Use of thermal imaging in sunflower phenomics

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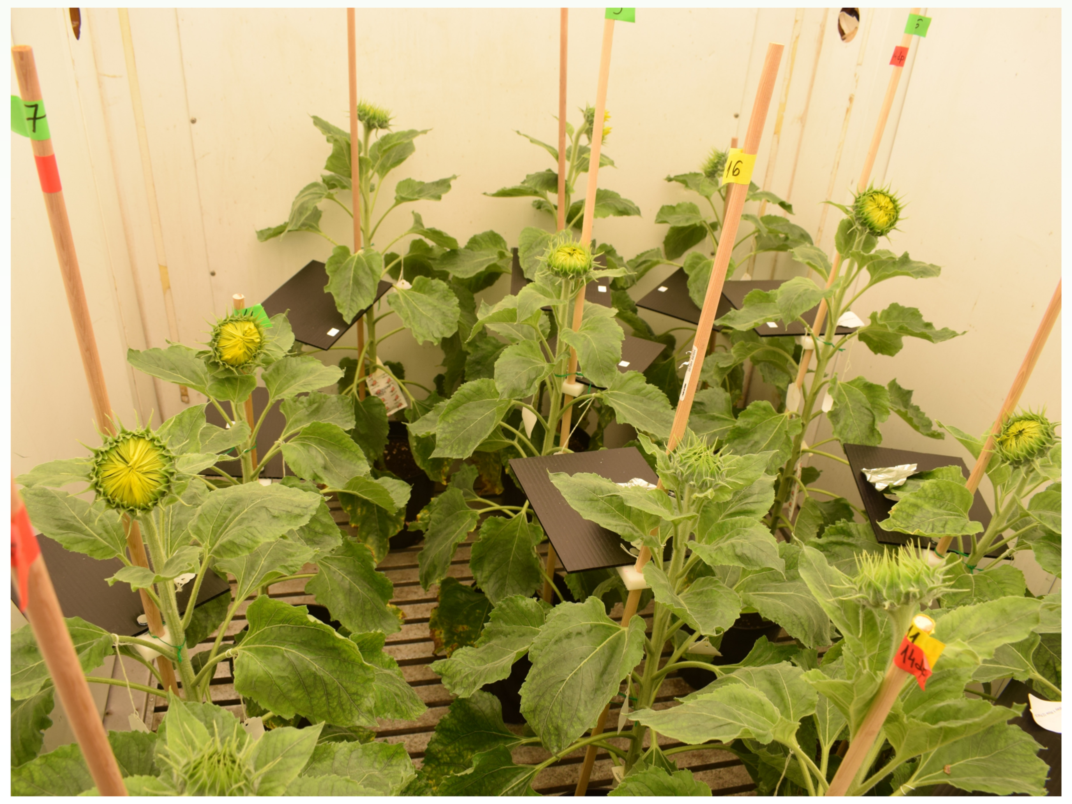
Background

- High-throughput and highly accurate phenotyping methods are needed for biotic traits, where rapid, precise, and reproducible quantification of symptoms is required for estimating the disease severity and evaluation of host resistance.
- Up until now, qualitative visual assessments have often been used to quantify disease severity.
- Recent advances in thermal imaging have made it feasible to assess plant-pathogen interactions by monitoring patterns of surface tissue temperature.
- We examined the utility of thermal imaging for resistance screening of Sclerotinia head rot, rust and Phomopsis stem canker in sunflower.

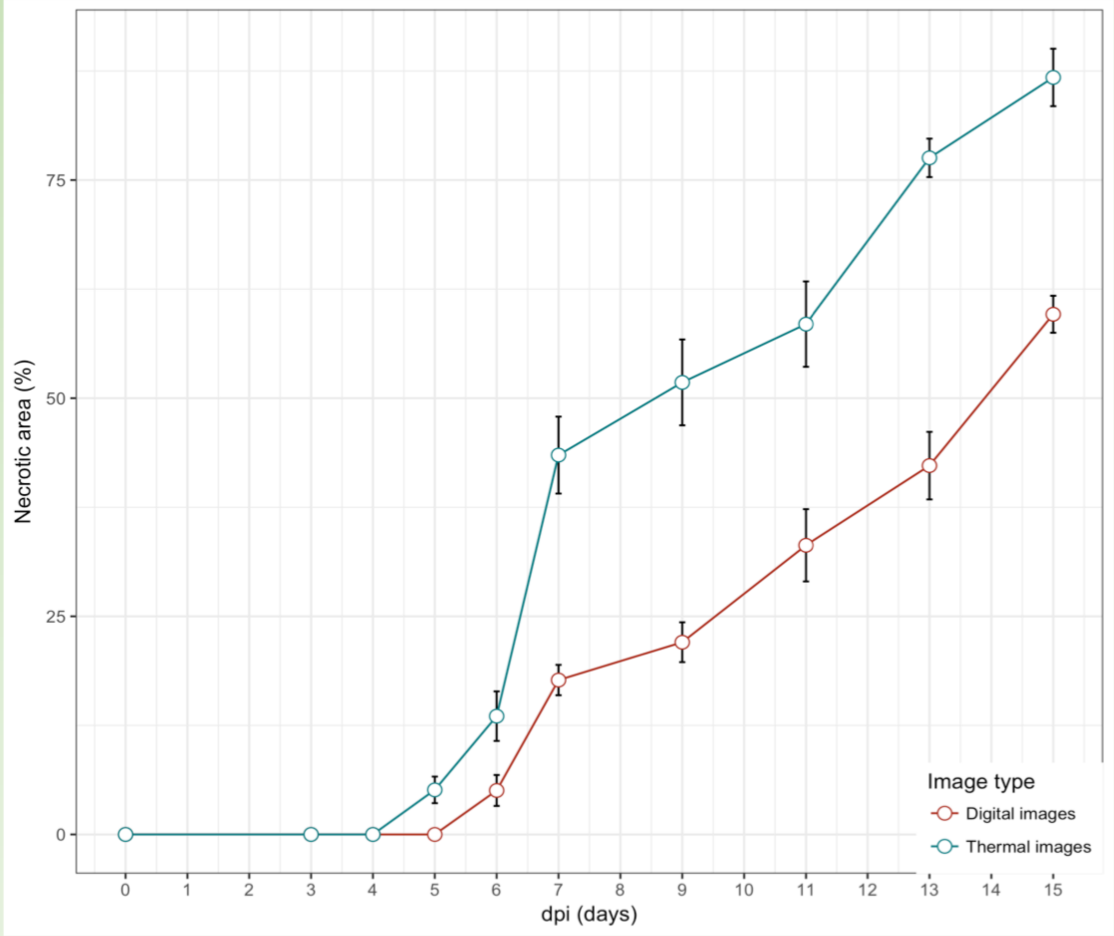
Materials and Methods

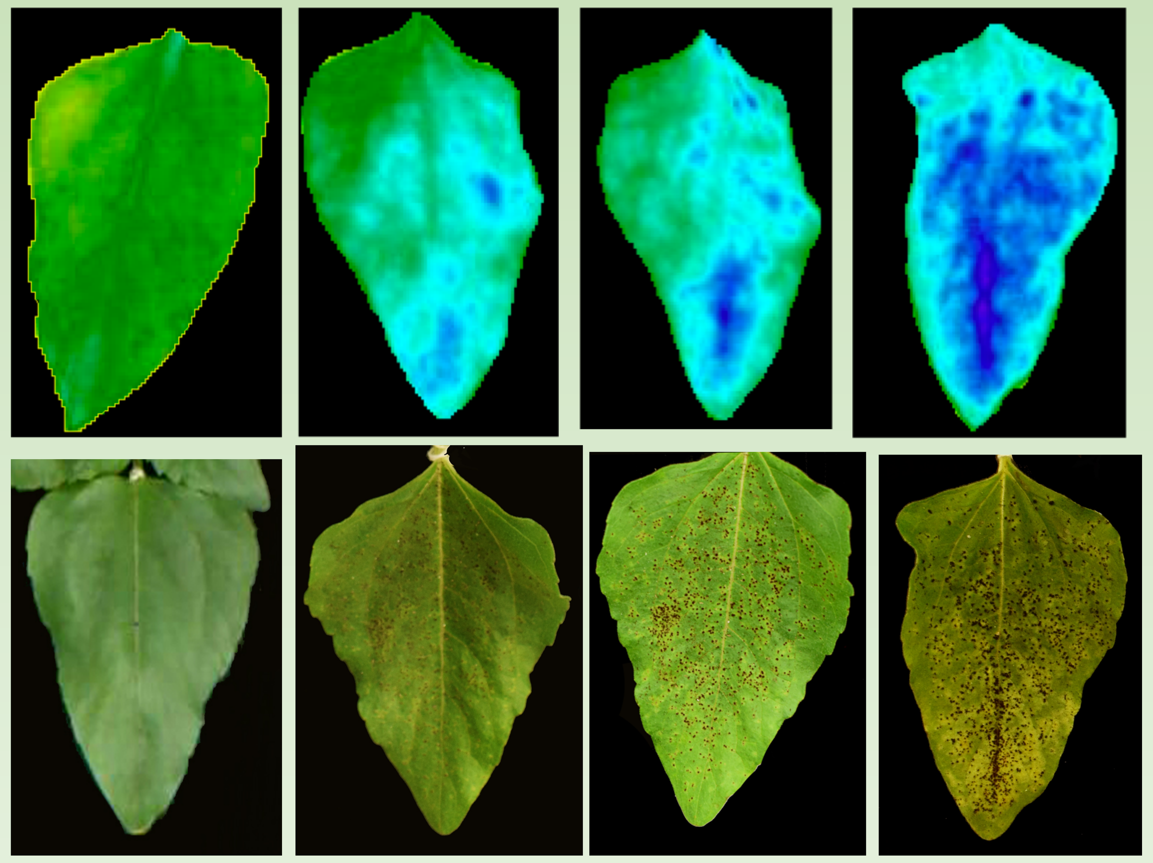
- For each disease one genotype that has previously shown high levels of susceptibility was used: HA 292 was used as a susceptible control for rust and PSC, whereas HA 457 was used for SHR infection.
- All of the plants were grown in Conviron PGW36 walk in chambers, where the temperature after infection was 23 ± 2 °C, and with a photoperiod of 16-h light and 8-h dark.
- Images were taken in the growth chambers every day until the appearance of the first visible symptoms, after which they were acquired every second day.



Results

Rust





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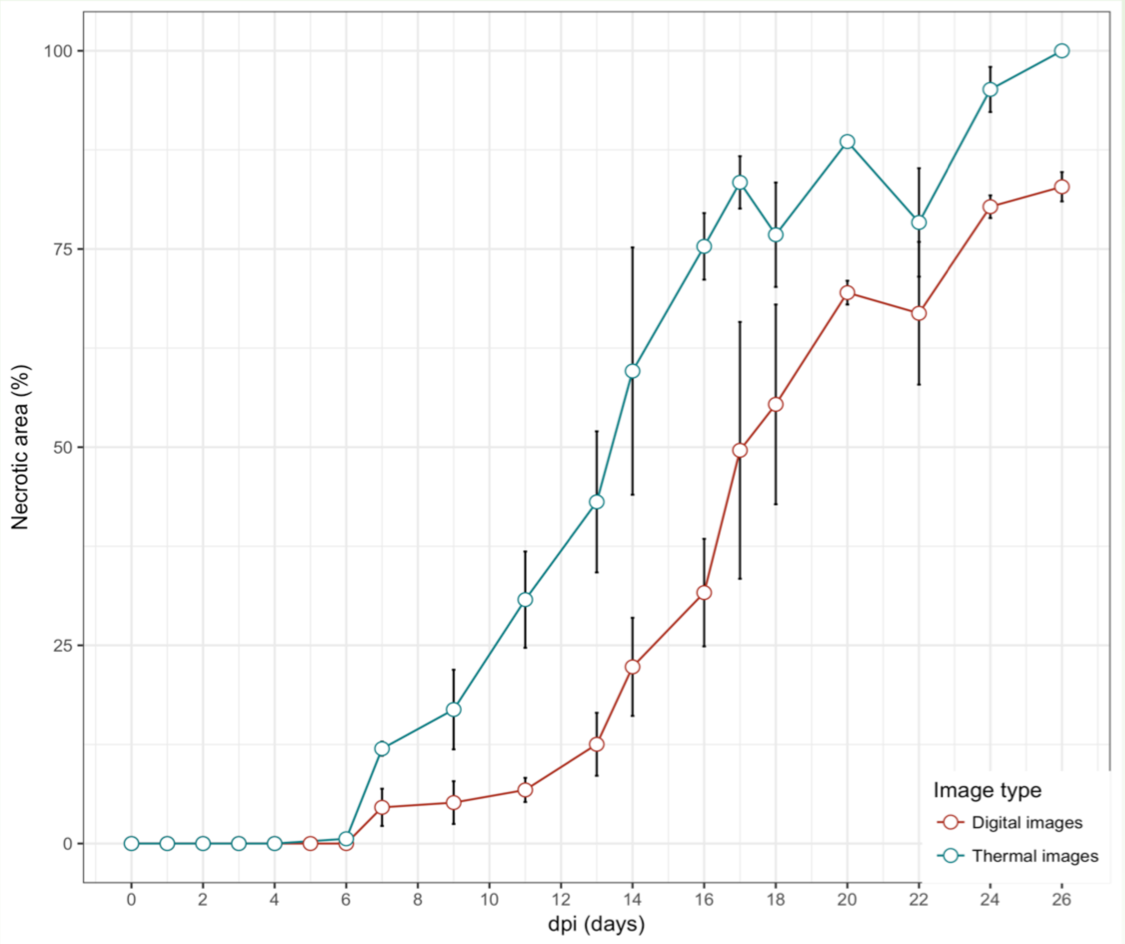
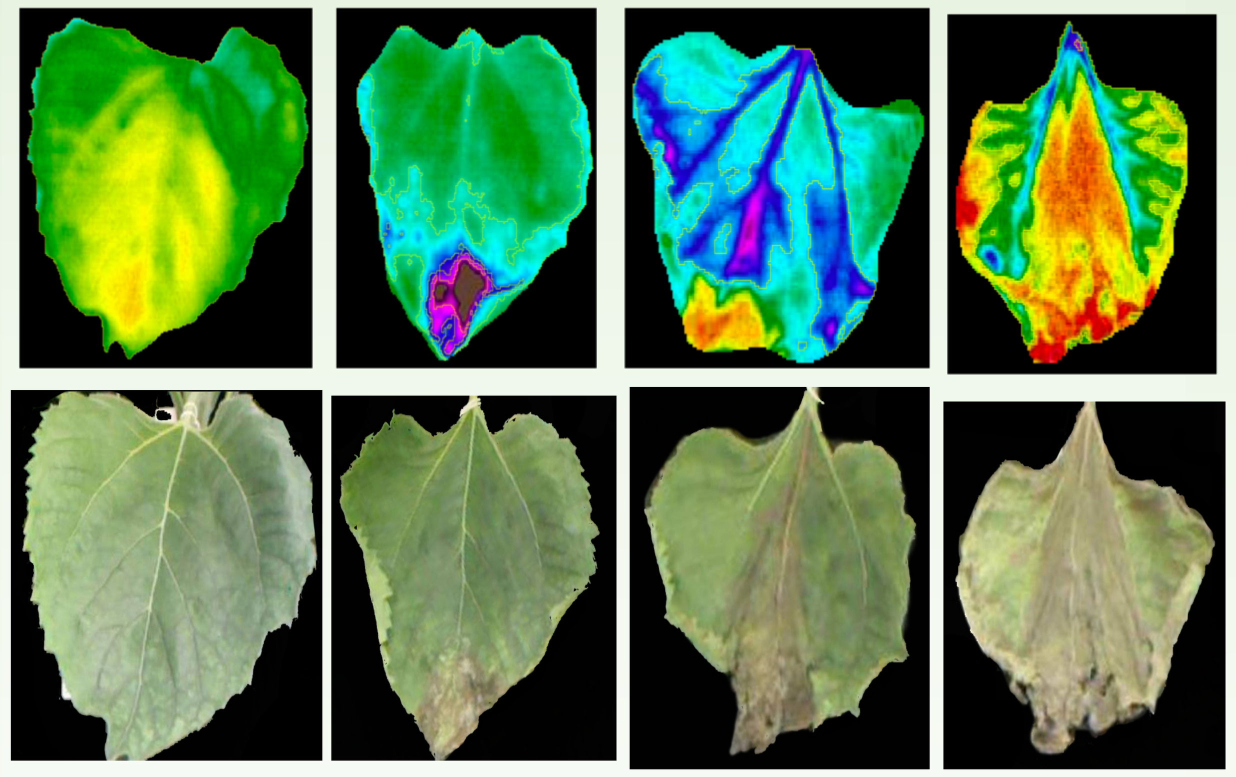
Phomopsis





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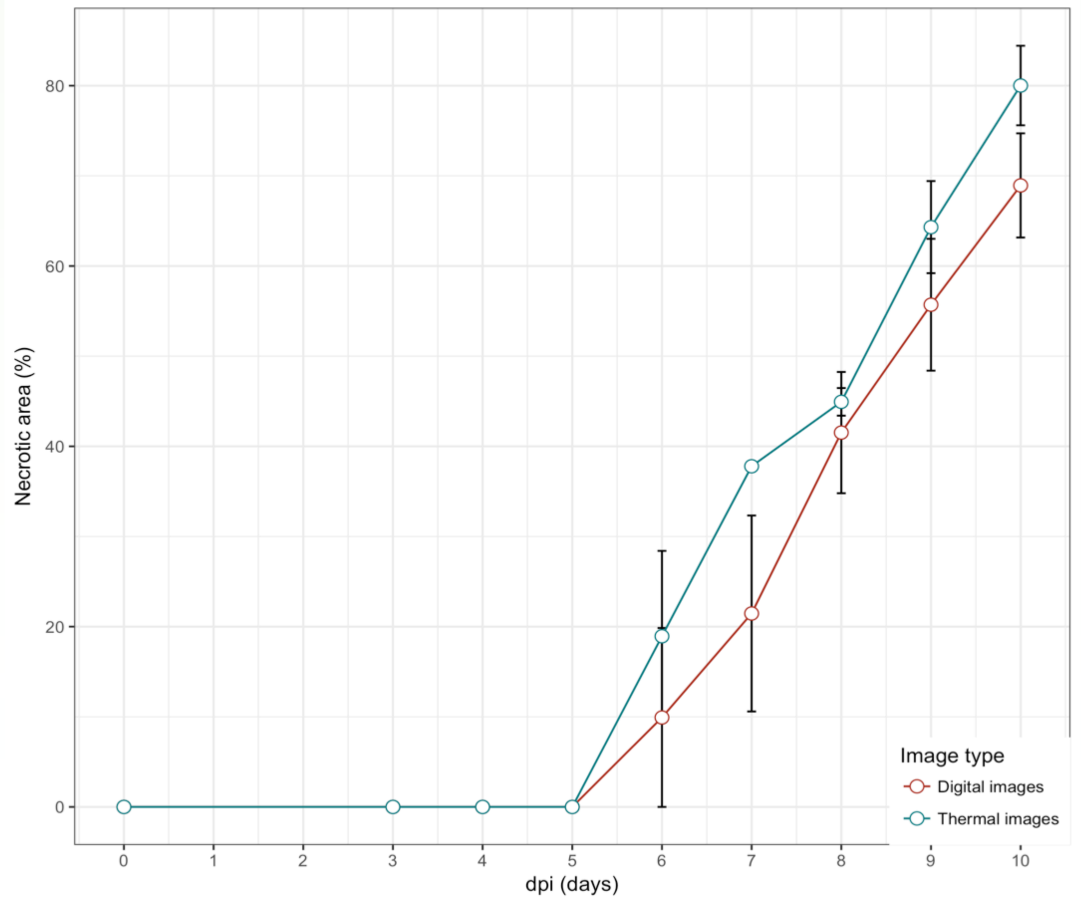
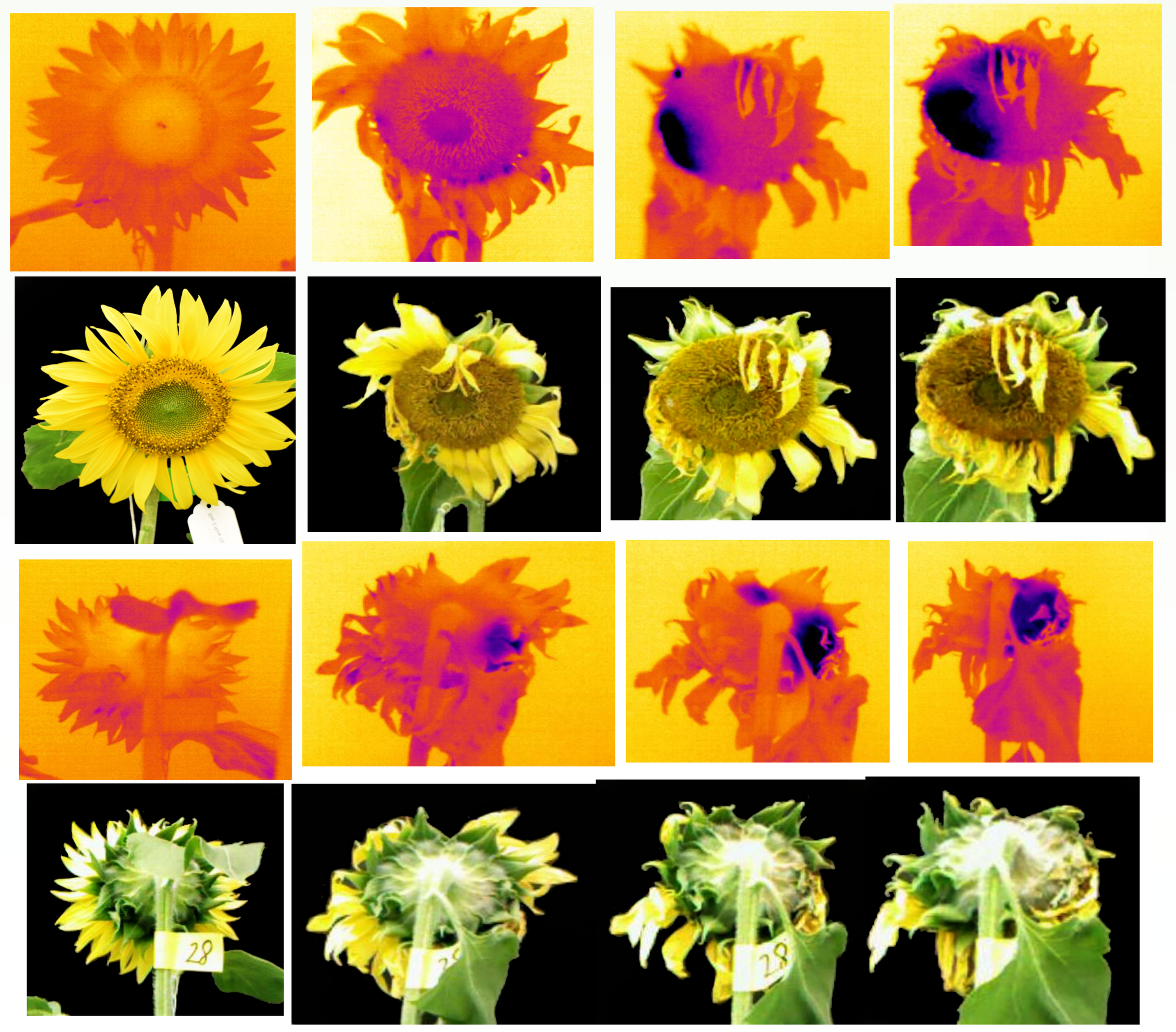
Sclerotinia





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Conclusions

- Temperature differences up to 4 °C were observed between the healthy and diseased tissue.
- Distinct areas of lower temperature preceded the appearance of necrotic lesions.
- The contrast between unaffected and lesioned areas on thermal images was markedly higher than in visible images, potentially facilitating automated quantification.
- These results suggest that thermal imaging could be highly suitable for disease quantification as well as for remote sensing approaches.
- Future research will include testing the efficacy of thermal imaging technology in the field conditions as well as development of machine learning algorithms for automated disease quantification.

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