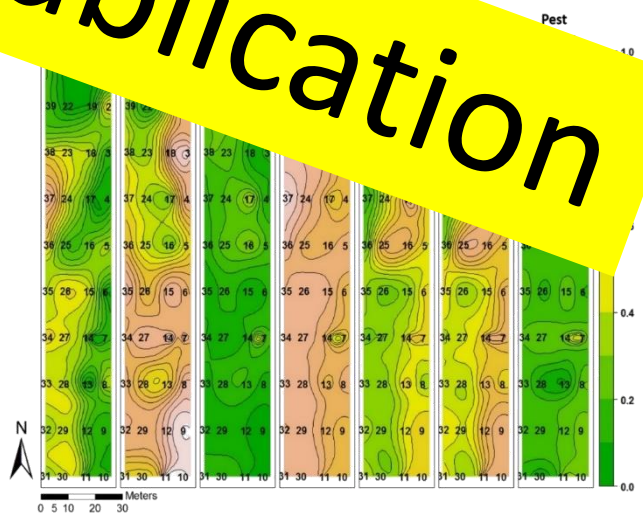
$$it_n = \frac{\sum(N_{S_n} \times T_S)}{\sum Weeds_n}$$

number for each weed species

value for each species *S*







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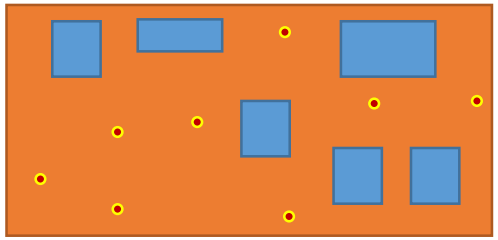

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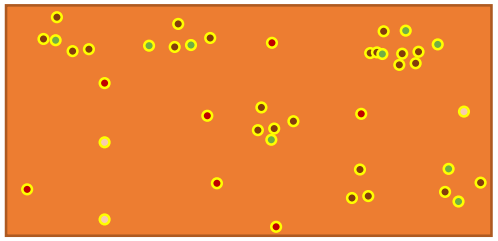

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- Every weed plant can be removed
- Every plant can be specifically managed.
- The population can be managed.

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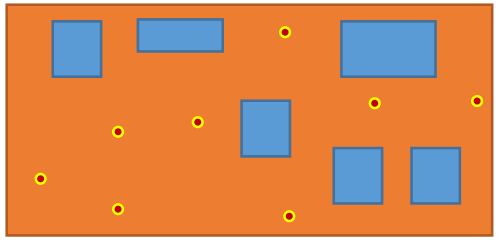

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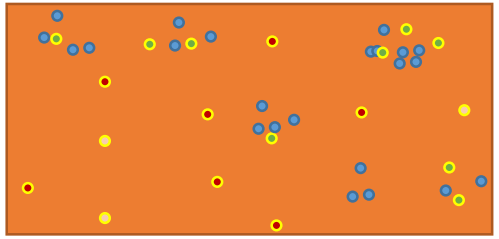

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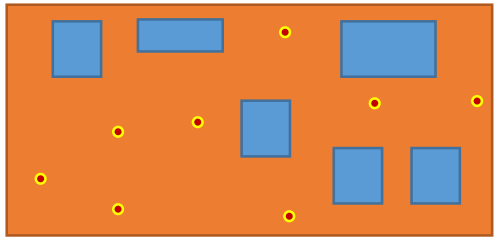

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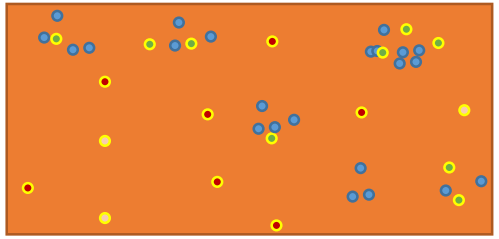

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The potential of single plant treatment is unknown for

- Yield
- Environment
- Biodiversity

Simulation approach!

Our simulation approach

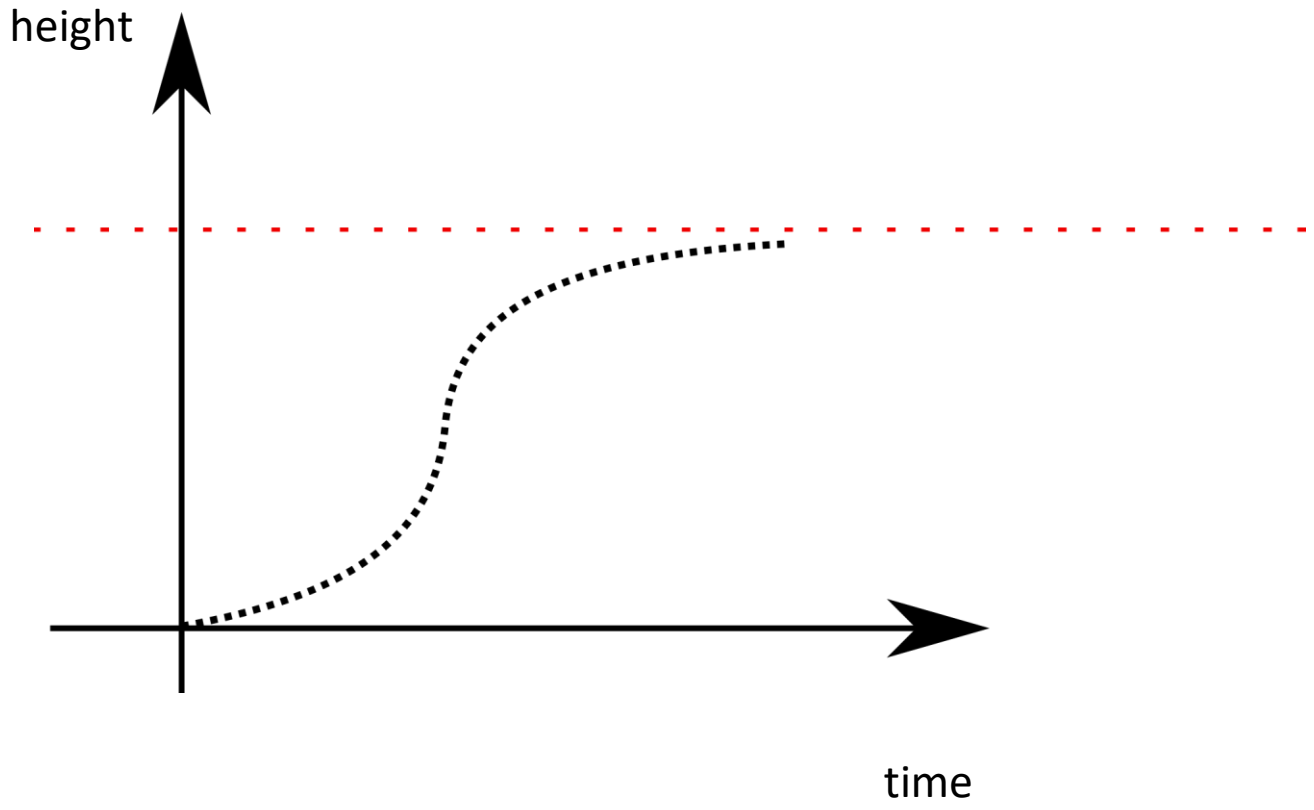
We display the

- Development of single plants
- Interactions between plants

We include the

- Species specific attributes or reactions
- Spatial arrangement

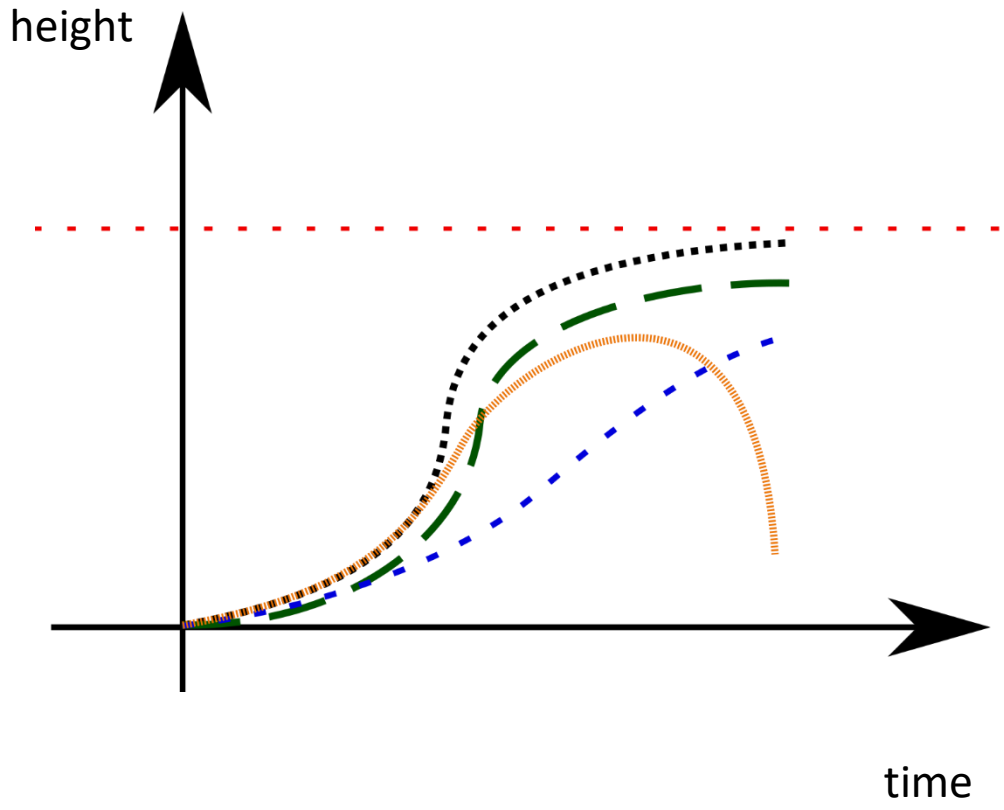
Growth curve



$$\frac{dy}{dt} = ry - \alpha y^2$$

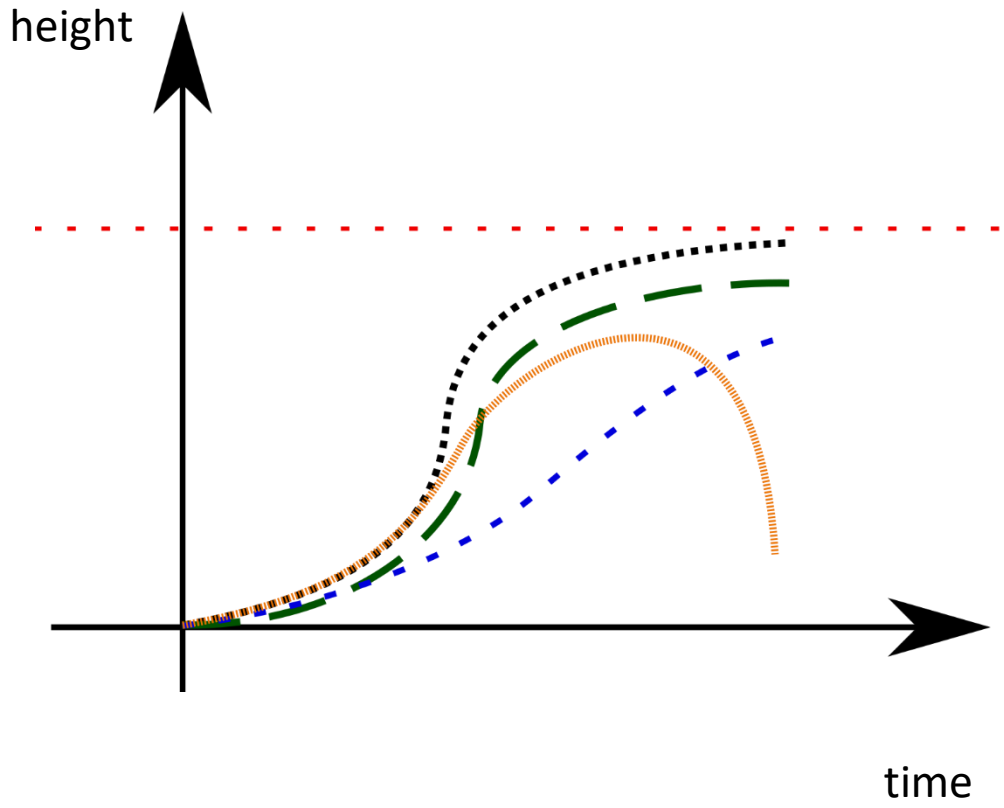
r	growth rate
α	retardation factor

Growth curves



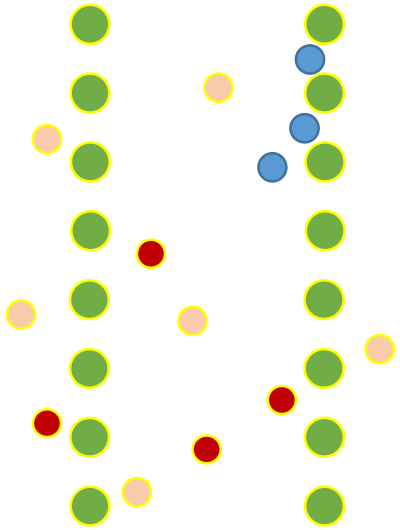
$$\frac{d\,y_i}{dt} = r_i\,y_i - \mu_i\,y_i(1 + \sum_{j=1}^{n} \alpha_{ij} y_j)$$

Growth curves



$$\frac{d\,y_i}{dt} = r_i\,y_i - \mu_i\,y_i\left(1 - \sum_{j=1}^{n}\alpha_{ij}y_j\right)$$

Spatial structure



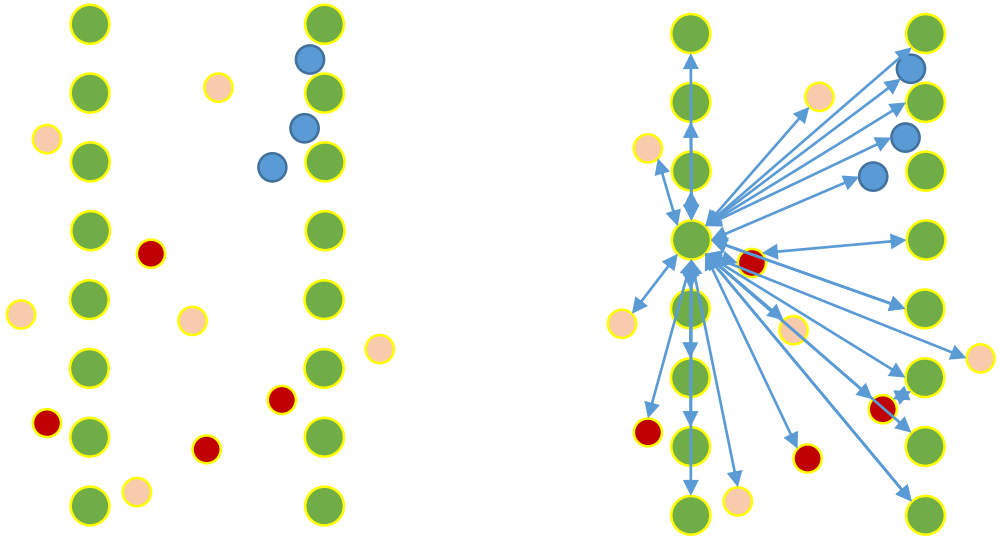
wheat

Weed species 1

Weed species 2

Weed species 3

Spatial structure



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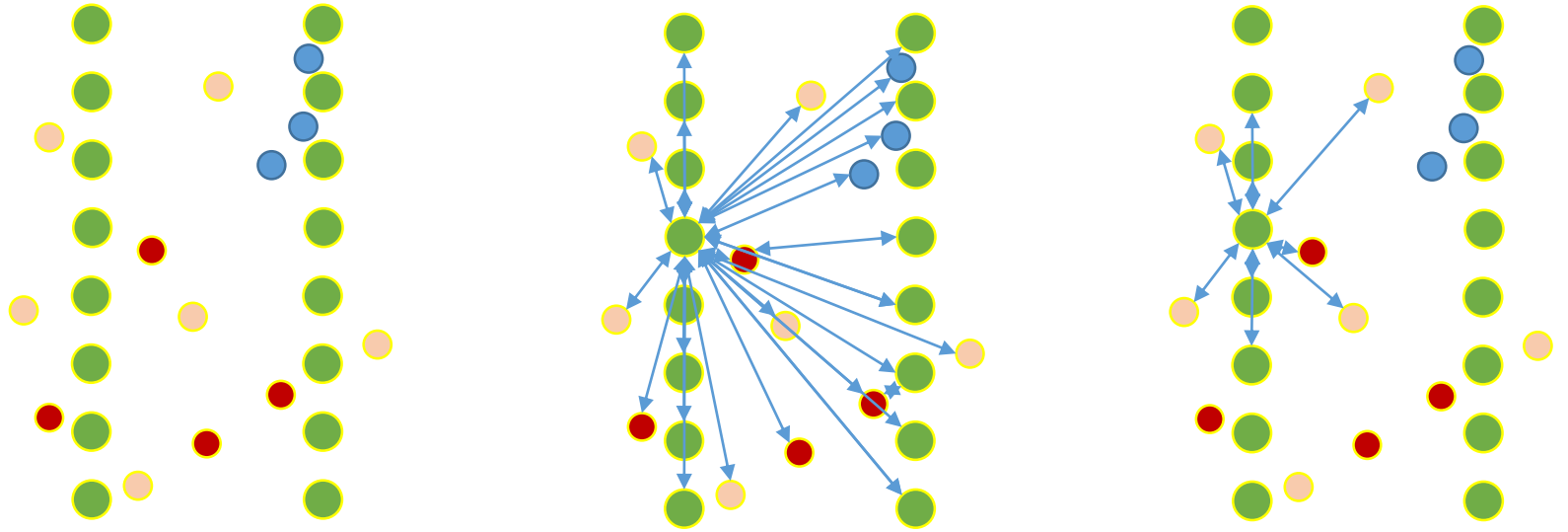

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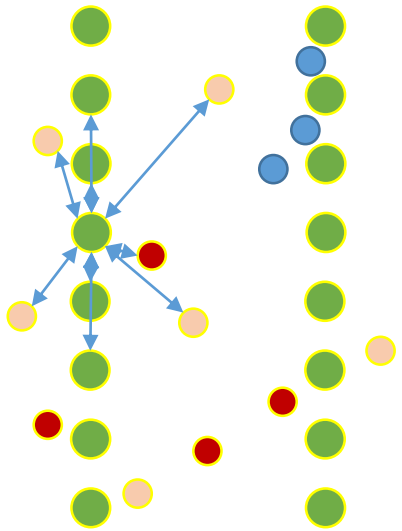


wheat

Weed species 1

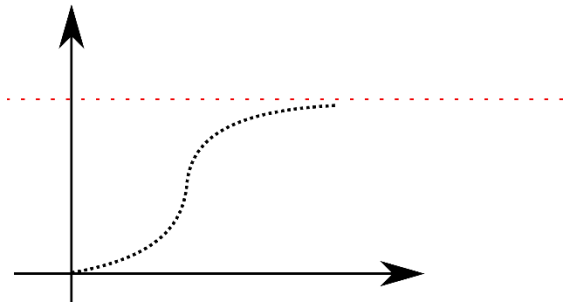
Weed species 2

Weed species 3

Spatial interaction

$$\alpha_{ij} = w_{ij} Exp[-\left(\frac{d_{ij}}{a}\right)^{\gamma}]$$

Growth combined with space



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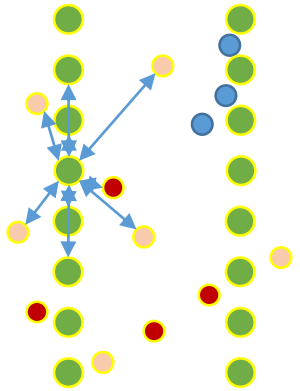


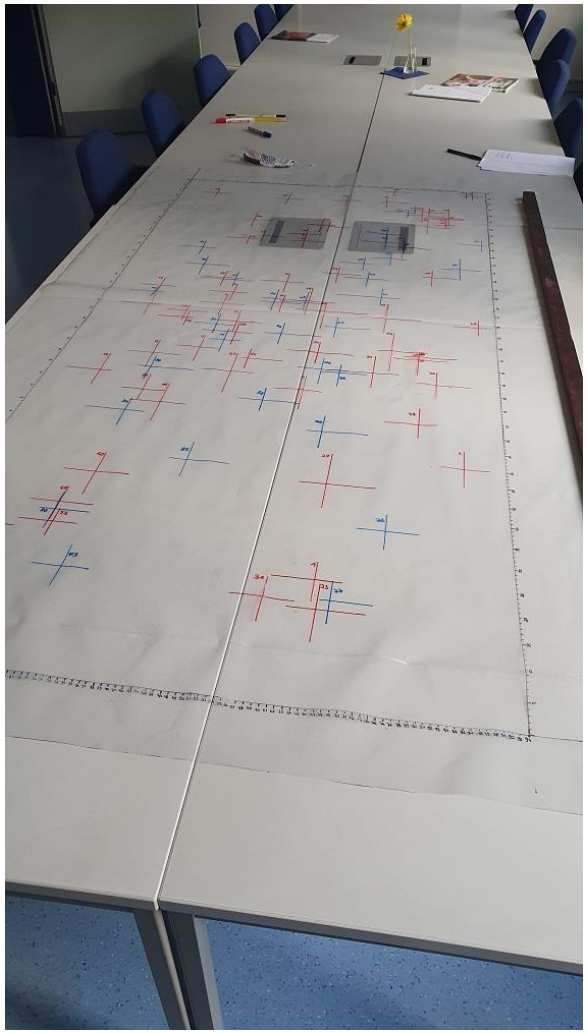
Growth curve

$$\frac{d\,y_i}{dt} = r_i\,y_i - \mu_i\,y_i(1 + \sum_{j=1}^{n}\alpha_{ij}y_j)$$

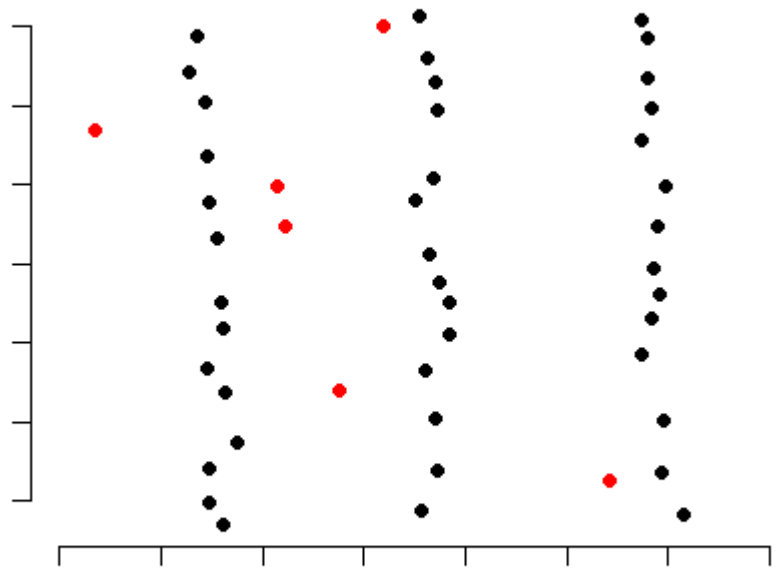
Spatial interaction

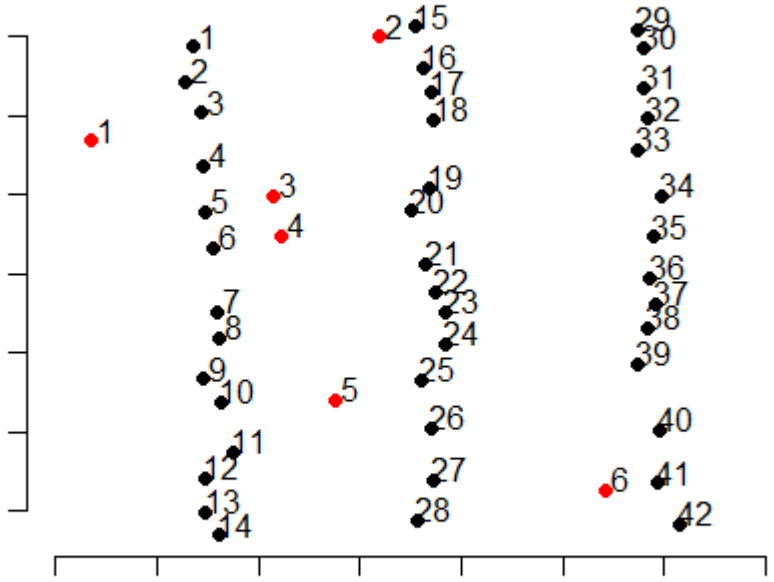
$$\alpha_{ij} = w_{ij}Exp[-\left(\frac{d_{ij}}{a}\right)^{\gamma}]$$

Wheat and Viola arvensis



Data generation





Data generation

Plant numbers:

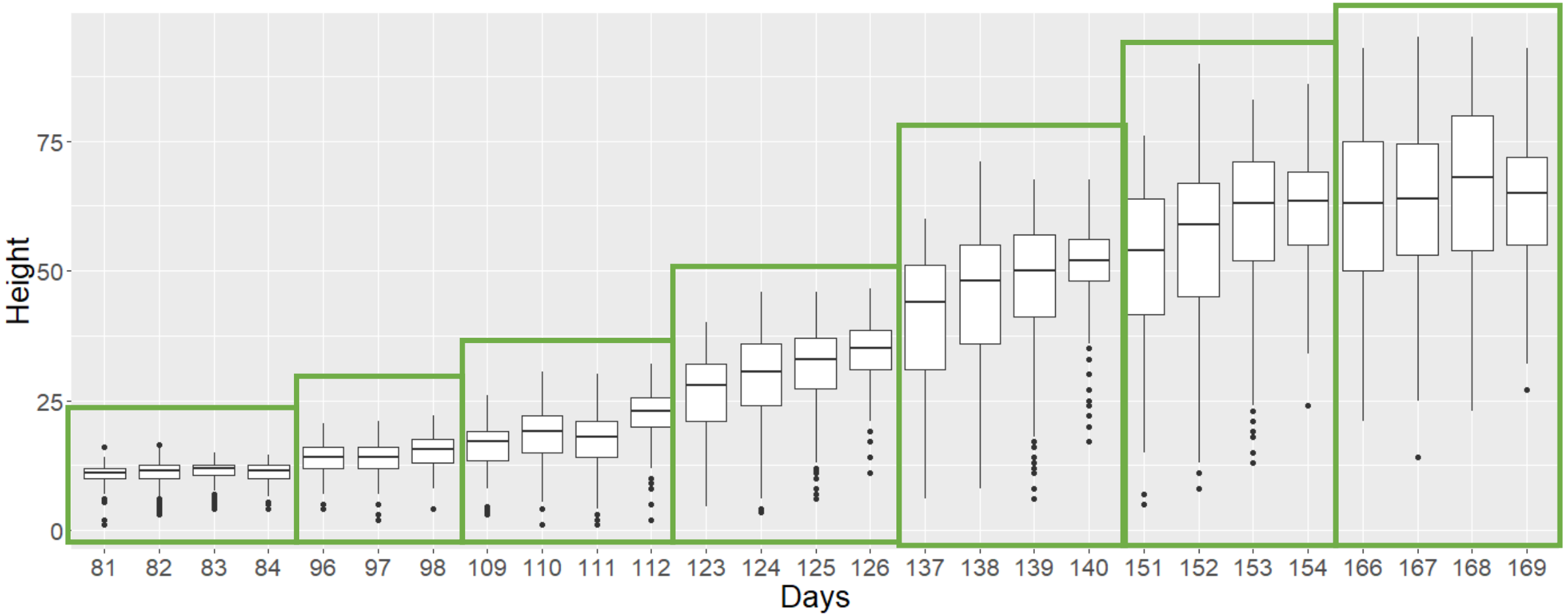
245 wheat plants

78 VIOAR plants

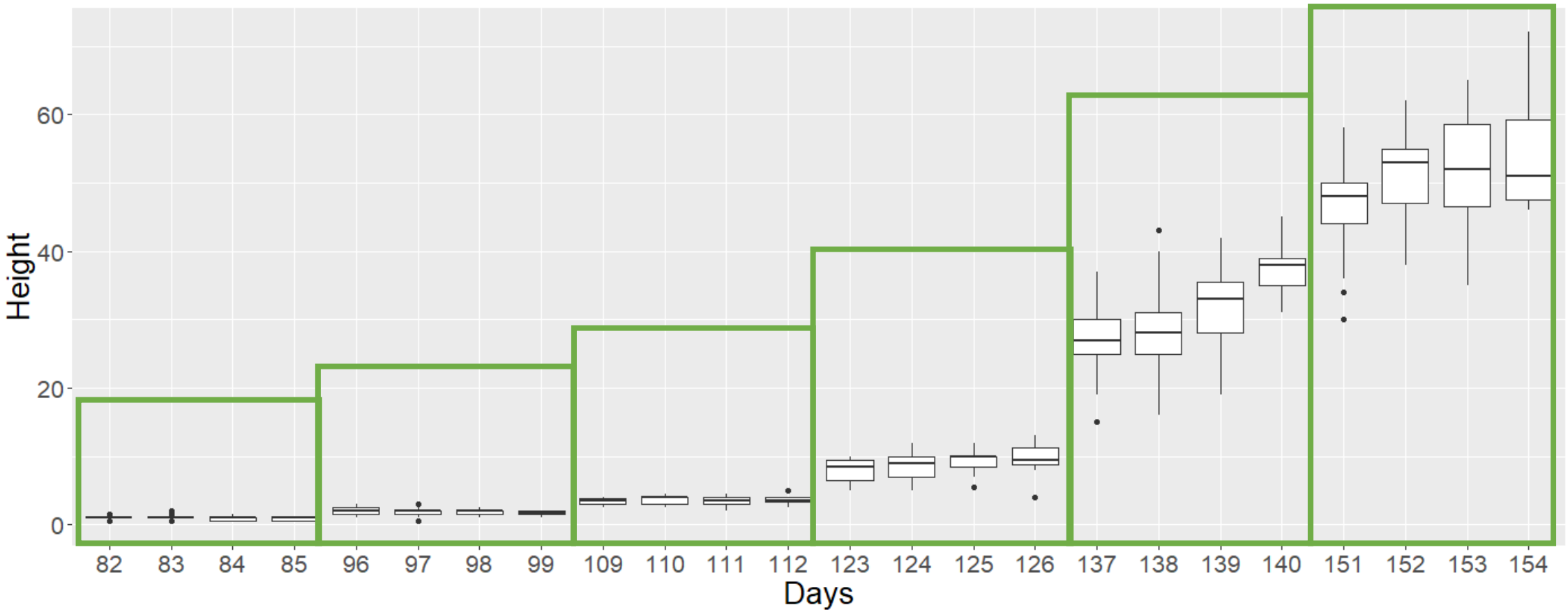
22 Plots

Measured 7 times

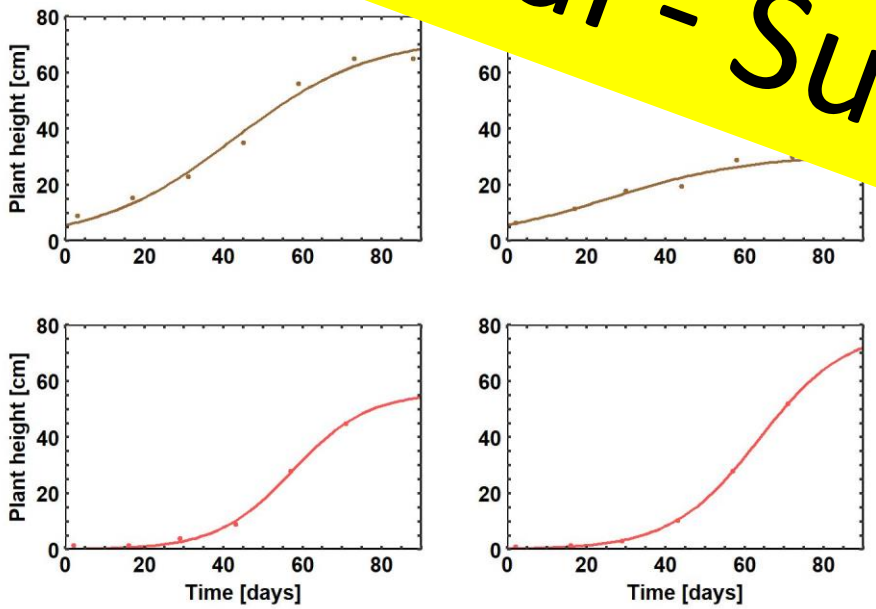
Growth of 245 wheat plants

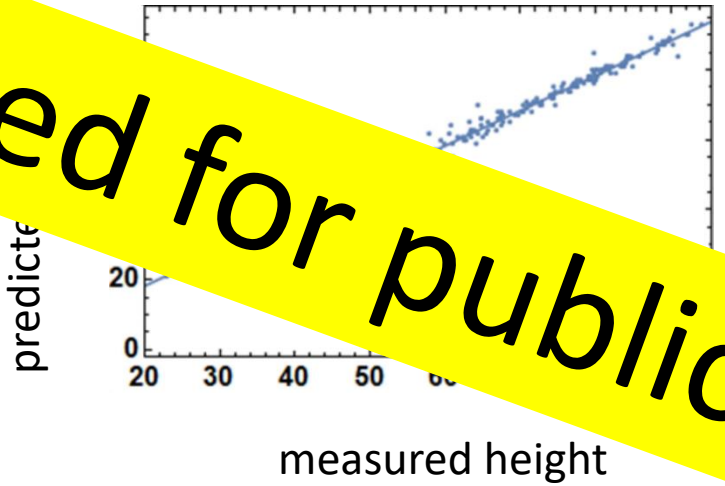


Growth of 78 viola plants



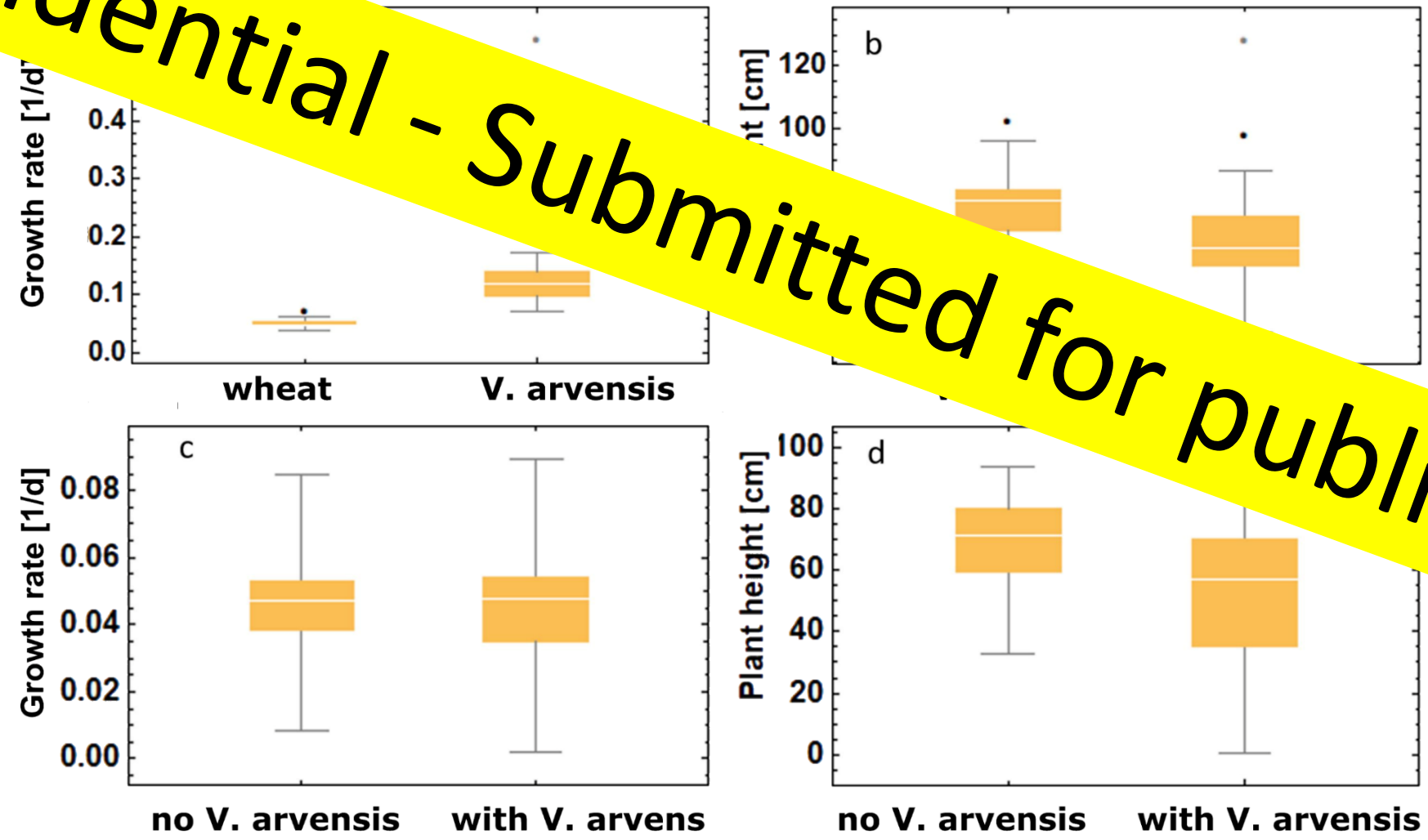
rametrization results





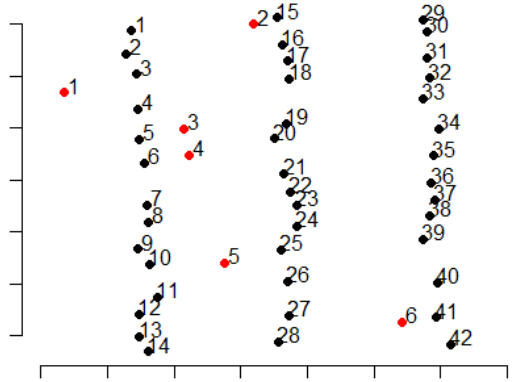
$$\frac{dy}{dt} = ry - \alpha y^2$$

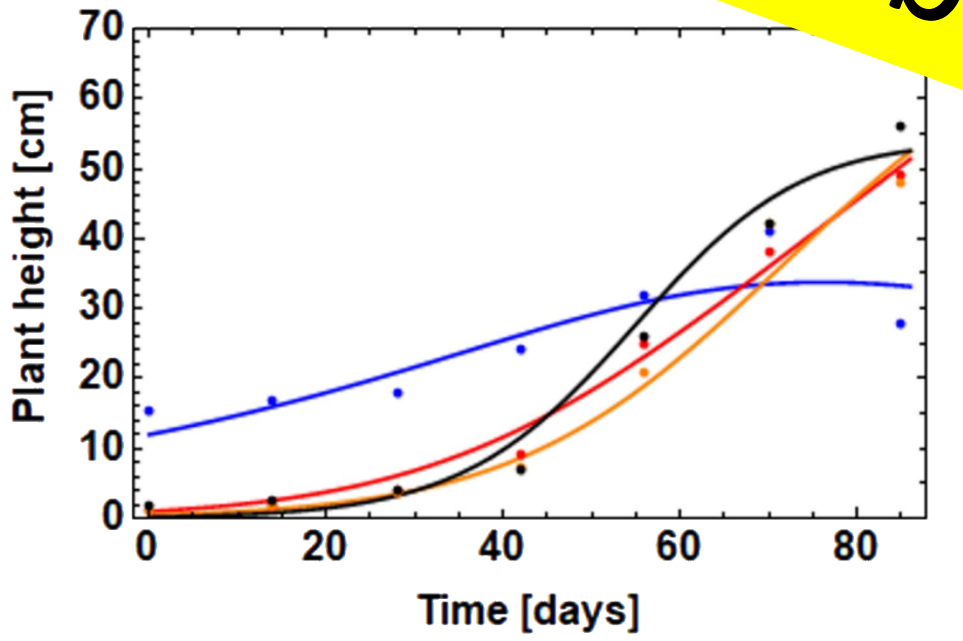
...ametrization of single plant growth

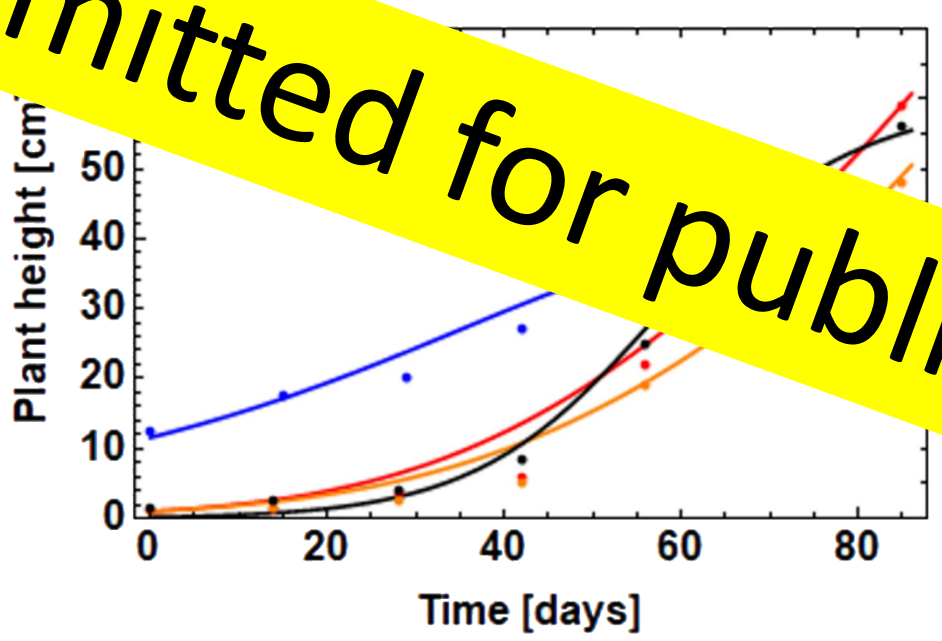


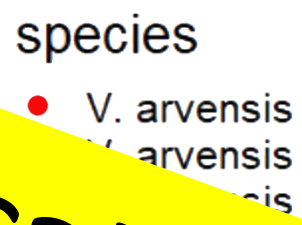
...rametrization of competition

$$\alpha_{ij} = w_{ij} Exp[-\left(\frac{d_{ij}}{a}\right)^{\gamma}]$$



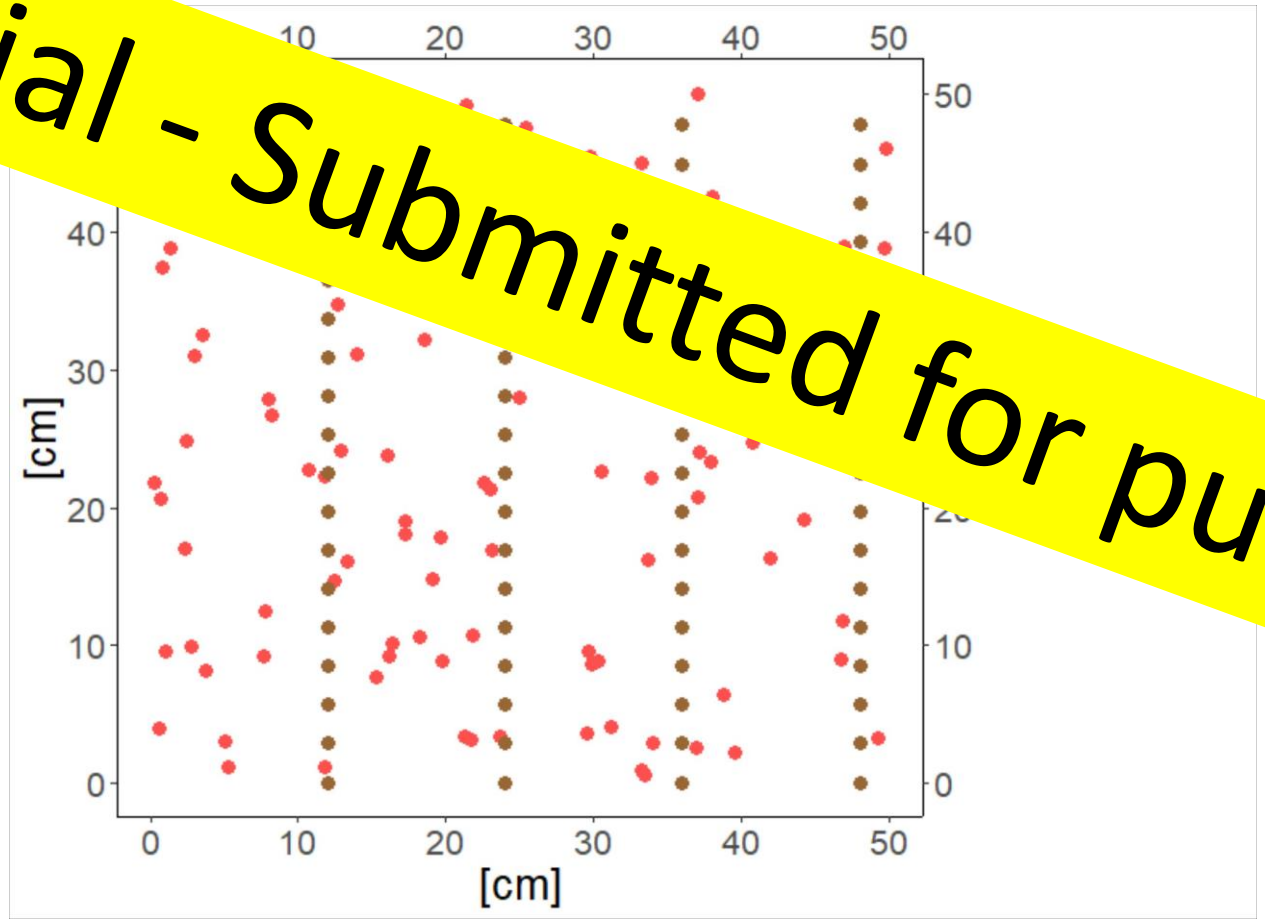






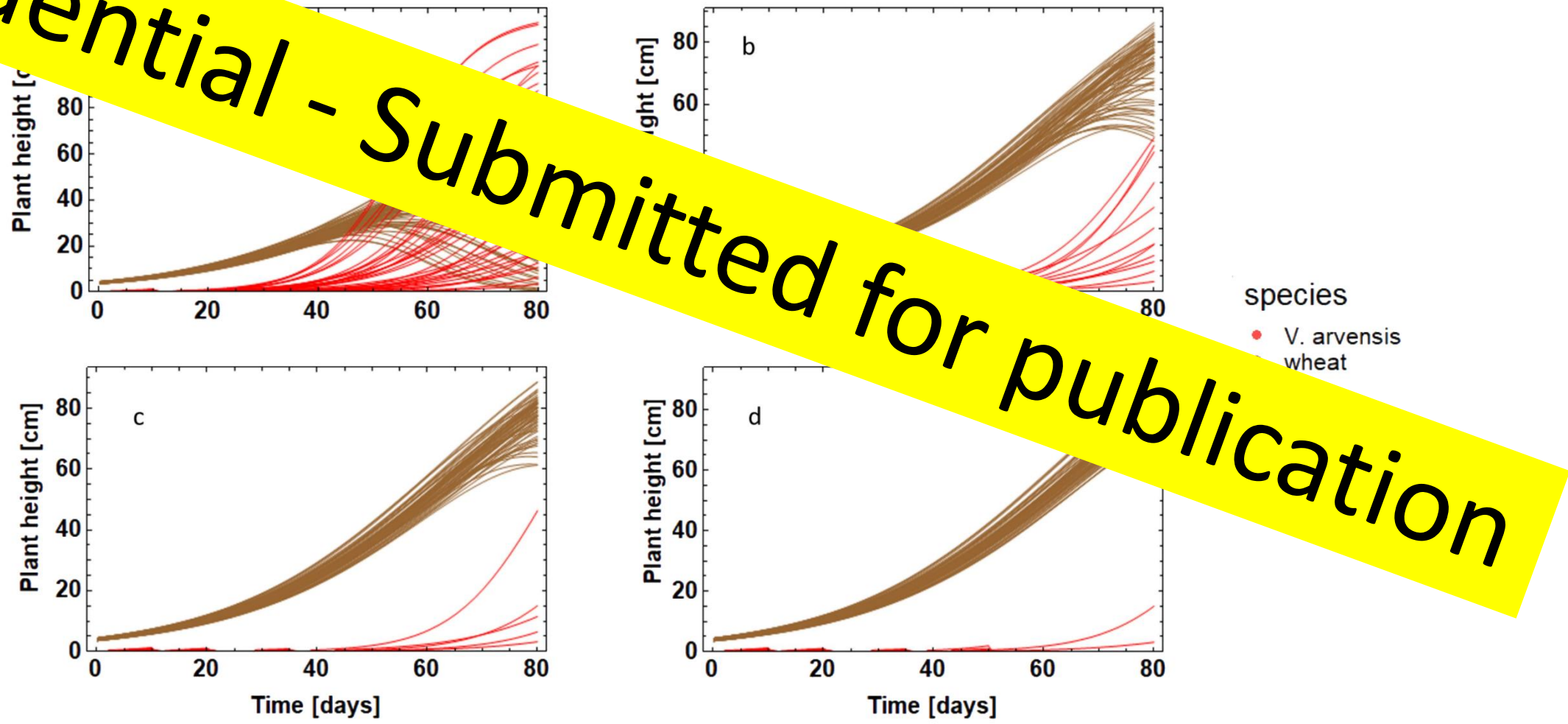
gle plant growth simulation

72 wheat plants
400 weed palnts



...ults of simulations

$$\frac{d\,y_i}{dt} = r_i\,y_i - \mu_i\,y_i(1 + \sum_{j=1}^{n} \alpha_{ij} y_j)$$



Coming next:

- Extension of the model to multiple weed species
- Simulation of floral trait development
- Population dynamics

→ Single plant management planning