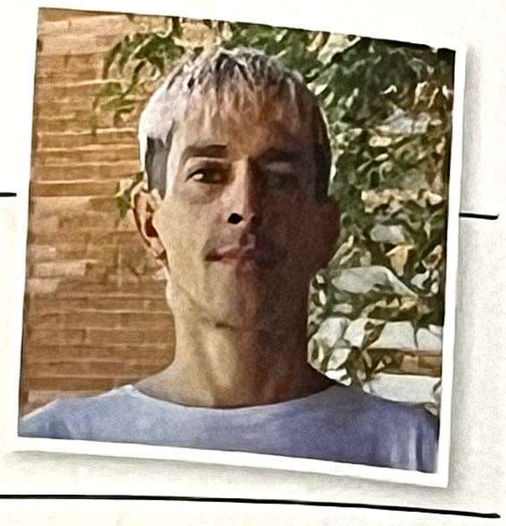


ADAPTING ROOTS IN THE CONTEXT OF GLOBAL CHANGE

How would a plant adapt its root production to a soil patch that is poor in resources? Understanding how plants decide how many roots to grow is fundamental for several biological and ecological disciplines. In the context of global change, it has serious consequences for biodiversity, food production, and climate. **Ciro Cabel** explores.

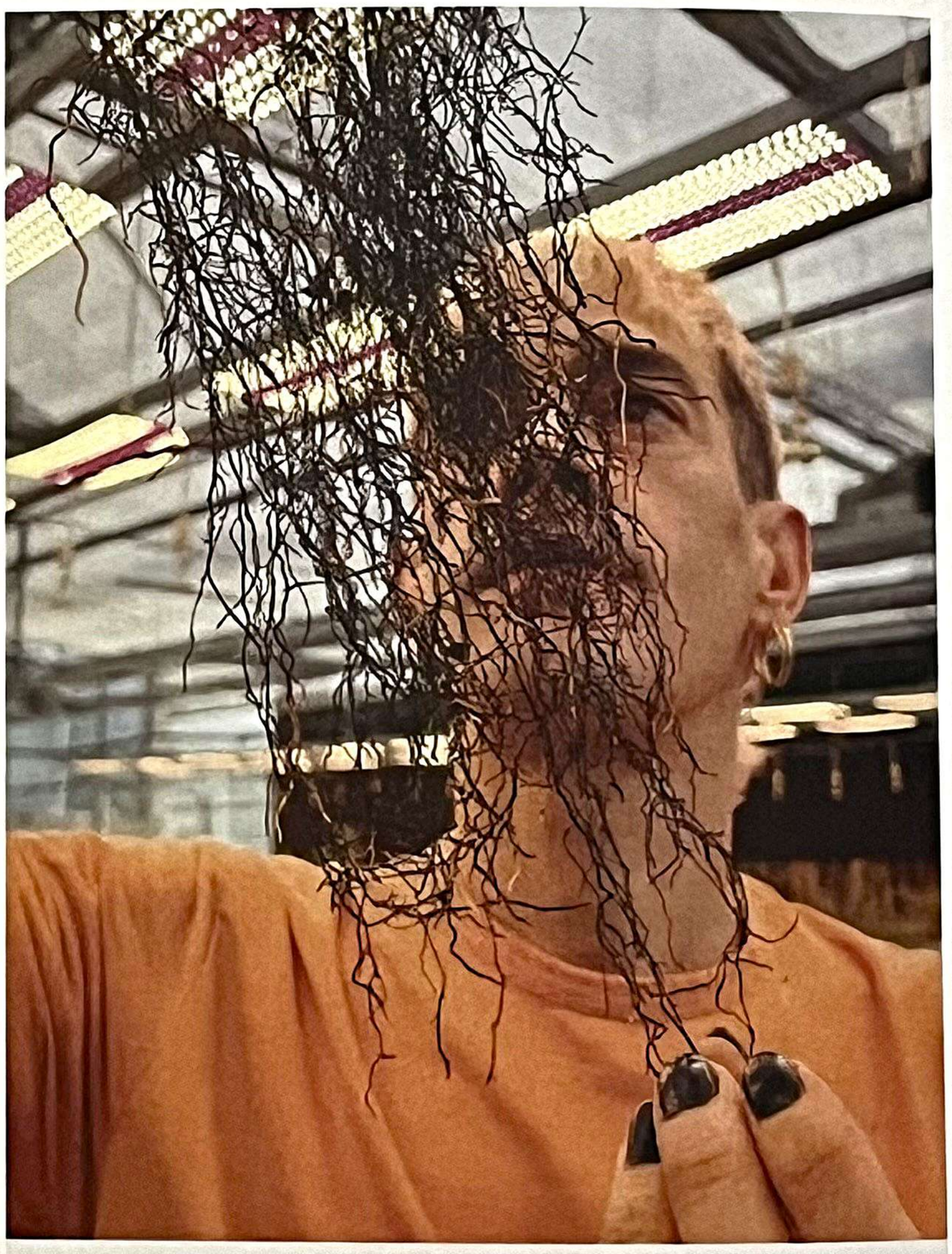
When resources are limited, you might expect a plant to grow fewer roots because we assume that this is caused by a reduced resource input. Yet, what would happen if resource scarcity is caused by a higher rate of resource depletion instead? This is what happens when non-self roots are also foraging in the same soil patch. Game theory models predict that plants would then increase their root production. This is what plant scientists have named the Root Tragedy of the Commons (RToC).

The RToC predicts that plants will invest sub optimally in roots following an exploitative response to competition. As a result, they overproduce roots compared to the investment predicted by cooperation models. It is fundamental to dissociate the exploitative (i.e., based on resource detection by plants) and the proactive (i.e. based on the active recognition of the neighbours) mechanisms of competition to understand the complexity of plant foraging behaviour. In the case of the RToC, such a suboptimal allocation is the consequence of plants' response to exploitative competition based solely on soil resource information.

When it was first published, the RToC was seen as a theory with the potential to explain fine root production in competitive contexts, but it has become a contentious idea over the last two decades. Unfortunately, such an exciting theory has fallen into oblivion after becoming an object of unresolved theoretical dispute grounded in methodological controversy and intensified by a misunderstanding of the underlying mechanisms. With this project, I aim to revive the interest in the theory from a conciliatory and constructive approach, because I believe that this theory has the potential to advance our understanding of plant foraging strategies and belowground plant-plant interactions.

The project TRAgEDy aims to provide a fresh methodological tool to demonstrate that the RToC is a widespread phenomenon based on resource depletion by plant neighbours. To that end, I propose experiments in which I will assess the response of plants to artificial resource depletion in containers. This will be achieved by developing artificial roots that simulate resource depletion by plants in cultivation pots. Porous PVC tubes connected to a vacuum pump will be placed inside cultivation containers so that they will absorb the nutritious solution, hence emulating root activity, but there won't be roots to detect. This experimental setup will allow me to test the exploitative response of the plant to competition, controlling other mechanisms that also operate together in nature based on the active detection of the neighbour.

This project should represent a first step toward proving that plants interacting belowground through resource depletion engage unavoidably in suboptimal allocation strategies, namely root over-proliferation. I expect that this project will, first, provide a method to test for this plant response, controlling for the causing mechanisms, and second, present the first evidence of this phenomenon in which the ecophysiological mechanisms are correctly proven. These expected results might foster new similar experiments performed in other plant species and, in the long term, the incorporation of the RToC as a ubiquitous mechanism acting upon all ecological communities in which plant individuals interact belowground.



Ciro Cabel won the John L Harper award for his project, 'The Tragedy of the Commons in Roots as an Agonistic Exploitative Dynamic in Plants (TRAgEDy): Using artificially rooted pots to assess root over-proliferation as a response to soil resource depletion.'
The John L Harper award is a BES fund for research that investigates the detailed study of plant populations and interactions.