

CARROT

Collecting and Analyzing Rhizodeposits: Reviewing and Optimizing Tool

Version: 2026-02-24

User manual - version R Shiny

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1 Aims & purpose

CARROT is a decision support tool aiming to guide a user towards the protocol of rhizodeposits collection and analysis best suited for his/her own objectives and constraints. The tool enables to move along a complex decision tree in order to identify options for successive protocol steps that are either recommended, alternative or incompatible with the set of choices progressively selected by the user. CARROT does not intend to create a complete, operational protocol of rhizodeposit collection & analysis, but rather aims to orientate the user towards the best methods by giving him/her synthetic information.

This document provides practical information about the way to use this tool.

2 How to start CARROT

CARROT has been written as an R Shiny application, and can be either:

- i) launched online without any installation at the GitHub Page
<https://freess86.github.io/carrot/>
- ii) used as an R program by executing the file "app.R" in an R console, available on
<https://github.com/frees86/carrot>
➔ Note that the file "app.R" needs to be located in the same folder as the folder 'source' containing the supporting tables.

3 How to use CARROT

After launching the program, the first step is to select one of the five groups of instructions from which to start:

1. Scientific questions & objectives
2. Growth conditions
3. Sampling method
4. Sample treatment
5. Sample analysis

Note: It is recommended to start by "Scientific questions & objectives" and to follow the logical order of these successive groups of instructions. However, the user can choose to go through these groups of instructions in any order, knowing that this order has consequences on the evaluation of the compatibility of successive options to one another.

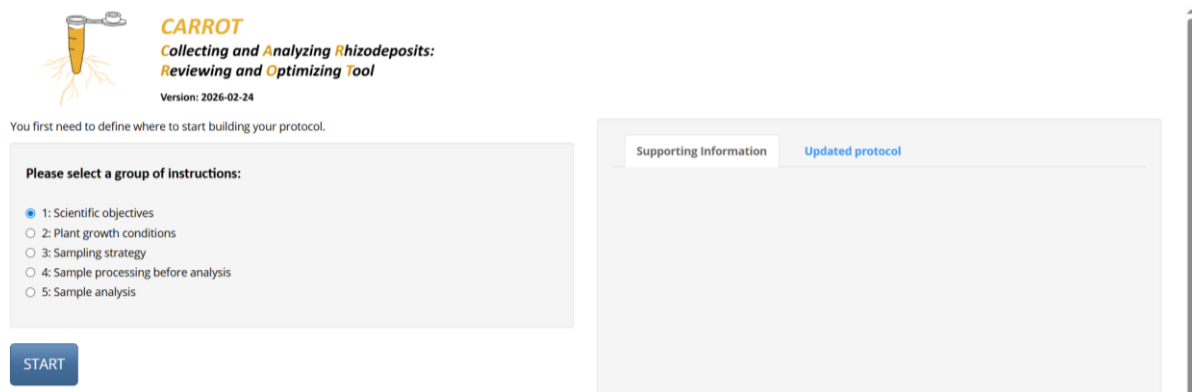
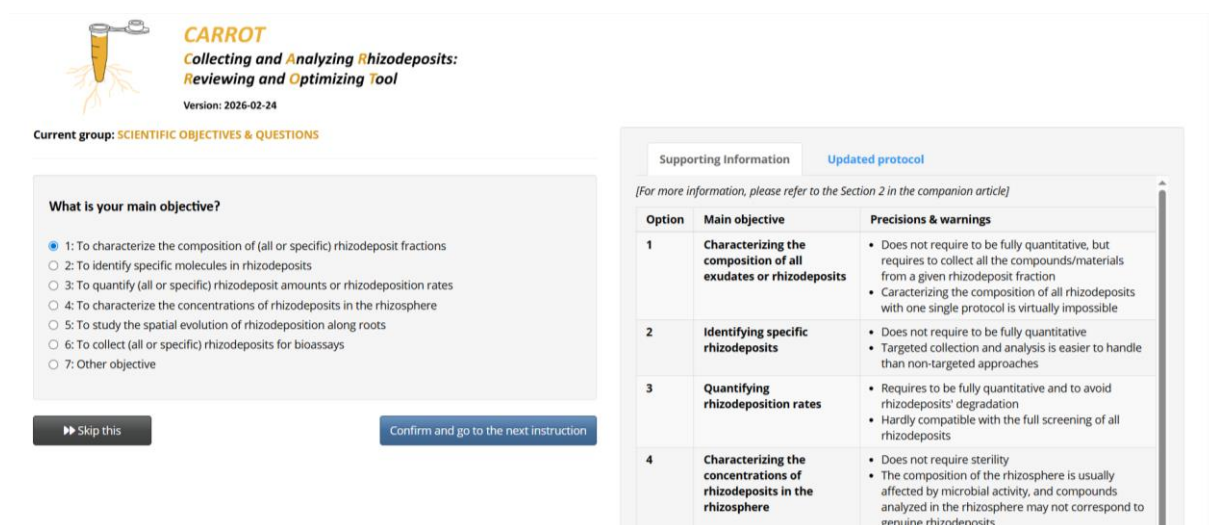


Fig. 1: Starting page of CARROT

The next step is to select one of the possible options corresponding to the first instruction. For this instruction and all subsequent ones, a Supporting Information table is displayed on the right panel and aims to provide relevant, synthetic information to support the decision. Additional information is also usually provided in the companion scientific article.



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Current group: **SCIENTIFIC OBJECTIVES & QUESTIONS**

What is your main objective?

- ☒ 1: To characterize the composition of (all or specific) rhizodeposit fractions
- ☐ 2: To identify specific molecules in rhizodeposits
- ☐ 3: To quantify (all or specific) rhizodeposit amounts or rhizodeposition rates
- ☐ 4: To characterize the concentrations of rhizodeposits in the rhizosphere
- ☐ 5: To study the spatial evolution of rhizodeposition along roots
- ☐ 6: To collect (all or specific) rhizodeposits for bioassays
- ☐ 7: Other objective

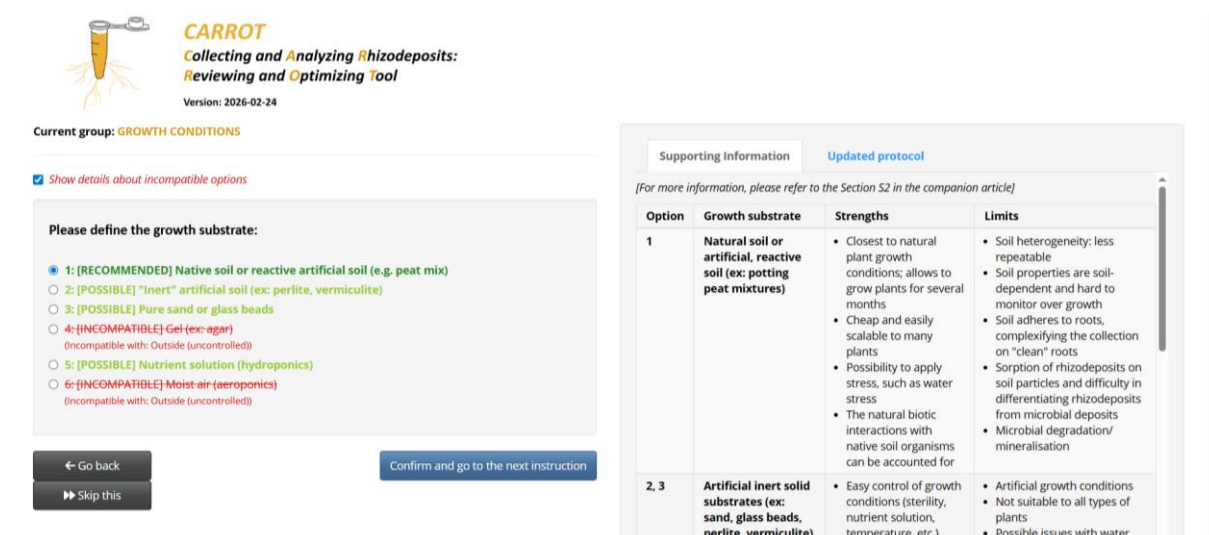
[Skip this](#) [Confirm and go to the next instruction](#)

| Option | Main objective | Precisions & warnings |
|--------|---|---|
| 1 | Characterizing the composition of all exudates or rhizodeposits | <ul style="list-style-type: none"> Does not require to be fully quantitative, but requires to collect all the compounds/materials from a given rhizodeposit fraction Characterizing the composition of all rhizodeposits with one single protocol is virtually impossible |
| 2 | Identifying specific rhizodeposits | <ul style="list-style-type: none"> Does not require to be fully quantitative Targeted collection and analysis is easier to handle than non-targeted approaches |
| 3 | Quantifying rhizodeposition rates | <ul style="list-style-type: none"> Requires to be fully quantitative and to avoid rhizodeposits' degradation Hardly compatible with the full screening of all rhizodeposits |
| 4 | Characterizing the concentrations of rhizodeposits in the rhizosphere | <ul style="list-style-type: none"> Does not require sterility The composition of the rhizosphere is usually affected by microbial activity, and compounds analyzed in the rhizosphere may not correspond to genuine rhizodeposits |

Fig. 2: A decision can be supported by a synthetic table summarizing information about the different options

Once a first option has been selected and the instruction for a new protocol step is considered, a compatibility test is activated, and automatically labels each option as “Recommended”, “Possible” or “Incompatible”, based on previous choices. The reason for which a given option is deemed incompatible can be further explored by ticking the box “Show details about incompatible options” displayed above the instruction.

Note: if all possible options of a given instruction are deemed incompatible with previous choices, the instruction will be skipped and the program will automatically display the next instruction without notice.



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Current group: **GROWTH CONDITIONS**

☒ Show details about incompatible options

Please define the growth substrate:

- ☒ 1: [RECOMMENDED] Native soil or reactive artificial soil (e.g. peat mix)
- ☐ 2: [POSSIBLE] "Inert" artificial soil (ex: perlite, vermiculite)
- ☐ 3: [POSSIBLE] Pure sand or glass beads
- ☐ 4: [INCOMPATIBLE] Gel (ex: agar)
(incompatible with: Outside (uncontrolled))
- ☐ 5: [POSSIBLE] Nutrient solution (hydroponics)
- ☐ 6: [INCOMPATIBLE] Moist air (aeroponics)
(incompatible with: Outside (uncontrolled))

[Go back](#) [Skip this](#) [Confirm and go to the next instruction](#)

| Option | Growth substrate | Strengths | Limits |
|--------|---|--|--|
| 1 | Natural soil or artificial, reactive soil (ex: potting peat mixtures) | <ul style="list-style-type: none"> Closest to natural plant growth conditions; allows to grow plants for several months Cheap and easily scalable to many plants Possibility to apply stress, such as water stress The natural biotic interactions with native soil organisms can be accounted for | <ul style="list-style-type: none"> Soil heterogeneity: less repeatable Soil properties are soil-dependent and hard to monitor over growth Soil adheres to roots, complicating the collection on "clean" roots Sorption of rhizodeposits on soil particles and difficulty in differentiating rhizodeposits from microbial deposits Microbial degradation/ mineralisation |
| 2, 3 | Artificial inert solid substrates (ex: sand, glass beads, perlite, vermiculite) | <ul style="list-style-type: none"> Easy control of growth conditions (sterility, nutrient solution, temperature, etc.) | <ul style="list-style-type: none"> Artificial growth conditions Not suitable to all types of plants Possible issues with water |

Fig. 3: When options have been deemed incompatible with previous choices, details can be obtained by checking the box “Show details about incompatible options”.

Once all possible instructions within one group of instructions have been covered, a new group of instructions can be selected, and the selection procedure can continue. Note that a group of

instructions can be revisited later one. In such case, a warning is displayed to confirm the choice, and, when confirmed, the previous choices related to this group of instruction will be overwritten.

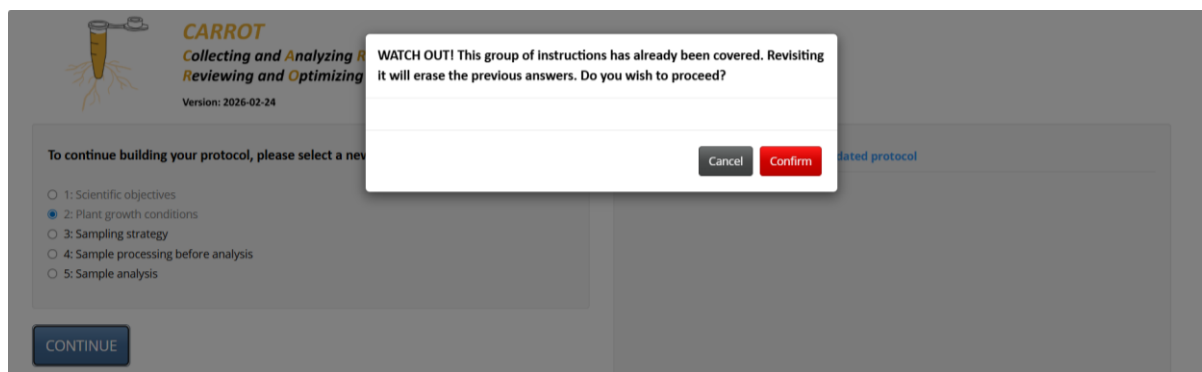


Fig. 4: Selecting an incompatible option remains possible, but raises a warning message.

Once all possible options within each group of instructions - or at any moment within the protocol construction, the user can access and download the resulting protocol corresponding to the selected choices by moving to the tab “Updated protocol”. There the user can either:

- i) download the protocol as a CSV file or an Excel file summarizing the instruction and corresponding choice in each group, as well as detailing the compatibility test for each option,
- ii) download a text file summarizing the main steps of the protocol.

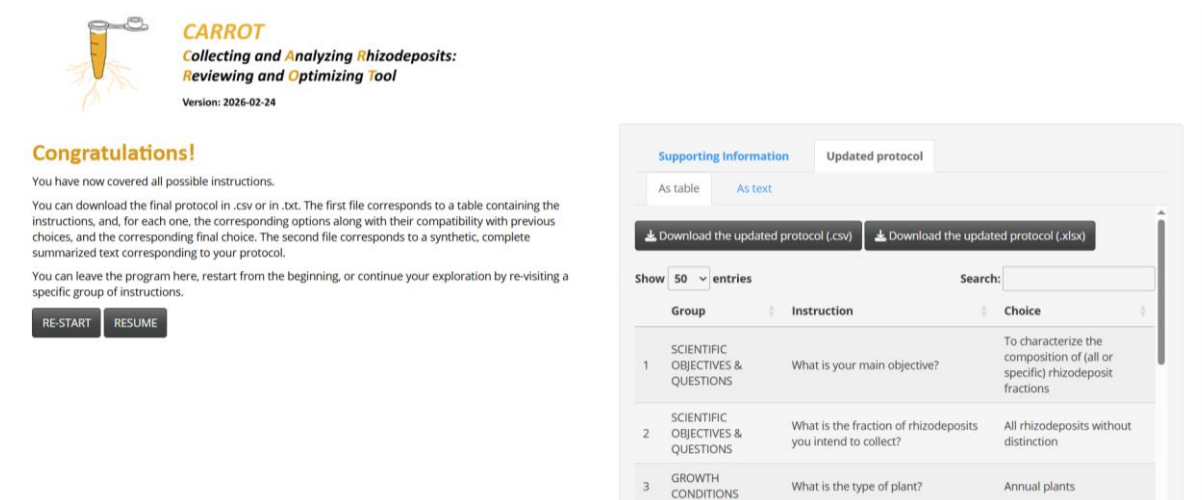


Fig. 5: The results can be checked and downloaded at any time by reaching the tab “Updated protocol” on the right.

4 Troubleshooting

To report bugs, persisting issues or possible improvements, please contact Frédéric Rees (frederic.rees@inrae.fr).

5 Credits

This work originates from discussions held within the French network *RhizosPHARE* and the previous project *PHARE* (2021-2022) funded by INRAE.

Conception & programming: Frédéric Rees, Sylvain Chéreau

Writing, editing & testing: Frédéric Rees, Virginie Lauvergeat, Jean-Benoît Peltier, Gabin Piton, Aude Tixier, Sylvain Chéreau, Sylvie Dinant, Barbara Pawlak, François Perreau, Emmanuelle Personeni, Jean-Bernard Pouvreau, Alexandre de Saint Germain, Anouk Zancarini, Agnès Attard

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