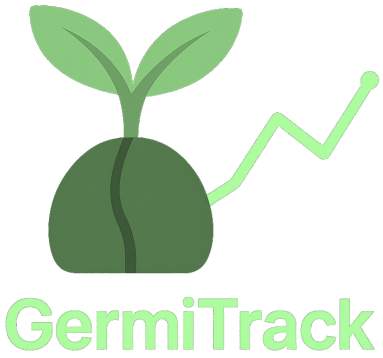
# GermiTrack

## User Guide

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## Authors & Institutional Note

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# Overview

**GermiTrack** is a professional desktop application designed for the smart analysis of seed germination data. It offers an intuitive interface, automated calculations of key germination parameters, and exports results ready for scientific reporting. The application is ideal for researchers, agronomists, and seed technologists seeking robust, reproducible, and transparent analysis. This guide explains how to extract the ZIP file, open the results folder, and run the executable for seamless use.

### 1. Extracting the ZIP File

Locate the ZIP File:

- ✓ Find the downloaded ZIP file, e.g., GermiTrack.zip.

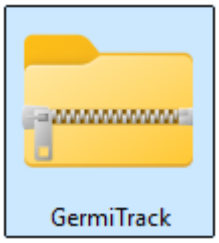
### 2. Extract the Contents:

- ✓ Right-click the ZIP file and select "Extract All..."
- ✓ Choose a destination folder (e.g., C:\Users\YourName\Desktop\GermiTrack).
- ✓ Click "Extract".

### 3. Result:

The extracted folder will contain files such as:

Build, Dist, User Guide.pdf, README.txt,



## 2. Opening the dist Folder

If your extracted folder contains a subfolder named “dist”:

Double-click the dist folder inside the extracted directory.

This folder contains the actual executable:

GermiTrack.exe


## 3. Running the Executable

**a. Navigate to the dist Folder:**

- ✓ Open the extracted folder, then open the dist subfolder if present.

**b. Run the Program:**

- ✓ Double-click GermiTrack.exe.
- ✓ If prompted by Windows SmartScreen or your antivirus, confirm that you want to run the program.

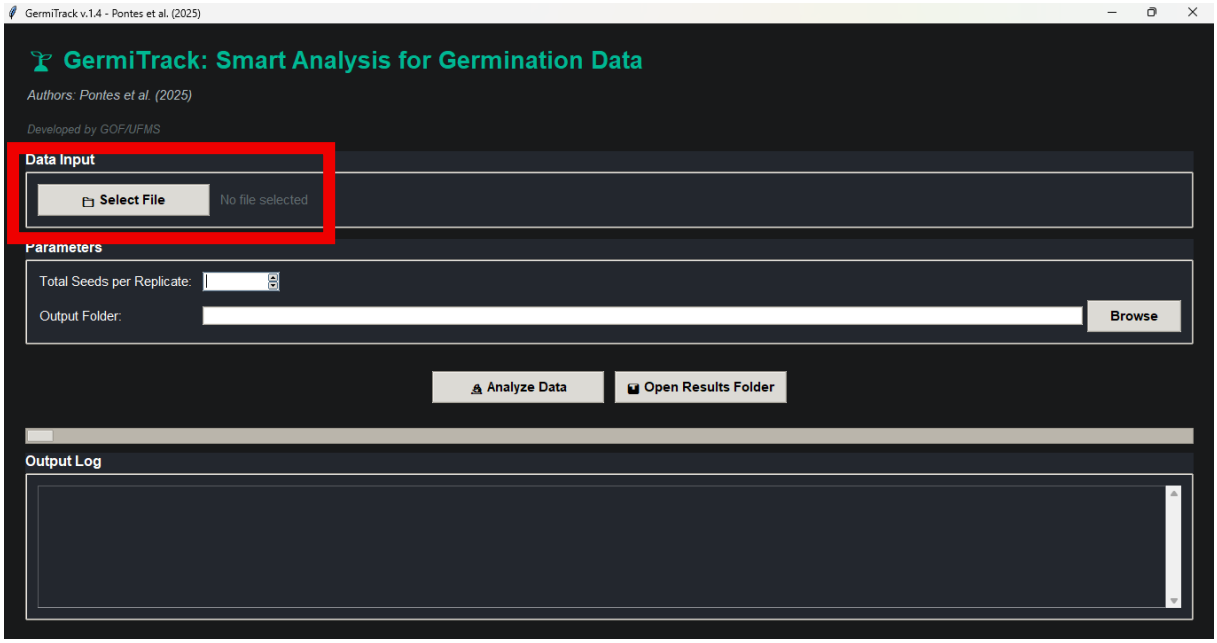
**c. No Installation Needed:**

- ✓ The application runs directly—no need to install Python or any additional libraries.

## 4. Using GermiTrack

Select File:

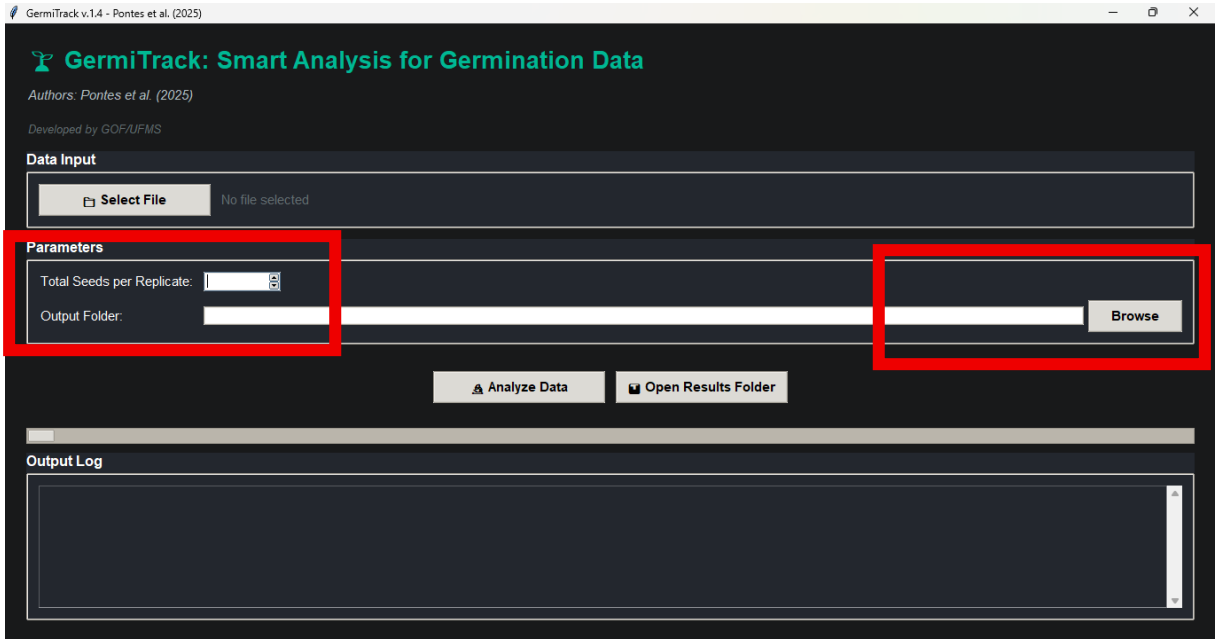
Click "Select File" and choose your germination data file (Excel, CSV, or TXT).




Set Parameters:

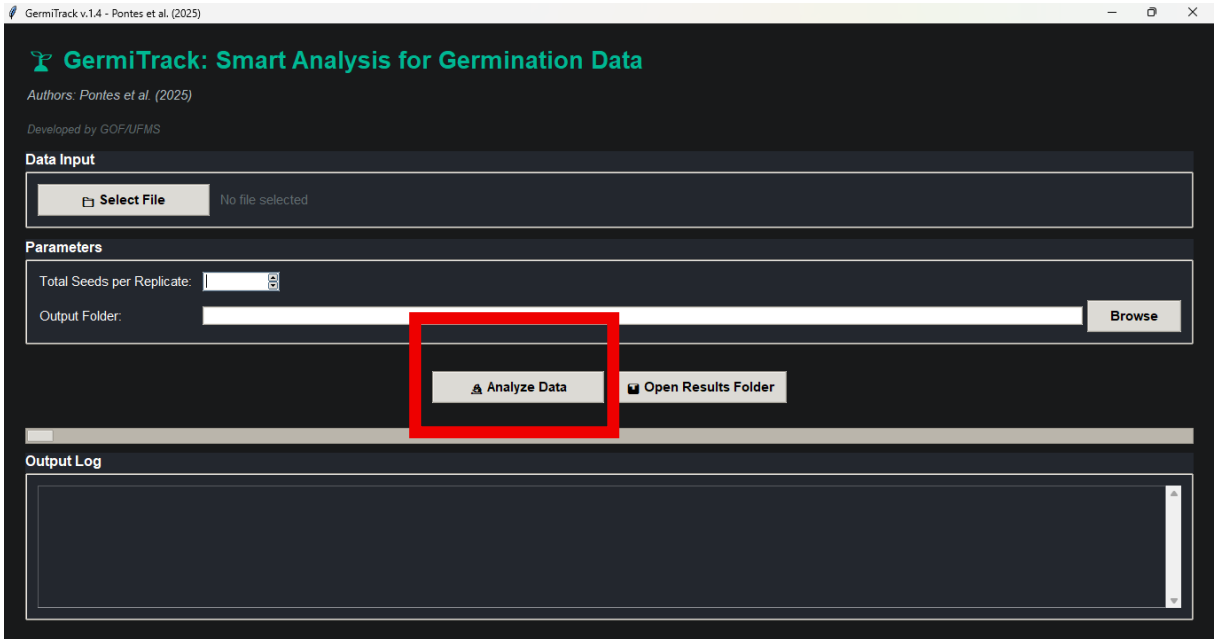
Enter the total number of seeds per replicate and select the output folder.

Select the output Folder.



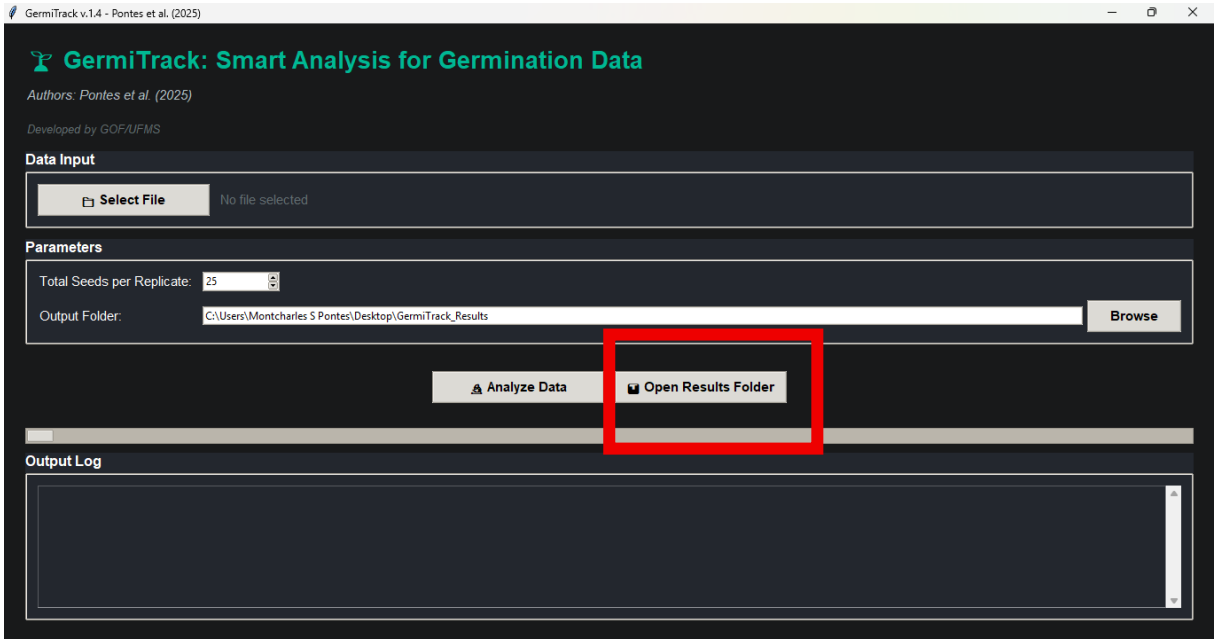

Analyze Data:

Click "Analyze Data" to perform the analysis and generate outputs.




Open Results Folder:

Click "Open Results Folder" to quickly access all output files (charts, Excel/CSV data, reports).




## 5. Troubleshooting

### a. If the executable does not start:

✓ Make sure your antivirus is not blocking the file.

✓ Ensure you have extracted all files from the ZIP before running.

✓ If you see a permission error, try running as administrator (right-click → "Run as administrator").

**b. To re-run the analysis:**

✓ Close any open output files before running a new analysis.

## 6. Supported File Formats

**GermiTrack** supports multiple file formats for input germination data, allowing flexibility for users to work with their preferred data organization tools.

| File Format | Extension(s) | Description | Notes |
|---|---|---|---|
| Excel | `.xlsx`, `.xls` | Microsoft Excel spreadsheet files | Supports multiple sheets |
| CSV | `.csv` | Comma-separated values text files | Simple text format, widely used |
| Text (Tab-separated) | `.txt` | Plain text files with tab delimiters | Useful for raw data exports |

## 7. Data Organization Requirements

- **First column:** Day or Time (numerical values indicating days or time points)
- **Subsequent columns:** Replicates (named like R1, R2, R3, etc.)
- **Cell values:** Number of seeds germinated on each day/time for each replicate (not cumulative)

This structure allows GermiTrack to accurately calculate germination parameters and generate detailed charts and reports.

## 8. Analytical Description of Germination Parameters Provided by GermiTrack

This document details each germination parameter calculated by the GermiTrack software, explaining its technical meaning and significance in seed germination studies. All descriptions are based on scientific literature, including key references.

## 9. Main Germination Parameters

| Parameter Name | Description & Technical Significance |
|---|---|
| **Germinability (%)** | The proportion of seeds that successfully germinate out of the total sown, expressed as a percentage. This is the fundamental indicator of seed lot viability and overall germination success. High germinability indicates a healthy, viable seed lot, while low values suggest dormancy, non-viable seeds, or adverse conditions. |
| **Mean Germination Time (MGT)** | The weighted average time required for seeds to germinate, calculated as $\sum(ni \cdot ti)/\sum ni$, where *ni* is the number of seeds germinated at time *ti*. Lower MGT values reflect faster germination, which is desirable for uniform crop establishment. |
| **Coefficient of Variation of Germination Time (CVt)** | Expresses the relative dispersion of germination times as a percentage of the mean. It is calculated as (Standard Deviation/MGT)×100. Lower CVt indicates more uniform germination, which is critical for synchronized seedling emergence. |
| **Mean Germination Rate (MGR)** | The reciprocal of MGT, representing the average speed of germination. Higher MGR values indicate faster germination, which is advantageous for agricultural practices requiring rapid establishment. |
| **Uncertainty Index (U)** | A measure of the temporal spread of germination, based on Shannon entropy: $U=-\sum f_i \log_2 f_i$, where fi is the relative frequency of germination at time *i*. Higher U values indicate greater dispersion of germination events across time, reflecting less predictability. |
| **Synchrony Index (Z)** | Quantifies the degree of simultaneous germination among seeds. Values close to 1 indicate high synchrony (most seeds germinate at the same time), while values near 0 reflect asynchronous germination. Synchrony is important for crop management and uniformity. |
| **Variance of Germination Time** | The statistical variance of the times at which seeds germinate, providing a measure of variability in the germination process. Higher variance means greater inconsistency among seeds. |
| **Standard Deviation** | The square root of the variance, indicating the average deviation from the mean germination time. It reflects the spread of germination events around the mean. |
| **Maguire's Speed Index** | A cumulative index calculated as the sum of (number of seeds germinated per day divided by the day number), $\sum(ni/ti)$. Higher values denote rapid and concentrated germination, which is desirable for uniform crop stands. |
| **T50 (Time to 50% Germination)** | The time required to reach 50% of the final germination percentage, calculated by interpolation. $T_{50}$ is a robust indicator of the median germination speed and is widely used for comparing treatments. |
| **ArcSin Transformation** | The arcsine square root transformation of the germinability percentage, often used to normalize proportional data for parametric statistical analyses. |

## 10. Significance in Germination Studies

- **Germinability** is essential for assessing seed lot viability and predicting field performance.
- **MGT, MGR, Maguire Index, and T50** are critical for evaluating the speed and uniformity of germination, which impact crop establishment and management.
- **CVt, Variance, Standard Deviation, Uncertainty, and Synchrony** provide insights into the temporal dynamics and predictability of germination, informing decisions on seed quality and suitability for mechanized planting.
- **ArcSin Transformation** ensures that statistical analyses of germination data meet the assumptions of normality, enhancing the validity of experimental conclusions.

## 11. References


[1] Ranal, M. A., & Santana, D. G. de (2006). How and why to measure the germination process? *Revista Brasileira de Botânica*, 29(1), 1–11. https://doi.org/10.1590/S0100-84042006000100002

[2] Ranal, M. A., Santana, D. G., Ferreira, W. R., & Mendes-Rodrigues, C. (2009). Calculating germination measurements and organizing spreadsheets. *Brazilian Journal of Botany*, 32(4), 849–855. https://doi.org/10.1590/S0100-84042009000400022

[3] Labouriau, L. G. (1983). *A Germinação das Sementes*. Washington, D.C.: Secretaria Geral da Organização dos Estados Americanos.