applied sciences

MDPI

*Supplementary Material*

# Classification of Plant Electrophysiology Signals for Detection of Spider Mites Infestation in Tomatoes

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**Table S1.** List of the five least dominant features used by the built GBT-based models to discriminate the status of the plant.

| All Samples | | | |
|---|---|---|---|
| **Original set of features** | | **Reduced set of features** | |
| **Feature** | **Weight** | **Feature** | **Weight** |
| Mean of WD8 30 min | <0.0001% | Minimum of WD4 30 s | <0.0001% |
| Mean of WD8 10 min | <0.0001% | GHE 1min | <0.0001% |
| Mean of WD8 5 min | <0.0001% | Shape factor 2 min | <0.0001% |
| Mean of WD8 2 min | <0.0001% | Crest factor 5 min | <0.0001% |
| Mean of WD8 1 min | <0.0001% | Kurtosis 10 min | <0.0001% |

| Daylight Samples | | | |
|---|---|---|---|
| **Original set of features** | | **Reduced set of features** | |
| **Feature** | **Weight** | **Feature** | **Weight** |
| Mean of WD8 30 min | <0.0001% | Kurtosis 30 min | <0.0001% |
| Kurtosis 30 min | <0.0001% | Brown noise 5 min | <0.0001% |
| Brown noise 10 min | <0.0001% | RMS frequency 5 min | <0.0001% |
| Mean of WD8 10 min | <0.0001% | Shape factor 5 min | <0.0001% |
| Max. of WD8 10 min | <0.0001% | Brown noise 2 min | <0.0001% |

| Night Samples | | | |
|---|---|---|---|
| **Original set of features** | | **Reduced set of features** | |
| **Feature** | **Weight** | **Feature** | **Weight** |
| Mean WD8 30 min | <0.0001% | Brown noise 10 min | <0.0001% |
| Blue noise 10 min | <0.0001% | White noise 1 min | <0.0001% |
| Mean WD8 10 min | <0.0001% | Minimum of WD1 1min | <0.0001% |
| Brown noise 5 min | <0.0001% | Kurtosis 1 min | <0.0001% |
| Mean WD8 5 min | <0.0001% | White noise 30 s | <0.0001% |

**Table 2.** List of features forming the reduced subset when analyzing the entire set of samples, the samples acquired during daylight and those during night.

| **All Samples** | | | | | | |
|---|---|---|---|---|---|---|
| **15 s** | **30 s** | **1 min** | **2 min** | **5 min** | **10 min** | **30 min** |
| Minimum | Variance | Variance | Variance | Variance | Maximum | Variance |
| Variance | Skewness | Skewness | Skewness | Skewness | Variance | Skewness |
| Skewness | Kurtosis | Kurtosis | Kurtosis | Kurtosis | Skewness | Kurtosis |
| Kurtosis | IQR | IQR | IQR | IQR | Kurtosis | IQR |
| IQR | Hjorth Mobility | Hjorth Mobility | Hjorth Mobility | Hjorth Mobility | IQR | Hjorth Mobility |
| Hjorth Mobility | Hjorth Complexity | Hjorth Complexity | Hjorth Complexity | Hjorth Complexity | Hjorth Mobility | Hjorth Complexity |
| Hjorth Complexity | General Hurst Exponent | General Hurst Exponent | General Hurst Exponent | General Hurst Exponent | Hjorth Complexity | General Hurst Exponent |
| General Hurst Exponent | Crest Factor | Crest Factor | Crest Factor | RMS | General Hurst Exponent | Logarithmic wentropy |
| Logarithmic wentropy | Shape Factor | Shape Factor | Shape Factor | Crest Factor | Crest Factor | Crest Factor |
| Shannon wentropy | Minimum WD1 | Margin Factor | Minimum WD1 | Shape Factor | Shape Factor | Shape Factor |
| Crest Factor | Minimum WD4 | Minimum WD1 | Minimum WD4 | Margin Factor | Margin Factor | Margin Factor |
| Shape Factor | Frequency Center | Minimum WD4 | Maximum WD4 | Minimum WD1 | Minimum WD4 | Minimum WD1 |
| Margin Factor | RMS frequency | Maximum WD4 | Frequency Center | Minimum WD4 | Maximum WD4 | Maximum WD4 |
| Minimum WD4 | White Noise | Frequency Center | RMS frequency | Frequency Center | Frequency Center | Minimum WD4 |
| Frequency center | Brown Noise | Root Variancy Frequency | White Noise | RMS frequency | White Noise | Mean WD4 |
| RMS frequency | | White Noise | Brown Noise | White Noise | | Frequency Center |
| White Noise | | Brown Noise | | | | RMS frequency |
| Brown Noise | | | | | | White Noise |
| | | | | | | Brown Noise |
| | | | | | | Purple noise |
| **Daylight Samples** | | | | | | |
| **15 s** | **30 s** | **1 min** | **2 min** | **5 min** | **10 min** | **30 min** |
| Minimum | Variance | Variance | Variance | Variance | Minimum | Maximum |
| Maximum | Skewness | Skewness | Skewness | Skewness | Variance | Variance |
| Variance | Kurtosis | Kurtosis | Kurtosis | Kurtosis | Skewness | Skewness |
| Skewness | IQR | IQR | IQR | IQR | Kurtosis | Kurtosis |
| Kurtosis | Hjorth Mobility | Hjorth Mobility | Hjorth Mobility | Hjorth Mobility | IQR | IQR |
| IQR | Hjorth Complexity | Hjorth Complexity | Hjorth Complexity | Hjorth Complexity | Hjorth Mobility | Hjorth Mobility |
| Hjorth Mobility | General Hurst Exponent | General Hurst Exponent | General Hurst Exponent | General Hurst Exponent | Hjorth Complexity | Hjorth Complexity |
| Hjorth Complexity | Crest Factor | Crest Factor | Crest Factor | Crest Factor | General Hurst Exponent | General Hurst Exponent |
| General Hurst Exponent | Shape Factor | Shape Factor | Shape Factor | Shape Factor | Crest Factor | Logarithmic wentropy |
| Logarithmic wentropy | Minimum WD1 | Minimum WD1 | Margin Factor | Minimum WD1 | Shape Factor | Crest Factor |

| | | | | | | |
|---|---|---|---|---|---|---|
| Crest Factor | Frequency Center | Minimum WD4 | Minimum WD1 | Minimum WD4 | Minimum WD1 | Shape Factor |
| Shape Factor | RMS frequency | Maximum WD4 | Maximum WD4 | Maximum WD1 | Minimum WD4 | Margin Factor |
| Margin Factor | White Noise | Frequency Center | Mean WD4 | Frequency Center | Maximum WD4 | Minimum WD1 |
| Minimum WD1 | Brown Noise | RMS frequency | Frequency Center | RMS frequency | Mean WD4 | Minimum WD4 |
| Minimum WD4 | | White Noise | RMS frequency | White Noise | Frequency Center | Maximum WD4 |
| Mean WD4 | | Brown Noise | White Noise | Brown Noise | RMS frequency | Mean WD4 |
| Frequency center | | | Brown Noise | RMS frequency | White Noise | Minimum WD8 |
| RMS frequency | | | | White Noise | Brown Noise | Frequency Center |
| White Noise | | | | Brown Noise | | White Noise |
| Pink Noise | | | | | | Brown Noise |
| Brown Noise | | | | | | |
| **Night Samples** | | | | | | |
| **15 s** | **30 s** | **1 min** | **2 min** | **5 min** | **10 min** | **30 min** |
| Minimum | Variance | Variance | Variance | Skewness | Variance | Maximum |
| Variance | Kurtosis | Skewness | Skewness | Kurtosis | Skewness | Variance |
| Kurtosis | IQR | Kurtosis | Kurtosis | IQR | Kurtosis | Skewness |
| IQR | Hjorth Mobility | IQR | IQR | Hjorth Mobility | IQR | Kurtosis |
| Hjorth Mobility | Hjorth Complexity | Hjorth Mobility | Hjorth Mobility | Hjorth Complexity | Hjorth Mobility | IQR |
| Hjorth Complexity | General Hurst Exponent | Hjorth Complexity | Hjorth Complexity | General Hurst Exponent | Hjorth Complexity | Hjorth Mobility |
| General Hurst Exponent | Crest Factor | General Hurst Exponent | General Hurst Exponent | Crest Factor | General Hurst Exponent | Hjorth Complexity |
| Logarithmic wentropy | Shape Factor | Crest Factor | Crest Factor | Shape Factor | Crest Factor | General Hurst Exponent |
| Shannon wentropy | Minimum WD1 | Shape Factor | Margin Factor | Minimum WD1 | Margin Factor | Logarithmic wentropy |
| Crest Factor | Minimum WD4 | Minimum WD1 | Minimum WD1 | Minimum WD4 | Minimum WD1 | Crest Factor |
| Shape Factor | Frequency Center | Minimum WD4 | Frequency Center | Frequency Center | Minimum WD4 | Shape Factor |
| Margin Factor | RMS frequency | Frequency Center | RMS frequency | RMS frequency | Maximum WD4 | Margin Factor |
| Minimum WD1 | White Noise | RMS frequency | White Noise | White Noise | Frequency Center | Minimum WD1 |
| Mean WD1 | Brown Noise | White Noise | Brown Noise | Brown Noise | RMS frequency | Maximum WD1 |
| Minimum WD4 | | Brown Noise | | | White Noise | Minimum WD4 |
| Frequency Center | | | | | Brown Noise | Mean WD4 |
| RMS frequency | | | | | | Frequency Center |
| White Noise | | | | | | White Noise |
| Brown Noise | | | | | | Brown Noise |

IQR: interrquartile range; Wentropy: wavelet packet entropy; WDn: wavelet decomposition of order n; RMS: root mean square

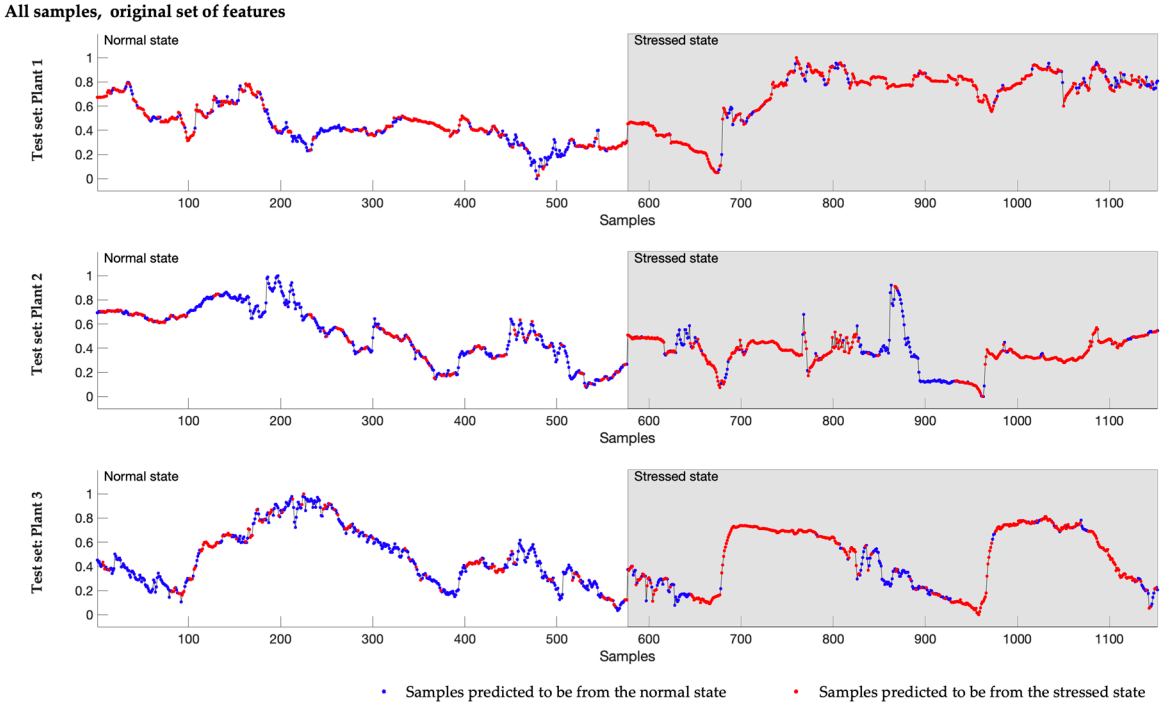


**Figure S1.** Predicted class of each sample forming the test set used to evaluate the model obtained when analyzing the whole dataset with all 238 features. The color of samples indicates the class that has been attributed to them by the classification model – blue represents the normal, whereas red the stressed state. For each plant, the plotted samples overlay the normalized feature *mean value* of the signal calculated for a window of 5 min.

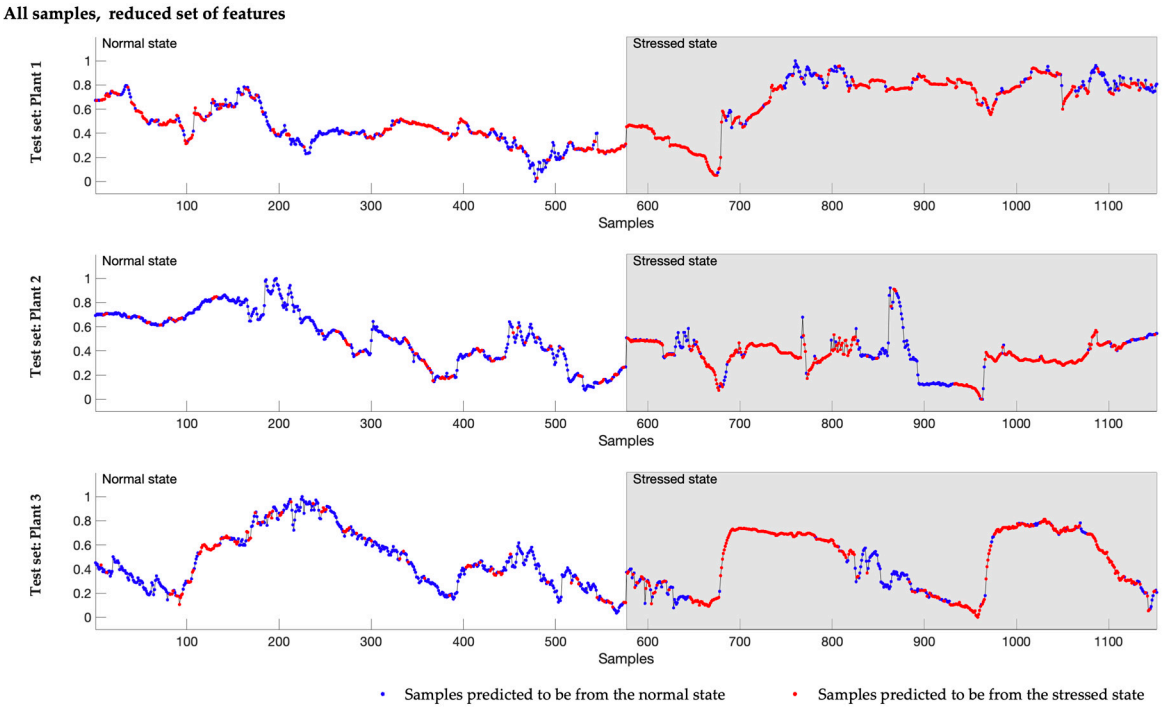


**Figure S2.** Predicted class of each sample forming the test set used to evaluate the model obtained when analyzing the whole dataset with the reduced set of features. The color of samples indicates the class that has been attributed to them by the classification model – blue represents the normal, whereas red the stressed state. For each plant, the plotted samples overlay the normalized feature *mean value* of the signal calculated for a window of 5 min.

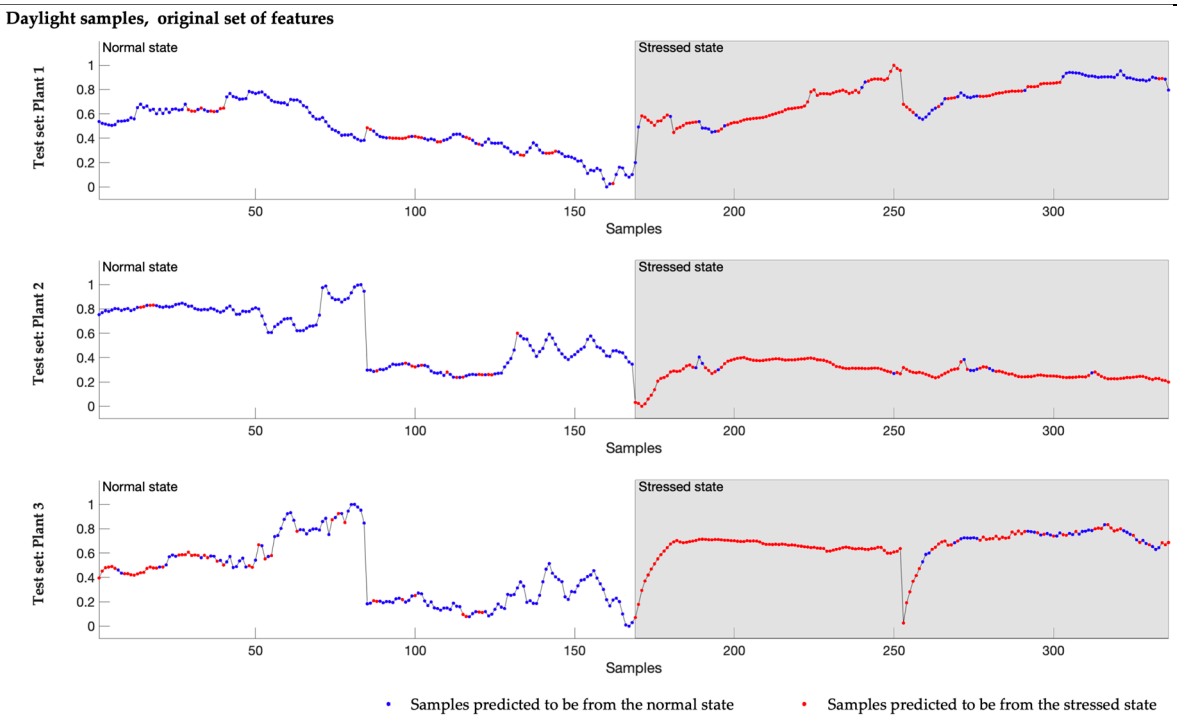


**Figure S3.** Predicted class of each sample forming the test set used to evaluate the model obtained when analyzing the daylight samples subset with all 238 features. The color of samples indicates the class that has been attributed to them by the classification model – blue represents the normal, whereas red the stressed state. For each plant, the plotted samples overlay the normalized feature *mean value* of the signal calculated for a window of 5 min.

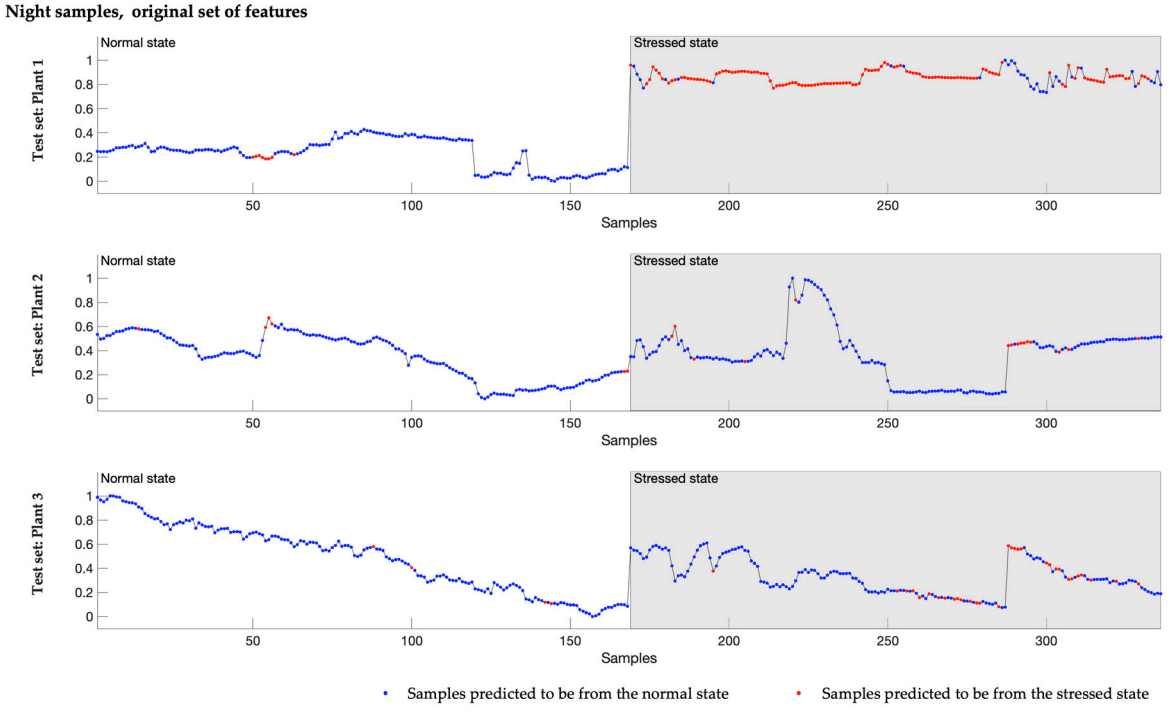


**Figure S4.** Predicted class of each sample forming the test set used to evaluate the model obtained when analyzing the night samples subset with all 238 features. The color of samples indicates the class that has been attributed to them by the classification model – blue represents the normal, whereas red the stressed state. For each plant, the plotted samples overlay the normalized feature *mean value* of the signal calculated for a window of 5 min.

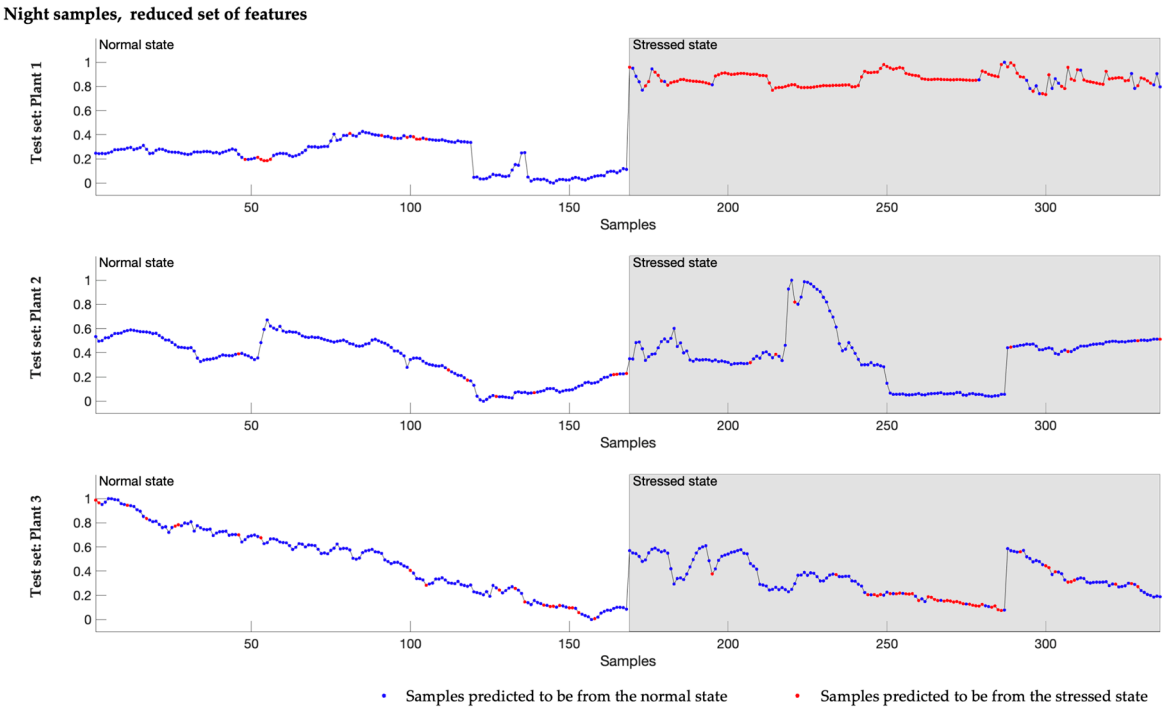


**Figure S5.** Predicted class of each sample forming the test set used to evaluate the model obtained when analyzing the night samples subset with the reduced set of features. The color of samples indicates the class that has been attributed to them by the classification model – blue represents the normal, whereas red the stressed state. For each plant, the plotted samples overlay the normalized feature *mean value* of the signal calculated for a window of 5 min.