

Soil pH and Its Influence on Crop Productivity

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Abstract:

Soil pH plays a critical role in determining soil fertility, nutrient availability, and overall crop productivity. It affects microbial activity, nutrient solubility, and root growth, ultimately influencing agricultural yields. This article explores the significance of soil pH, factors affecting it, methods for pH management, and its impact on crop productivity. Understanding soil pH is essential for optimizing agricultural practices and ensuring sustainable food production.

- 1. Introduction:** Soil pH is a measure of the acidity or alkalinity of soil, expressed on a scale from 0 to 14. A pH of 7 is neutral, values below 7 indicate acidity, and values above 7 indicate alkalinity. Soil pH directly impacts plant growth by influencing nutrient availability, microbial activity, and root development (Brady & Weil, 2016). Different crops have specific pH requirements, and deviations from the optimal range can lead to nutrient deficiencies or toxicities, reducing yield and quality.
- 2. Factors Affecting Soil pH:** Several natural and anthropogenic factors influence soil pH, including:
 - 2.1. Parent Material and Weathering:** The mineral composition of the parent rock affects the initial soil pH. Granite-derived soils tend to be more acidic, whereas limestone-derived soils are alkaline (Sparks, 2003).
 - 2.2. Rainfall and Leaching:** High rainfall contributes to soil acidification by leaching basic cations (e.g., calcium, magnesium) and replacing them with acidic ions like hydrogen and aluminum (Havlin et al., 2014).

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2.3. Organic Matter Decomposition: The breakdown of organic matter releases organic acids, which can lower soil pH (Schlesinger & Bernhardt, 2013).

2.4. Agricultural Practices: Fertilizer Use: Ammonium-based fertilizers, such as urea and ammonium sulfate, contribute to soil acidification (Fageria & Baligar, 2008).

Lime Application: The addition of agricultural lime increases pH by neutralizing acidity.

Irrigation with Alkaline Water: Long-term use of alkaline irrigation water raises soil pH.

3. Effect of Soil pH on Nutrient Availability: Soil pH significantly influences the solubility and availability of essential plant nutrients (Marschner, 2012):

Macronutrients (N, P, K, Ca, Mg, S): Most are available in the pH range of 6.0–7.5. Phosphorus availability decreases in highly acidic or alkaline soils due to precipitation with iron, aluminum, or calcium. **Micronutrients (Fe, Mn, Zn, Cu, B, Mo):** Iron, manganese, and zinc are more available in acidic soils, while molybdenum is more available in alkaline conditions. Extreme pH levels can lead to nutrient deficiencies or toxicities, adversely affecting plant growth and yield.

4. Impact of Soil pH on Crop Productivity:

The effect of soil pH on crops varies depending on their tolerance levels. Some examples include:

Acidic Soils (pH < 5.5): Common in tropical and high-rainfall regions. Aluminum and manganese toxicity can inhibit root growth. Nutrient deficiencies (calcium, magnesium, phosphorus).

Crops affected: Wheat, maize, and legumes.

Neutral Soils (pH 6.0–7.5): Optimal for most crops (e.g., wheat, rice, corn, and vegetables). Maximum nutrient availability and microbial activity.

Alkaline Soils (pH > 7.5): Common in arid and semi-arid regions. Nutrient deficiencies (iron, zinc, phosphorus). **Crops affected:** Corn, citrus, and sorghum.

5. Soil pH Management Strategies:

Maintaining an optimal soil pH is crucial for sustainable crop production. Some key strategies include:

5.1. Liming Acidic Soils: Adding lime (calcium carbonate, dolomite) neutralizes soil acidity and improves nutrient availability (Fageria & Baligar, 2008).

5.2. Acidifying Alkaline Soils: Applying elemental sulfur, gypsum, or organic matter can help lower pH. Using acidifying fertilizers (ammonium

sulfate, sulfur-coated urea) enhances soil acidity.

5.3. Proper Fertilizer Management: Choosing balanced fertilizers to prevent excessive acidification or alkalization. Rotating crops to maintain soil fertility.

5.4. Organic Amendments: Incorporating compost, manure, and crop residues enhances soil buffering capacity. Cover cropping improves soil structure and microbial activity.

6. Conclusion: Soil pH is a fundamental factor influencing crop productivity, affecting nutrient availability, microbial activity, and root development. Proper soil pH management through liming, acidification, balanced fertilization, and organic amendments can enhance soil fertility and agricultural sustainability. Farmers and agronomists should conduct regular soil testing and adopt appropriate pH management practices to optimize crop yield and ensure long-term soil health.

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