DECODE 6

How Does Soil Biology Impact Nutrient Availability?

The short answer: Soil biology plays a significant role in nutrient availability by influencing nutrient cycling, transformation, and uptake by plants. Here's how soil biology impacts nutrient availability:

- **Soil microbes, through processes like nitrogen fixation and mineral solubilization, transform and mobilize nutrients for plant absorption, reducing reliance on synthetic fertilizers and leading to nutrient-dense crops.**
- **Soil biology, including symbiotic relationships with fungi, enhances plants' nutrient uptake, influences soil pH, and increases resistance to environmental stress, supporting overall crop health and productive farming.**

Break it down: Soil biology exerts a profound influence on nutrient availability, ultimately shaping the nutritional status and productivity of crops. This happens thanks to microorganisms that are especially abundant close to the rhizosphere (the area comprised of the plant roots) or endophytic microorganisms (those living inside the roots). Some of these microorganisms are involved in:

1. Nutrient cycling: Microbes are involved in the cycling of essential nutrients in the soil.

- **For example, certain soil bacteria are known to solubilize otherwise inaccessible minerals, such as phosphorus, iron, and zinc. Plants that can access these essential minerals through their relationship with these microbes often demonstrate enhanced nutrient profiles, leading to more nutrient dense crops. This process is essential for human nutrition, especially in areas where mineral deficiencies are unfortunately common in the diet.**
- **By understanding and promoting the activity of these mineral-solubilizing bacteria, farmers and crop advisers can aim to produce crops with improved nutritional quality. You can read more about how microbes do this in this Decode 6 article: https://bit.ly/4cu8OXx.**

2. Nutrient transformation: Soil microbes also play a role in nutrient transformation. As an example, microorganisms are involved in several pathways of the nitrogen cycle:

- **Nitrogen fixation:** **Some bacteria have the ability to convert atmospheric nitrogen gas into forms that plants and microbes can use.**
  - **While certain groups of these bacteria form symbiotic relationships with specific plants (legumes), others can exist independently in the soil. By fixing nitrogen, they contribute to the soil's nitrogen content and thus play an important role in reducing dependency on nitrogen fertilizers.**
  - **Soil microbes contribute up to 65% of the nitrogen demanded by crops and help explain why legumes like soybeans do not require as much nitrogen input as other non-legume crops that lack symbiotic relationships with N-fixing bacteria.**
- **Other Pathways of Nutrient Transformation:** **Soil microbes are also involved in other transformation pathways of nitrogen and other nutrient cycles.**
  - **For example, nitrifying bacteria convert ammonium (NH_4^+) into nitrate (NO_3^-), a form of nitrogen that is more readily available for plant uptake.**
  - **Denitrifying bacteria, on the other hand, convert nitrate (NO_3^-) back into atmospheric nitrogen (N_2), thus completing the nitrogen cycle.**

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In addition to rhizosphere microorganisms and endophytes, there are also mutualistic relationships between fungi and plants:

3. Mycorrhizal fungi form mutualistic associations with plant roots.

- **These fungi extend their hyphae into the soil, significantly increasing the surface area for nutrient absorption.**
- **In return, plants provide the fungi with carbohydrates produced through photosynthesis. Mycorrhizal associations enhance nutrient uptake, particularly phosphorus and micronutrients, improving plant nutrient availability and overall plant health.**
- **These networks not only increase the plant's nutrient and water absorption capacity, but also enhance the plant's resistance to various environmental stresses like drought.**

Decode 6

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Finally, soil microorganisms also affect plant nutrient availability indirectly:

4. Soil pH and availability: Some microbes, like acid-producing and alkaline-producing bacteria, can influence soil pH by secreting acidic or alkaline compounds during their metabolic processes. Soil pH affects the availability of nutrients to plants.

- **For example, some nutrients like phosphorus are less available in alkaline soils while others like iron and manganese may be less available in acidic soils.**
- **Microbial activity can impact soil pH and consequently influence nutrient availability.**

In short, soil biology is a powerful driver of nutrient availability, influencing critical processes like nitrogen fixation, nutrient transformation, and nutrient cycling. Practices such as cover cropping and conservation tillage play a pivotal role in preserving soil microbiomes and maintaining the delicate balance of nutrient dynamics. By embracing soil health management strategies and nurturing the interplay between plants and soil microbes, we can optimize nutrient availability, enhance crop productivity, and promote sustainable agricultural systems.

Let us embrace the power of soil microbes as allies in our quest for nutrient optimization and resilient farm and food systems!