

## **Understanding the Rhizosphere**

### **A Deeper Look Into the Process of Rhizophagy**

#### What Is the Rhizosphere?

The rhizosphere is a narrow zone surrounding the plant roots where plants interface with soil and the microbes that inhabit it. This zone can extend from 2 mm (cereal crop) and up to 80mm (trees) away from the root surface. Within this zone, biological activity becomes increasingly dynamic as you approach the root, with the highest activity concentrated at the root tips.

#### What Is a Microbiome?

The rhizosphere hosts a complex microbiome—a community of microorganisms, including bacteria, fungi, and other microbes all drawn to and interacting with the plant roots. The microbiome plays a crucial role in nutrient cycling, disease suppression, and overall plant health.

#### Plants Can Manipulate the Rhizosphere pH

Plants can raise or lower the pH around the roots using several different chemical mechanisms. This is important because the availability of certain nutrients to a plant depends on the local pH and the form in which the nutrient exists in the soil. Modifying soil pH can help the plant acquire nutrients it that they would not otherwise have access to.

#### How Do Plants Lower pH?

- The release of hydrogen ions ( $H^+$ ) from the plant roots.
  - The released hydrogen ions acidify the surrounding soil, which lowers soil pH.
- Cation exchange ( $K^+$ ,  $Ca^{2+}$ ,  $Mg^{2+}$ ).
  - When a plant uptakes cations, the plant will release hydrogen ions ( $H^+$ ) into the rhizosphere to maintain an internal charge balance. This process results in acidification or the lowering of pH.
- Root respiration (release of  $CO_2^+$ ).
- The production of root exudates in the form of organic acids, such as citric or malic acid.

#### How Do Plants Increase pH?

- The uptake of nitrate anions by the plant roots ( $NO_3^-$ ).

- Plants will often release hydroxide ions ( $\text{OH}^-$ ) to maintain their internal chemical balance which will increase the pH in the rhizosphere.
- Release of bicarbonate ions ( $\text{HCO}_3^-$ ).
- The production of root exudates in the form of organic alkali exudates (glutamine and asparagine).

## Plants Alter the Oxidation-Reduction Potential (Eh)

Plants can alter the redox value (Eh) through the process of oxidation and reduction at the roots, and it is also an important factor in a plant's ability to absorb nutrients. By influencing the soil's redox conditions, plants can actively create an environment favorable for their nutrient uptake and root health.

Plants can induce oxidation in the rhizosphere by releasing oxygen and organic compounds as root exudates (indirectly by feeding microbes that oxidize), and through the creation of oxidase enzymes. Plants can induce reduction in the rhizosphere through root respiration (oxygen consumption at roots), organic compounds (donation of electrons to soil or microbes), and the creation of peroxidase enzymes.

## Plants Affect Nutrient Cycling Through Rhizosphere Microbiome

In a natural system, plants work symbiotically with microbes to obtain nutrients. They do so by secreting specific root exudates that signal to microbes to deliver specific nutrients or other products that the plant can't obtain for itself. This includes nitrogen (plants cannot get N from the air and often rely on nitrogen-fixing bacteria), phosphorus (difficult for plants to access on their own), carbon (*Pseudomonas* break down organic matter) and other nutrients. Some examples of attracting free living microbes in the soil are rhizobium bacteria for nitrogen fixation and mycorrhiza fungi for phosphorus uptake.

## Observing Rhizospheres

There is huge value in grabbing a shovel and going out into the field to find out what is happening with plant roots. The following are a few things to look for when examining the plants roots:

- Is there a rhizosheath?
- Compare the soil around the root to the soil with no root, especially perennials. Do you observe any differences?
- Are there mycorrhiza?
- Can you find *Rhizobia*?
- Are there root hairs?

Through observations, we can gain valuable insights. Over time, these insights can help direct our management practices.

## For Further Information

- [The rhizosphere microbiome: Plant–microbial interactions for resource acquisition](#) (Article)
- [Unveiling the significance of rhizosphere: Implications for plant growth, stress response, and sustainable agriculture](#) (Article)
- [Regenerative Farming Network Ep. 3 - Exploring the Root Rhizosphere](#) (Video)
- [Uncovering the secret world of the rhizosphere microbiome, the plant's 2nd genome](#) (Video)