Quantification of intra-plot variation

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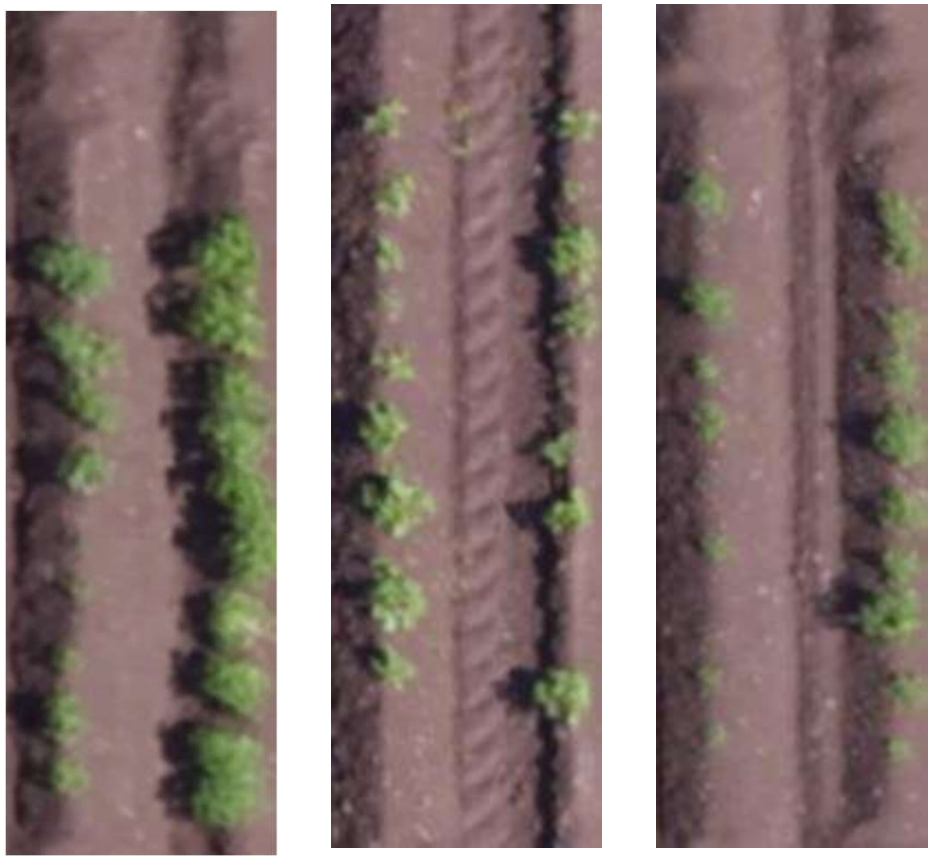
A nice walk in the experimental field...

… and then again



Why quantify the variation?

- Warning indicator
  - Too high variation in a plot may be problematic and due to ”outer” circumstances (pests etc.)
- Adjustment factor
  - Or simply to explain an observed low value/rating
- Of direct interest
  - Variation in germination
  - Detect phenotypic qualities
    - Lodging
    - Winter hardiness

What do we want to quantify?

- Spatial variation
- Variation in what?
  - Variation in coverage
  - Variation in plant size
  - Variation in color
  - Variation in plant density
- The observed data determine what kind of variation may be measured
- Different approaches for different crops

How to quantify intra-plot variation

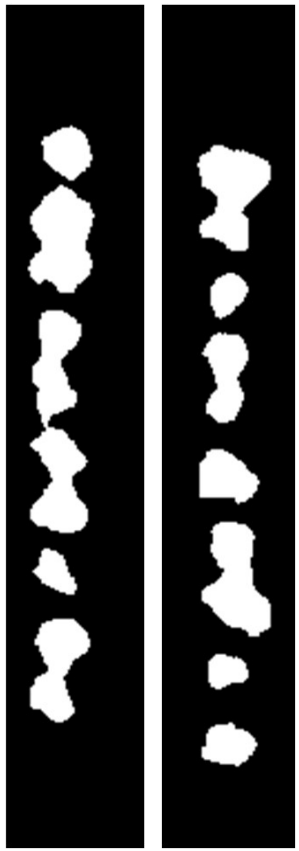
- Definition: Direct or indirect
- Tools for quantifying variation
  - Coefficient of variation of plant specific characteristic
    - Coverage
    - Color
  - Measure of deviation from homogeneity defined as randomness
  - Variograms
  - (Open) Spaces between plants

Germination of potatoes

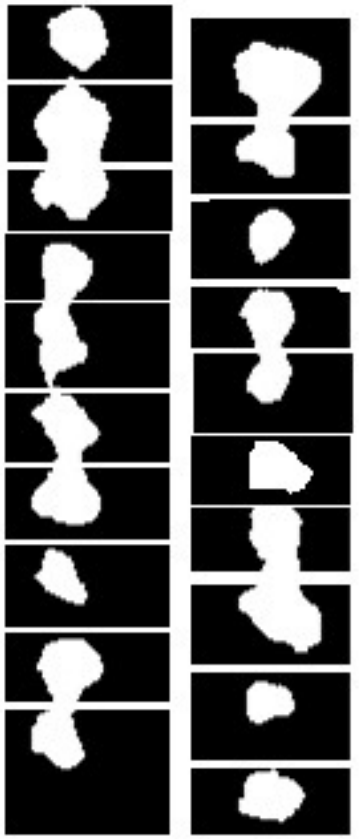
- Experiment at Danespo Potato Breeding
- 623 plots
- UAV flight campaign 8th of June 2017
- Using binary images

Comparing coverage of subsets of the plots

Comparing rows

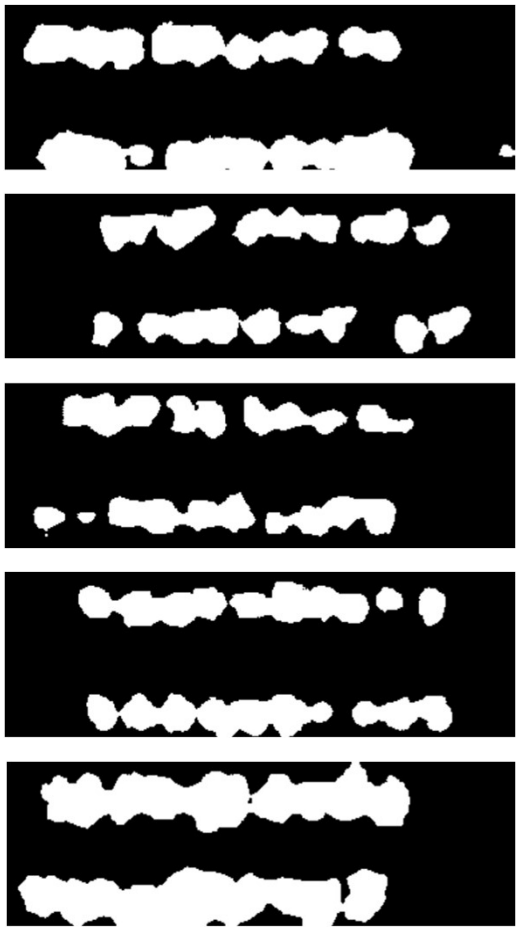


Comparing plants

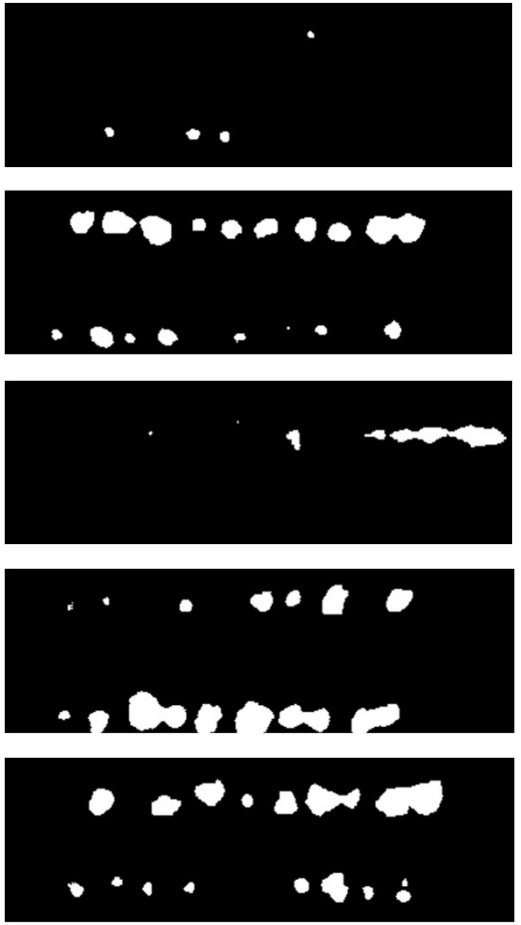


CV for row coverage - Results

Low variation



High variation



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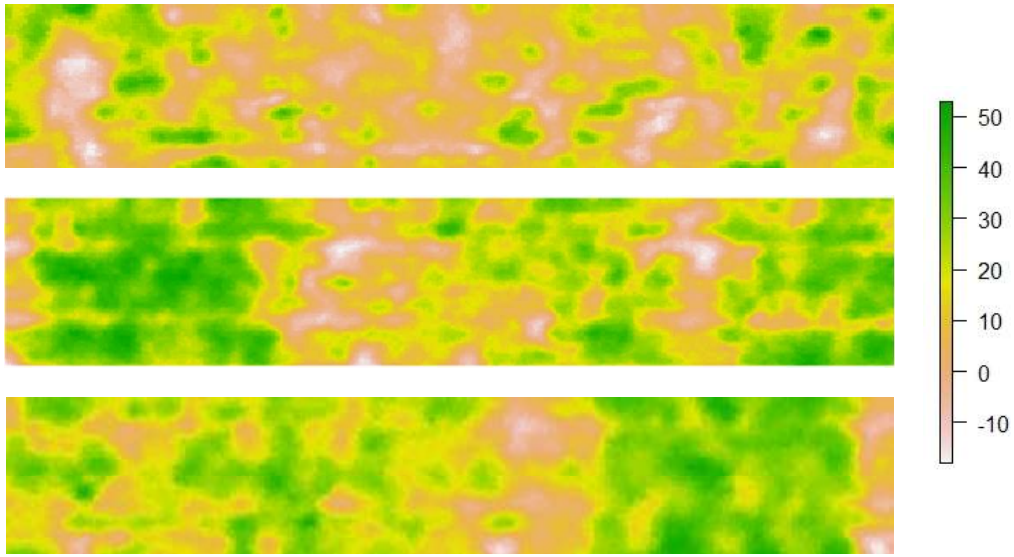
Germination/winter hardiness of winter barley

- Experiment at Sejet Plant Breeding
- 160 plots
- UAV fligt campaign 6th of April 2018
- Using ExG index images

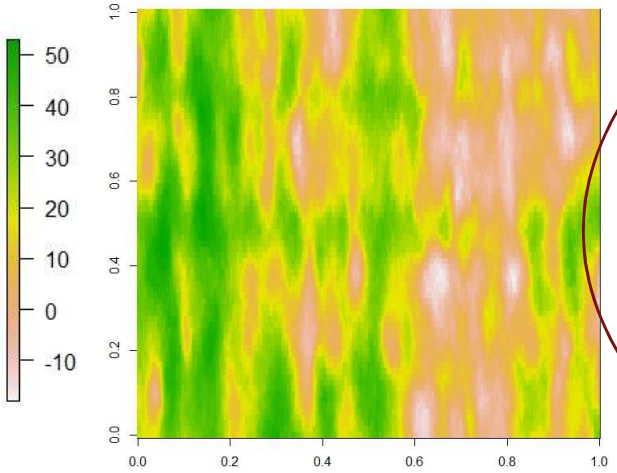


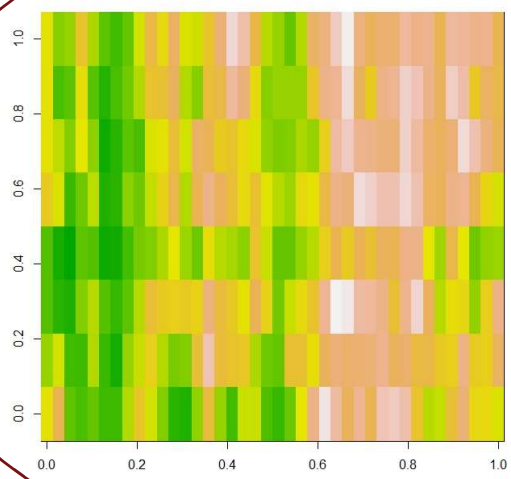
Indirect definition of variation – Deviation from spatial homogeneity

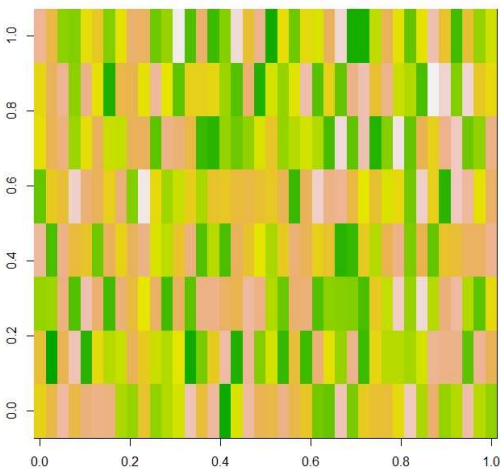
Original ExG index map

Low resolution ExG index map

Randomized pixel values



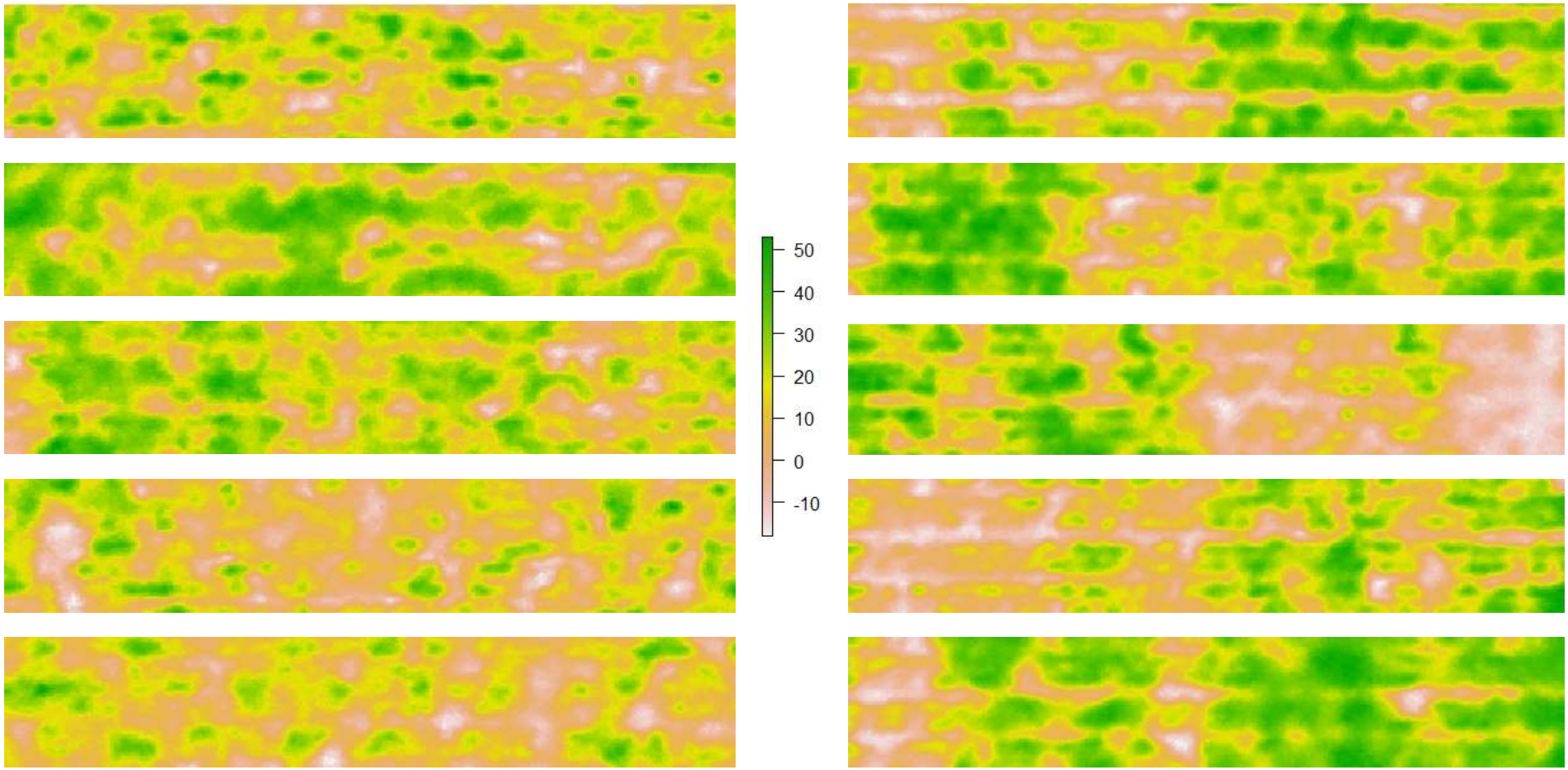




Deviation from spatial homogeneity - Results

Low variation

High variation



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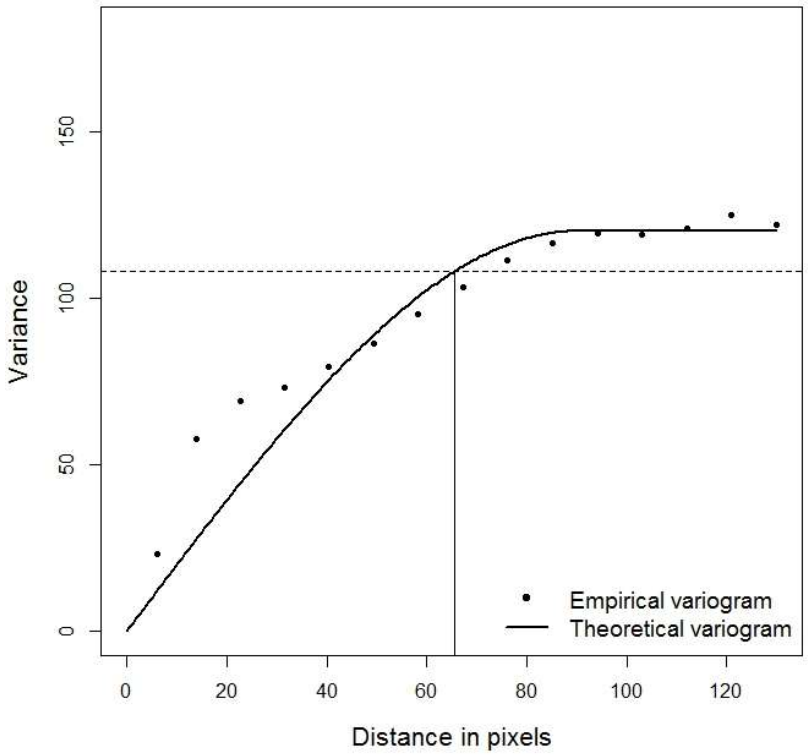
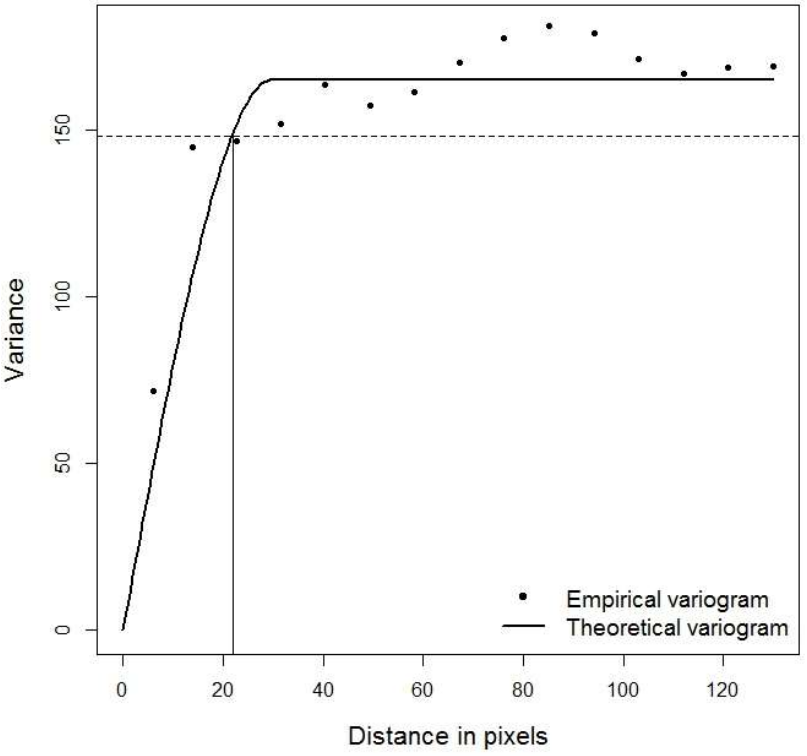
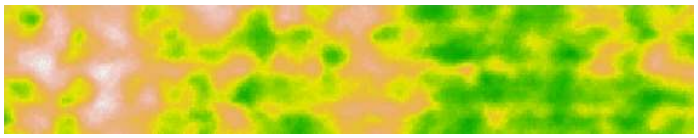
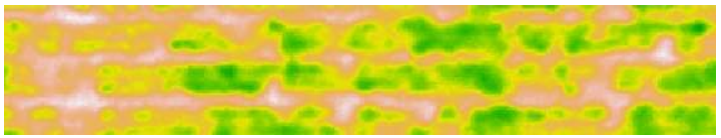
Variograms

Range: Distance to reach 90% of the level of the plateau



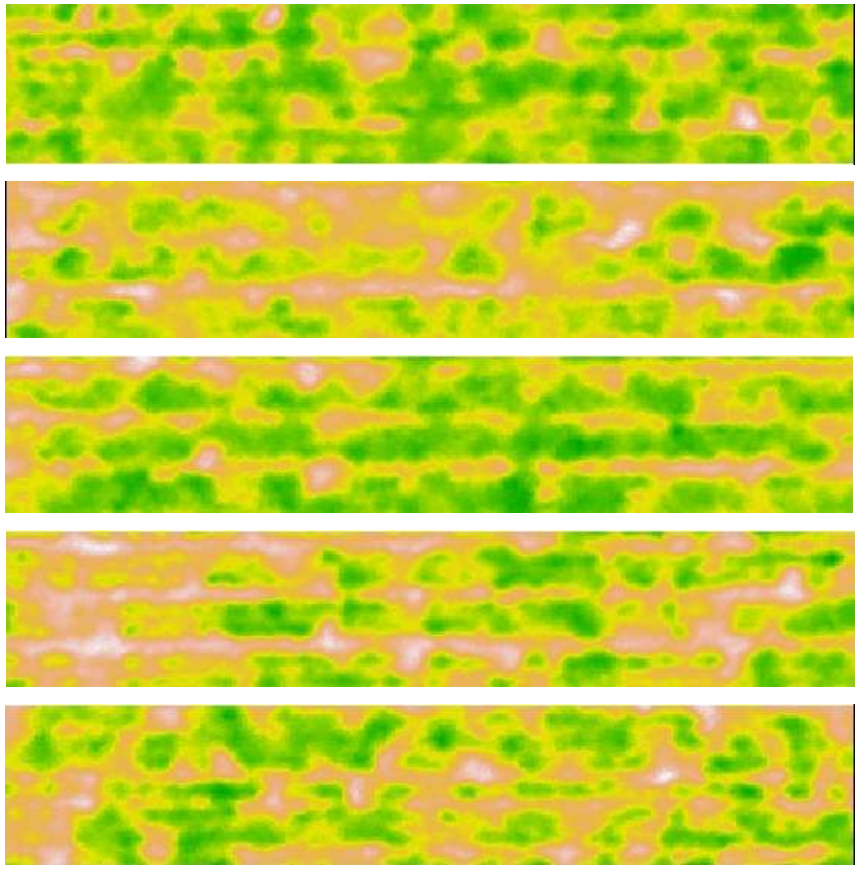


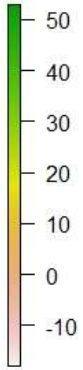




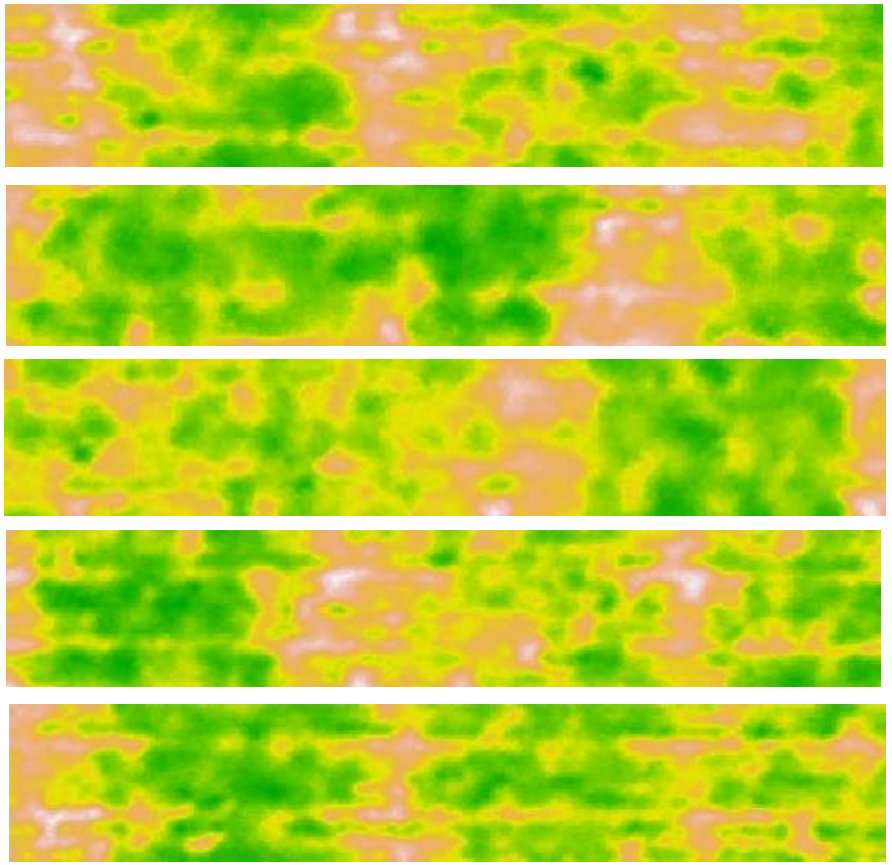
Using variograms - Results

Low variation





High variation



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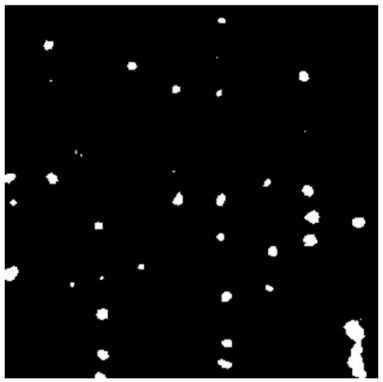
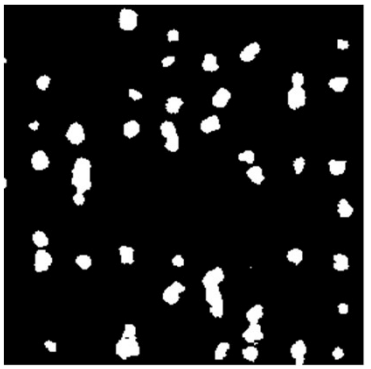
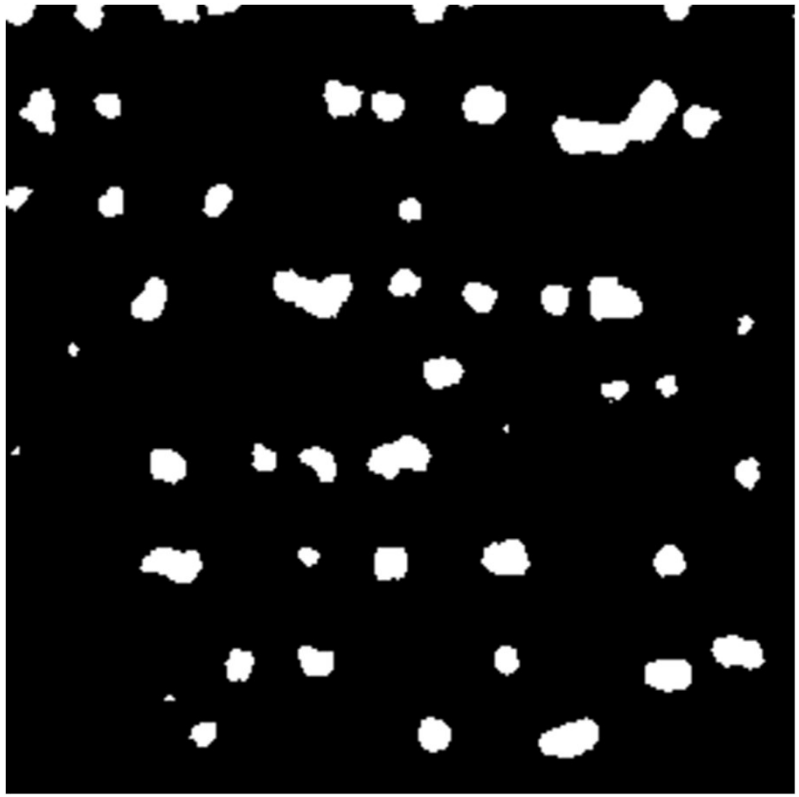
Germination of faba beans

- Experiment at Sejet Plant Breeding
- 60 images (app. 1 m^2)
- UAV flight campaign 9th of May 2017

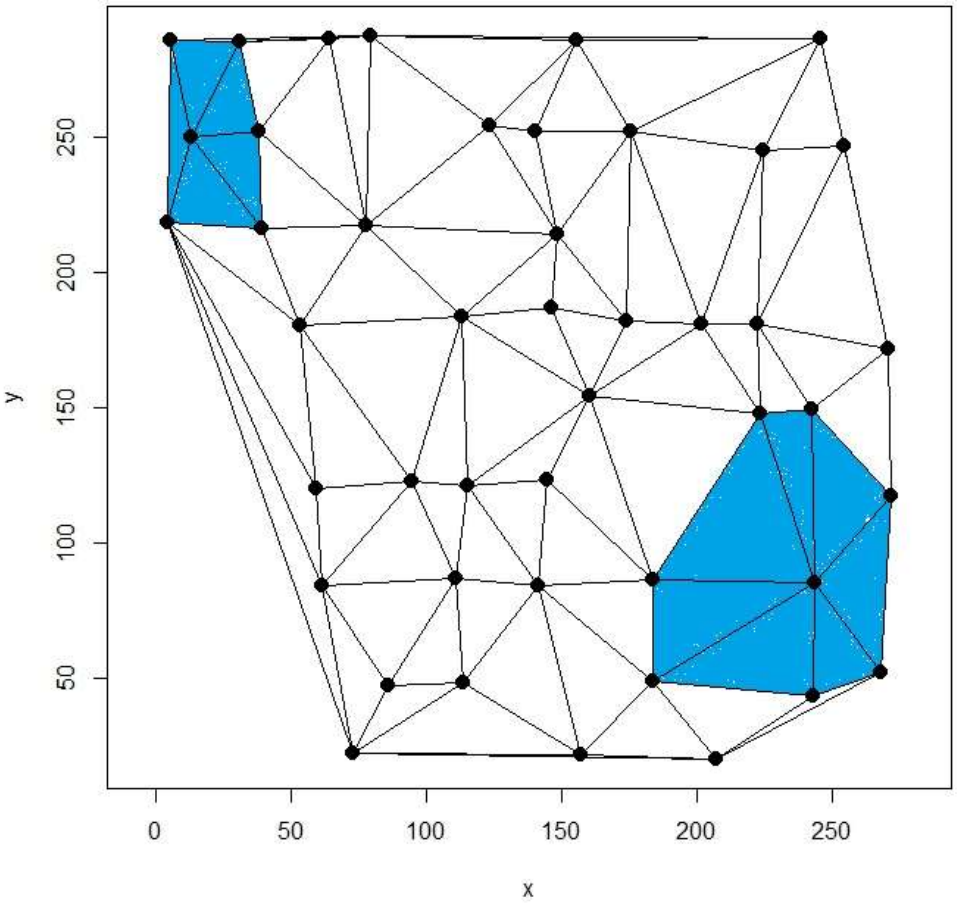




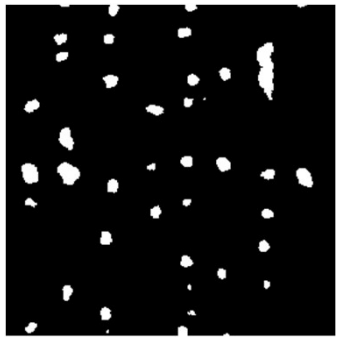
Open spaces

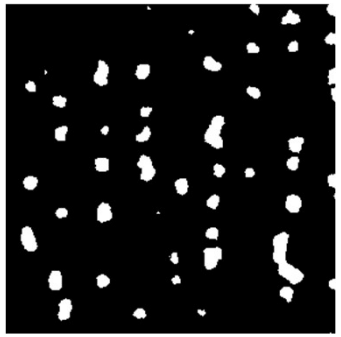


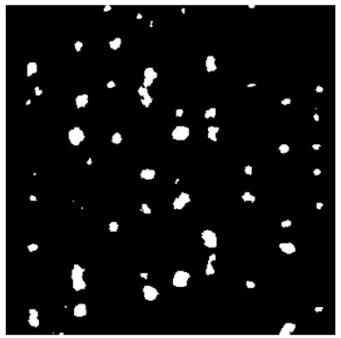
Delaunay Triangulation



Open spaces - Results







Low variation

High variation

Conclusions

- Known methods from geostatistics looks promising for quantifying intra-plot variation
- One method doesn't fit them all
- Resolution of the images may impact the results

Challenges and perspectives

- To avoid influence of the size of the plants
  - Larger/more developed plants may overlap
- To avoid influence of the colors
  - Different colors of the soil
  - Different colors of the cultivars
- Weed
  - Timing of the flight campaign my be important
- Could be relevant for other purposes
  - Drought
  - Lodging
  - Maturing

Source of variation: G×E×M

- Environment
  - Soil type and quality
  - Small and large pests
  - Plant disease
  - …
- Management
  - Soil tillage
  - Fertilization
  - …
- Genetics
  - Robustness
  - Homogeneity within each genotype
  - Winter hardiness
  - …

Literature

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- Li H & Reynolds JF (1995). On definition and quantification of heterogeneity. *OIKOS.* 73: 280-284

Thank you


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