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Data in Brief 63 (2025) 112165

Contents lists available at ScienceDirect

Data in Brief

journal homepage: www.elsevier.com/locate/dib

Data Article

Data of electrical signalling in tomato for the detection of powdery mildew

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ARTICLE INFO

Article history:
Received 22 July 2025
Revised 27 September 2025
Accepted 6 October 2025
Available online 10 October 2025

Dataset link: DATASET_ElectricalSignaling-in-tomato-for-detect-PowderyMildew (Original data)

Keywords:
Tomato
Powdery mildew
Electrical potential
Early diagnosis
PLS-D

ABSTRACT

Here we present the data used to analyse the electrical signals acquired in tomato plants grown in peat and water substrates that were infected with the fungal pathogen *Oidium neolycopersici*, the causative agent of powdery mildew, along with the statistical analyses used to detect the differences in electrical responses between healthy and infected plants, as reported in [1]. Voltages were acquired periodically, scanning repeatedly in sequence all lines in use, with acquisitions separated from each other by approximately 200 s. They were recorded by means of a dedicated custom Python program run by a Raspberry Pi board. Data are made available here both in raw text form, covering the whole monitoring period (15 days, including values for inoculated and healthy plants), and as Excel files with calculations for statistical analyses [2]. More details about the experimental background can be found in the related research article.

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https://doi.org/10.1016/j.dib.2025.112165

Specifications Table

Subject	Biology, Agricultural Sciences, Plant Pathology
Specific subject area	Plant Pathology, Precision Agriculture, Non-destructive Diagnosis
Type of data	Raw (Tables, .csv format), Processed (.xls format)
Data collection	For detection of electrical signals in the plants, pure gold electrodes were inserted into plant stems, providing the electrical connection to the voltmeter (Agilent 34970A), each with independent ground reference. The voltmeter was set to autorange to account for variations in the potentials. Overall, the setup used 15 cables (30 electrically fully independent bipolar lines) that could be automatically switched. The reference ground electrodes were placed into the basal portion of the main stem (water substrate) or directly into the peat. The last two lines (cable 15) were connected to sensors to monitor temperature and illumination during the experiment. Potentials were acquired periodically, scanning repeatedly in sequence all lines in use, with acquisitions separated from each other by approximately 200 s. They were recorded by means of a dedicated custom Python program run by a Raspberry Pi board. Measurement data are saved into a file in comma-separated-values format.
Data source location	Institute for Sustainable Plant Protection (IPSP), National Research Council of Italy (CNR), Strada delle Cacce 73, 10,135, Torino, Italy (coordinates: 45,0179,823 N;7,6423923E)
Data accessibility	Repository name: Mendeley Data Data identification number: 10.17632/yr8zhsc6mh.1 Direct URL to data: https://data.mendeley.com/datasets/yr8zhsc6mh/
Related research article	"Electrical signalling in tomato - Oidium neolycopersici pathosystem for detection of powdery mildew" (Matić et al., Computers and Electronics in Agriculture Volume 237, Part B, October 2025, 110,585)

1. Value of the Data

- These data provide a reference dataset of values observed in tomato plants both in healthy conditions and after pathogen inoculation.
- Access to these experimental results can support the development of non-destructive diagnostic methods for combating powdery mildew, one of the most destructive fungal diseases
- The database can be reused by other researchers to compare values with those obtained in new experiments
- *Re*-processing raw results with different statistical methods allows researchers to derive new conclusions and compare efficacy of statistical tools for the task

2. Background

The dataset [2] is made available to allow direct analysis of results that may not be easy to obtain due to difficulties in the selection of electrodes and data collection over time of signals from many different electrodes.

Various studies demonstrated the role of electrical signalling in plant systemic communication. Four types of electrical potentials are found: action (APs), slow wave or variation (SWPs), wound, and system. APs and SWPs are elicited by biotic and abiotic stimuli. Only a limited number of publications investigated electrical signals under biotic stress caused by pathogens [3,4]. Electrical signals can be of great importance in developing innovative diagnostic methods that can detect disease in the early stages of development, before the appearance of symptoms. In addition, they are economical, sustainable and quickly lead to results even remotely. They offer a solution in between chemical and non-contact analyses, since they provide, at the same time, analysis at microscale level and simplicity similar to imaging methods. We studied electrical signals to detect powdery mildew, one of the most economically important tomato diseases.

It is not easy to monitor [5] and may be detrimental to plant vitality under climate change [6]. The objective of this public dataset is to extend knowledge of the electrophysiological status of tomato plants infected with powdery mildew during the course of infection.

3. Data Description

The files associated with this article are:

I. Comma-Separated-Value (text) files with data in columns, divided in groups of three indicating: the acquisition channel; the time in seconds from the measurement start; the electrical potential in Volt (V) measured at the plant by the channel electrode. Each file covers measurements spanning approx. 40 min: files can be concatenated to analyse data over longer durations. The last 2 channels are used for monitoring environmental light and humidity.
II. Excel (.xls) files are used to show the calculations used to process data with different algorithms and the results in the successive stages of the process. Operations are performed on columns, where the data from a set of selected .csv files are transposed to allow processing by the XLStat statistical analysis software.

4. Experimental Design, Materials and Methods

4.1. Plants and fungi

Small plug trays were used for sowing tomato seeds, and after two weeks the seedlings were transplanted into 1-L pots containing a peat-based substrate mixture (peat-coconut granules-volcanic pumice; 6:2:1) with a slow-release (NPK + microelements) fertilizer (Vigorplant, Italy) or into 1-L flasks containing unsupplemented tap water (six plants per each substrate).

The MB1 isolate of the plant pathogenic fungus *Oidium neolycopersici* (*On*) [7] was maintained on tomato plants (cv. Marmande) under greenhouse conditions at 23–19 °C (day-night), with a relative humidity of 70 %, in order to preserve its infectiousness for subsequent inoculation.

4.2. Fungal inoculation and assessment of disease index

Thirty days after sowing, artificial inoculation of three of the six plants with *On* was done as described in [7]. Specifically, 10 μL of conidial suspension (5×10^{-4} spores/mL) was sprayed on the leaflets of three randomly selected leaves, prepared from conidial spores collected from heavily infected plants. The plants were cultivated for 22 days after inoculation and evaluated for the progression of powdery mildew disease. The three non-inoculated plants were used as healthy controls. The experiment was carried out twice and the two repetitions were averaged and included in the analyses. The disease symptoms were observed at 8, 15, and 22 days post-inoculation (dpi) evaluating the disease index (DI) as the percentage of the symptomatic leaf area. The DI was evaluated at the same time instants for all plants by observing the same leaflets, and the observation scheme was prosecuted until 22 dpi, to ensure full symptom development. The measured DI was then linearly regressed on the dpi to obtain a daily disease rate (DR) for each plant.

4.3. Electrical measurements

The choice of the material for electrodes is essential for reliable results: different metals as pure copper and 750 ‰ Gold showed prone to contamination of the surface and oxidation in 5 experiments lasting several days. Therefore, pure gold was finally adopted to overcome electrode degradation. Thus, for detection of electrical signals in the plants, pure gold custom-made electrodes with 0.1 mm diameter and 10 mm length were inserted into plant stems to a depth of 3 mm, in order to reach the conducting bundles. To acclimate, [8] the electrodes were placed one day before the start of electrical signal recordings. Cables with 4 wires, soldered to 4 separate electrodes, provided the electrical connection to the voltmeter (Agilent 34970A) for measuring the electromotive force on two channels, each with independent grounding. In the measurements, the voltmeter was set to “auto” range to guarantee full adaptability for changes in the potentials, while the integration time, set at 200 Power-Line-Cycles, allowed to reduce noise, providing sensitivity at mV level without the need for a Faraday cage [9]. To further minimize interference effects in the measurements, the internal prefilter of the voltmeter was set to “low”, i.e. operated as low-pass with 3 Hz cutoff frequency, allowing us to observe all frequencies relevant for AP and SWPs, excluding electrical disturbances and unwanted effects from WP and SP signals.

Overall, the setup used 15 cables (30 electrically fully independent bipolar lines) that could be automatically switched to separately monitor the line voltages. Three electrodes per plant were distributed throughout the stem, to detect a possible dependency of voltages vs. distance from the top. Three electrodes were also placed in each growing substrate (peat and water) without the plants as reference control electrodes. The last two lines (cable 15) were not soldered to electrodes but connected to sensors to monitor temperature and illumination during the experiment.

The ground (negative) electrodes were inserted into the basal part of the plant stem (in water substrate) or directly into the peat (in peat substrate). The same electrode placement was performed in non-inoculated control plants in both growing media.

Voltages were acquired periodically, scanning repeatedly in sequence all lines in use, with acquisitions separated from each other by approximately 200 s, and were recorded for 15 dpi by means of a dedicated custom Python program run by a Raspberry Pi board.

Limitations

Data collection: measurement issues

Electrical plant signals reflect chemical processes inside the vegetal tissues, and depend on several electrochemical factors that may affect the measurements. Contacts are essential for proper voltage measurements, besides the observed effects of contaminants that may increase the electrical resistance of contact and suggested the adoption of gold, there are other options that may be considered, like platinum and inox that, as gold, are not prone to oxidation; however, there are cases where Ag/AgCl (Silver/Silver Chloride) electrodes are used [8], since they are non-Polarizable and relatively biocompatible. In general, electrodes may significantly affect results.

Four types of electrical signals are observed in plants, they have different speeds and frequencies. By filtering the input, one selects the signals of interest and reduces noise, but some interesting information may be inaccessible.

Data Treatment

Owing to the several day span of the experiment, the length of recorded data is relevant, and the statistical analysis may be difficult. To overcome the difficulty, it is possible to reduce the acquisition frequency, but this may increase the risk of missing faster changes.

Ethics Statement

The authors have read and followed the ethical requirements for publication in Data in Brief and confirm that the current work does not involve human subjects, animal experiments, or any data collected from social media platforms.

Credit Author Statement

Slavica Matić: Conceptualization, Methodology, Investigation, Resources, Data Curation, Writing - Original Draft, Writing - Review & Editing, Supervision; **Giorgio Masoero**: Conceptualization, Formal analysis; **Pier Paolo Capra**: Investigation, Resources; **Andrea Sosso**: Conceptualization, Methodology, Software, Investigation, Writing - Original Draft, Writing - Review & Editing, Supervision.

Data Availability

DATASET_ElectricalSignaling-in-tomato-for-detect-PowderyMildew (Original data) (Mendeley Data)

Acknowledgments

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] S. Matić, G. Masoero, A. Egidi, C. Francese, P.P. Capra, A. Sosso, Electrical signalling in tomato — *Oidium neolycopersici* pathosystem for detection of powdery mildew, Comput. Electron. Agricult. 237 (2025) 110585 Part B.
[2] 'DATASET_ElectricalSignaling-in-tomato-for-detect-PowderyMildew', Mendeley Data, V1, doi: 10.17632/yr8zhsc6mh.1
[3] F. Simmi, L. Dallagnol, A. Ferreira, D. Pereira, G. Souza, Electrome alterations in a plant-pathogen system: toward early diagnosis, Bioelectrochemistry 133 (2020) 107493.
[4] E. Ghasemi, E. Ebrahimie, A. Niazi, Machine learning for early detection of plant viruses: analyzing post-infection electrical signal patterns, Smart Agricult. Technol. 9 (2024) 100668.
[5] S. Panno, S. Davino, A.G. Caruso, S. Bertacca, A. Crnogorac, A. Mandić, E. Noris, S. Matić, A review of the most common and economically important diseases that undermine the cultivation of tomato crop in the mediterranean basin, Agronomy 11 (11) (2021) 2188.
[6] S. Matić, M.A. Cucu, A. Garibaldi, M.L. Gullino, Combined effect of CO_2 and temperature on wheat powdery mildew development, Plant Pathol. J. 34 (4) (2018) 316–326.
[7] C. D'Errico, M. Forgia, M. Pisani, S. Pavan, E. Noris, S. Matić, Overexpression of the c4 protein of tomato yellow leaf curl sardinia virus increases tomato resistance to powdery mildew, Front. Plant Sci. 14 (2023) 1163315.
[8] A.G. Volkov, D.J. Collins, J. Mwesigwa, Plant electrophysiology: pentachlorophenol induces fast action potentials in soybean, Plant Sci. 153 (2) (2000) 185–190.
[9] D. Tran, F. Dutoit, E. Najdenovska, N. Wallbridge, C. Plummer, M. Mazza, L.E. Raileanu, C. Camps, Electrophysiological assessment of plant status outside a faraday cage using supervised machine learning, Sci. Rep. 9 (1) (2019) 17073.