

CARROT: Collecting and Analyzing Rhizodeposits

- Reviewing and Optimizing Tool

User manual - version R Shiny

Update: 2026-02-11

1	Aims & purpose	2
2	How to start <i>CARROT</i>	2
3	How to use <i>CARROT</i>	2
4	Troubleshooting	4
5	Credits.....	5

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://frees86.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.

CARROT: Collecting and Analyzing Rhizodeposits - Reviewing and Optimizing Tool

Version: 2026-02-10

You first need to define where to start building your protocol.

Please select a group of instructions:

- 1: Scientific objectives
- 2: Plant growth conditions
- 3: Sampling strategy
- 4: Sample processing before analysis
- 5: Sample analysis

START

Supporting information Updated protocol

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.

CARROT: Collecting and Analyzing Rhizodeposits - Reviewing and Optimizing Tool

Version: 2026-02-10

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

[For more information, please refer to the Section 2 in the companion article]

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
5	Studying the spatial evolution of rhizodeposition along roots	<ul style="list-style-type: none"> Studying the spatial distribution requires a specific collection device (e.g. rhizodeposit traps in rhizobox)

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.

CARROT: Collecting and Analyzing Rhizodeposits - Reviewing and Optimizing Tool

Version: 2026-02-10

Current group: SAMPLING RHIZODEPOSITS

Show details about incompatible options

In which medium will the sample be collected?

- 1: [INCOMPATIBLE] Solid medium (ex: soil)
- 2: [INCOMPATIBLE] Liquid medium (ex: soil-solution; nutrient-solution)
- 3: [RECOMMENDED] Gas medium (ex: air)

◀ Go back
Confirm and go to the next instruction
▶ Skip this

[For more information, please refer to the Section 2 in the companion article]

Option	Sampling medium	Precision
1	Solid medium	<ul style="list-style-type: none"> Typically soil or solid growth substrate (e.g. sand, glass beads)
2	Liquid medium	<ul style="list-style-type: none"> Typically water or nutrient solution
3	Gas medium	<ul style="list-style-type: none"> Typically air to analyze VOC

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.

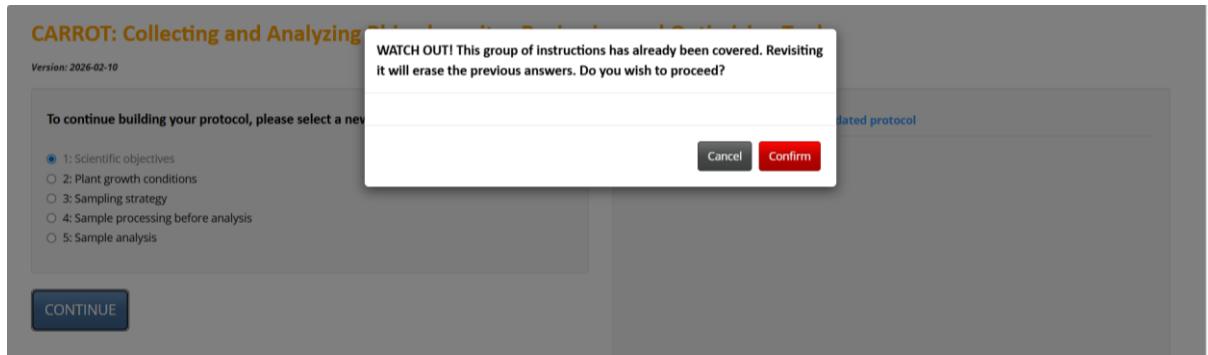


Fig. 4: Selecting an incompatible option remains possible, but raises a warning message.

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 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.

CARROT: Collecting and Analyzing Rhizodeposits - Reviewing and Optimizing Tool

Version: 2026-02-10

Congratulations!

You have now covered all possible instructions.

You can download the final protocol in .csv or in .txt. The first file corresponds to a table containing the instructions, and for each one, the corresponding options along with their compatibility with previous choices, and the corresponding final choice. The second file corresponds to a synthetic, complete summarized text corresponding to your protocol.

You can leave the program here, restart from the beginning, or continue your exploration by re-visiting a specific group of instructions.

RE-START

RESUME

Supporting information		Updated protocol	
		As table	As text
 Download the updated protocol (.csv)			
Show	50	entries	Search:
Group	Instruction	Choice	
1	SCIENTIFIC OBJECTIVES & QUESTIONS	What is your main objective?	To characterize the composition of (all or specific) rhizodeposit fractions
2	SCIENTIFIC OBJECTIVES & QUESTIONS	What is the fraction of rhizodeposits you intend to collect?	All rhizodeposits without distinction
3	GROWTH CONDITIONS	What is the type of plant?	Annual plants
4	GROWTH CONDITIONS	What will be the age of the plant at the time of sampling?	Seedling (< 1 week)

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.

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