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Artificial intelligence algorithms for the detection of black rot in brassicas under current and future climate change conditions

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Black rot of brassicas is a devastating disease caused by *Xanthomonas campestris* pv. *campestris* (Xcc). A method has been designed to detect Xcc infection in brassica leaves based on computer vision (recording of different optical signals from leaves) coupled to artificial intelligence (AI) algorithms able of learning patterns. Based on this knowledge, the algorithms classify the plants into categories (healthy or infected). The method has also been tested in future alterations of climatic conditions, as global warming is a challenge for both plants and pathogens.
Thermography and multi/hyperspectral reflectance imaging are the most commonly used sensors in proximal and remote sensing for stress detection. On the one hand, leaf to air differential temperature (TL-TA) is an indirect measurement of vegetation transpiration. On the other hand, a collection of vegetation indices (VIs) is available from hyperspectral reflectance measurements, providing information on several plant traits (vigour, fitness, pigment composition, etc.). Furthermore, a multicolour fluorescence imaging (MCFI) device, which records blue (F440) and green (F520) fluorescence emitted by phenolic compounds related to plant defense, was applied.
Using those sensors, the response of broccoli and oilseed rape plants to Xcc infection was analysed in two future environments for the years 2081-2100, taking as reference the current climate conditions: an extreme, and an intermediate climate change scenario.
For broccoli plants, values of TL-TA and five conventional VIs were recorded. Furthermore, three novel VIs, named diseased broccoli indices (DBI1-DBI3), were designed based on the spectral reflectance signature of leaves. Finally, these nine parameters were used to train three classifying algorithms: artificial neural networks (ANN), support vector machines (SVM), and k-nearest neighbour analysis (kNN). These classifiers were then tested and showed high classification performance in identifying healthy and Xcc-infected leaves under the three climatic treatments. DBI1-DBI3 proved to be very informative parameters for the black rot detection [1].
For oilseed rape plants, values of TL-TA, F520 and two VIs were recorded from asymptomatic leaves. These parameters were used to train four classifiers: ANN, SVM, kNN and LRA (binary logistic regression analysis), obtaining high classification accuracies under the three climatic conditions in the absent of symptoms. However, the predictive capability of the models decreased under the projection of extreme climate change [2].
Overall, these results highlight the importance of computer vision and AI algorithms for early detection of crop diseases, noting the importance of considering environmental conditions in the performance of these techniques.

References

[1] Pineda *et al*. 2022. *Frontiers in Plant Science* 13: 790268, doi:10.3389/fpls.2022.790268.
[2] Pineda and Barón, 2023. *Plants*. Assessment of black rot in oilseed rape grown under climate change conditions using biochemical methods and computer vision. In Press.