Applications of Near Infrared Hyperspectral Imaging for crop disease detection

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Assessment of resistant plants in sugar beet breeding program

Assessment of *cercospora* leaf spots development on sugar beet leaves

Objective:

Discriminate between cercospora leaf spots and healthy leaves as well as to quantify the disease area.

Material & methods:

4 tolerant and 4 susceptible to cercospora leaf spot sugar beet plants were grown in a greenhouse. The plants were infected by spraying with *Cercospora beticola*. Two classification methods have been developed using Support Vector Machine (SVM) and Partial Least Squares Discriminant Analysis (PLS-DA).

Figure 1: Image acquisition of sugar beet leaves using a line scan hyperspectral imaging system instrument.

Results:

Clear differences are observed between tolerant and susceptible plants. The disease development is slower on tolerant plants compared to susceptible plants. Similar conclusions were achieved using PLSDA or SVM models.

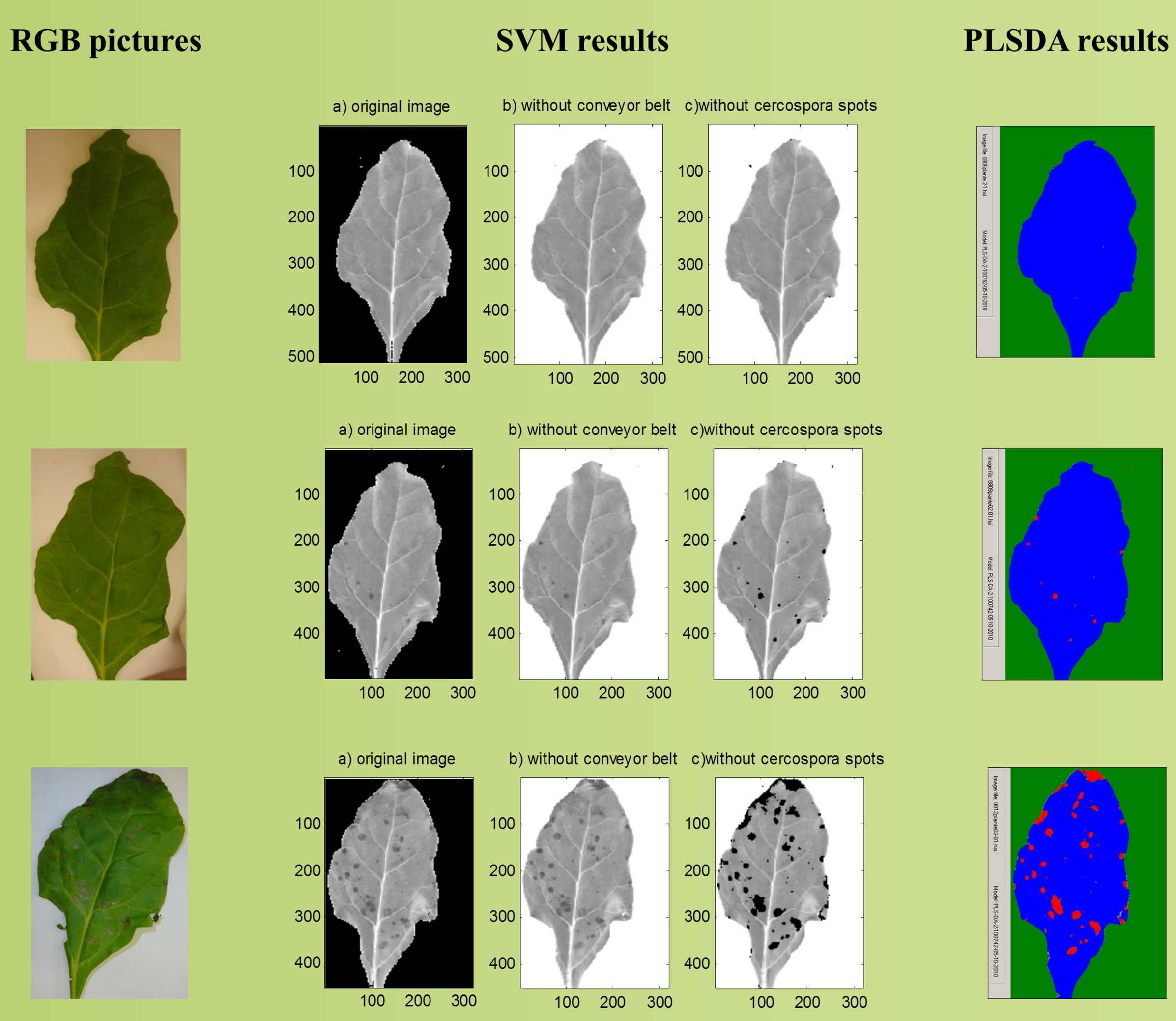

Figure 2: RGB picture, SVM and PLSDA results, showing the cercospora leaf spots observed at three dates (3 days before the first symptoms, the day of the first symptoms and 3 days after the first symptoms) on a leaf from a tolerant plant inoculated by spray with cercospora and analysed using the line scan hyperspectral imaging system.

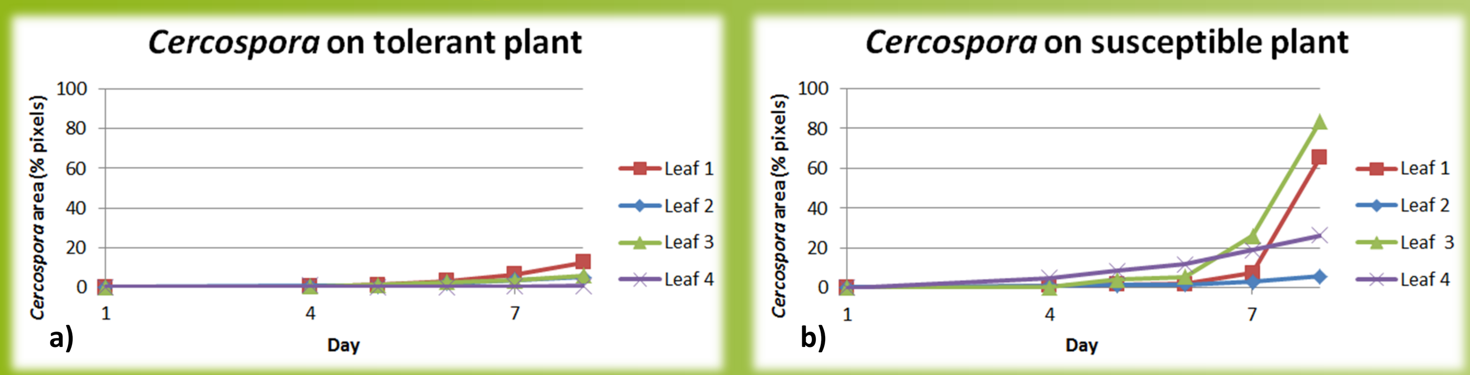

Figure 3: Cercospora development on leaves from tolerant (a) and susceptible (b) plants with PLS-DA model.

Assessment of fungal contamination in cereals

On-line detection and quantification of ergot bodies in cereals

Objective:

Detect and quantify the presence of ergot bodies in cereals by on-line NIR hyperspectral imaging.

Material & methods:

Seven samples of wheat contaminated with 0.01% to 1% (100 to 10 000 ppm) of ergot were prepared and measured using a NIR hyperspectral line scan system combined with a conveyor belt (BurgerMetrics). Partial Least Squares Discriminant Analysis (PLSDA) and Support Vector Machines (SVM) were used as classification methods.

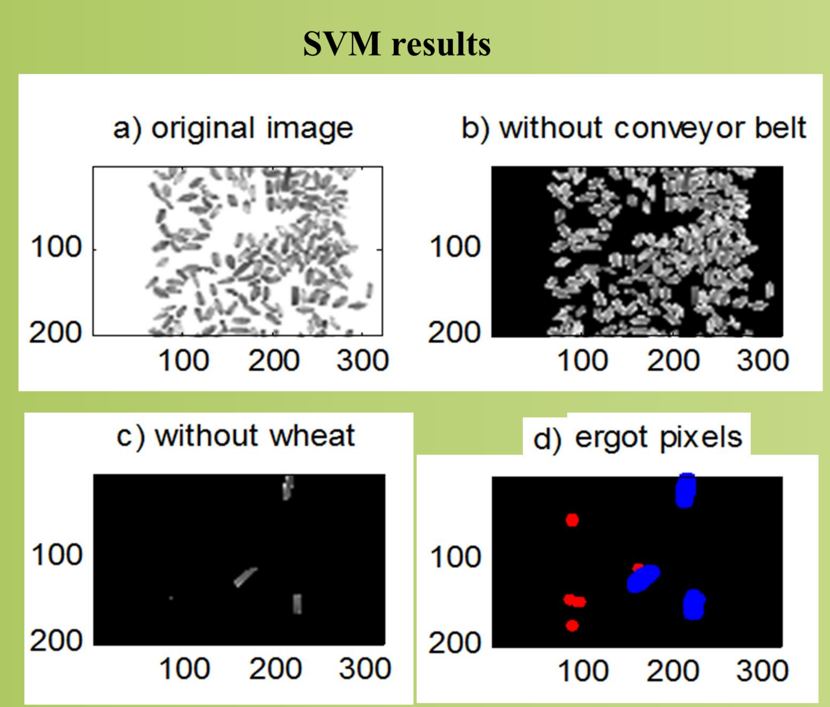

Figure 1: Ergot prediction in wheat using the SVM model displaying a) the hyperspectral image, b) the image a after removing the pixels detected as conveyor belt, c) the image b after removing the pixels detected as wheat, d) the image c after applying the density-based clustering method (DBScan): red pixels are erroneous pixels detected as ergot, blue clusters are set of pixels detected as ergot body, e) RGB picture.

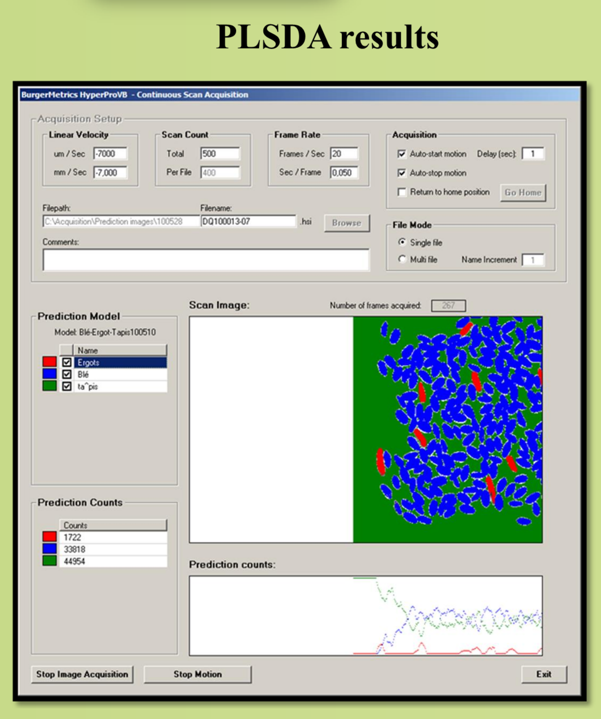

Figure 2: Image from HyperSee software showing the results of the PLSDA on-line prediction for a wheat sample on the conveyor belt. Wheat grains are in blue, ergot bodies in red and background in green.

Results:

The results showed a correlation higher than 0.99 between the predicted and the reference values using PLSDA and SVM models. For a wheat sample containing a level of contamination of ergot as low as 0.01 %, it has been possible to detect enough pixels of ergot to conclude that the sample was contaminated. Moreover, no false positives were obtained when dealing with non contaminated samples (0% ergot samples).

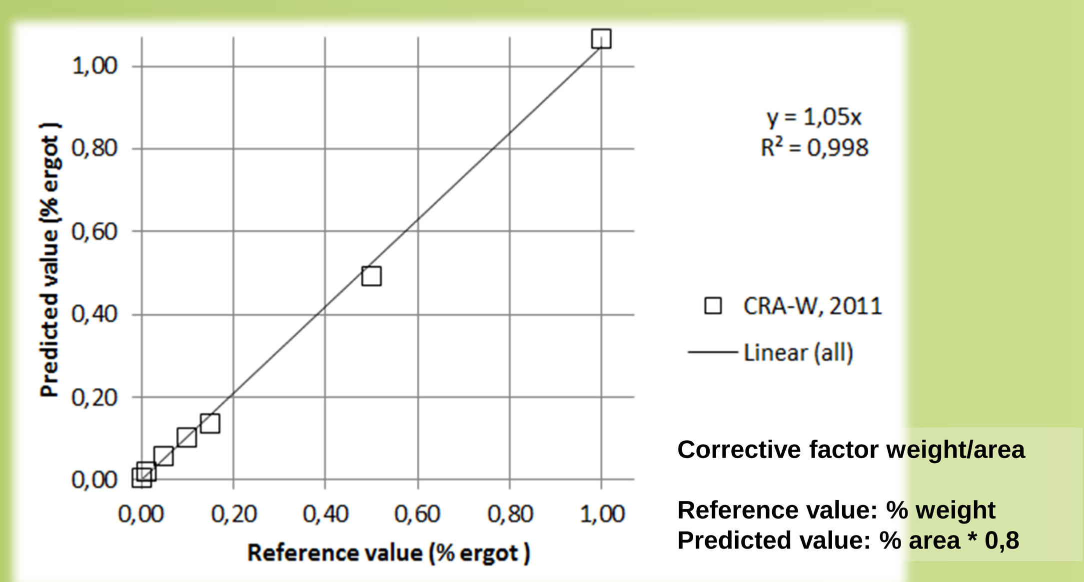

Figure 3: Results of ergot bodies detection in wheat expressed in ergot % using PLSDA model.

References

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