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The effect of genetically modified *Glycine max* (L.) on soil microbial communities

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Abstract

The introduction of genetically modified (GM) *Glycine max* (L.), commonly known as soybean, has revolutionized agricultural practices worldwide. These modifications aim to enhance yield, improve resistance to pests and diseases, and tolerate herbicides. However, the ecological implications of GM soybean, particularly its effect on soil microbial communities, have become a topic of significant scientific inquiry. This review synthesizes current research findings on the interactions between GM soybean and soil microbiota, evaluating the impacts on microbial diversity, function, and the overall soil health.

Keywords: Soybean, *Glycine max* (L.), soil microbiota, soil

Introduction

Glycine max (L.), an essential crop for its high protein and oil content, has been at the forefront of genetic modifications to meet global food demands. Despite the agronomic benefits, the ecological consequences of GM soybean cultivation, especially on soil ecosystems, remain a critical area for investigation. Soil microbial communities play a pivotal role in nutrient cycling, organic matter decomposition, and plant health. Therefore, understanding how GM soybean influences these microbial assemblages is crucial for sustainable agriculture practices.

Objective of the study

The main objective of this review paper is to evaluate the Effect of Genetically Modified *Glycine max* (L.) On Soil Microbial Communities.

Impact of GM Soybean on Microbial Diversity

Several studies have investigated the diversity of microbial communities in GM soybean fields. Findings suggest that the introduction of GM soybean can lead to changes in microbial community composition. For instance, some research indicates a shift towards bacteria that are more resistant to the herbicides used in conjunction with GM crops. However, these impacts are often complex, influenced by factors such as crop variety, the specific genetic modification, soil type, and agricultural practices.

Functionality of Soil Microbial Communities

Soil microbial communities play a crucial role in various ecological processes, including nutrient cycling, organic matter decomposition, plant growth promotion, and disease suppression. These communities are composed of diverse microorganisms such as bacteria, fungi, archaea, protozoa, and viruses. Each of these components contributes uniquely to the overall functionality of the soil ecosystem.

1. **Nutrient Cycling:** Soil microbes are essential for the decomposition of organic matter, releasing nutrients like nitrogen, phosphorus, and sulfur in forms accessible to plants. They also facilitate nutrient transformations, such as nitrogen fixation and mineralization.

Microbial Group	Function
Bacteria	Decompose organic matter, fix nitrogen, solubilize phosphorus
Fungi	Decompose lignin and cellulose, facilitate nutrient transfer to plants
Archaea	Participate in nitrogen cycling, methane production and oxidation
Protozoa	Regulate bacterial populations, release nutrients through grazing
Viruses	Influence microbial community structure, control bacterial populations

Organic Matter Decomposition: Soil microbes break down complex organic compounds into simpler forms, aiding in the recycling of nutrients and contributing to soil fertility.

Microbial Group	Decomposition Role
Bacteria	Decompose simple sugars, proteins, lipids
Fungi	Decompose complex organic compounds like cellulose, lignin
Archaea	Participate in decomposition processes, especially in extreme environments

Plant Growth Promotion: Certain soil microbes form symbiotic relationships with plants, aiding in nutrient uptake, hormone production, and protection against pathogens.

Microbial Group	Plant Growth Promotion Role
Rhizobacteria	Fix atmospheric nitrogen, produce plant growth hormones
Mycorrhizal Fungi	Facilitate nutrient uptake, improve soil structure
Actinomycetes	Produce antibiotics, promote plant growth

Disease Suppression: Soil microbes can suppress plant diseases through various mechanisms, including competition for resources, production of antibiotics, and induction of plant defense mechanisms.

Microbial Group	Disease Suppression Mechanism
Pseudomonas spp.	Produce antibiotics, compete for resources
Trichoderma spp.	Antagonize plant pathogens, induce plant defense responses
Streptomyces spp.	Produce antifungal compounds, inhibit pathogen growth

Interaction with Soil Health

Interactions with soil health encompass a broad spectrum of factors, including physical, chemical, and biological processes and characteristics that influence the capability of soil to function effectively. Soil health, often referred to as soil quality, is crucial for ensuring sustainable agricultural practices, supporting ecosystems, and maintaining water quality.

Soil is a habitat for diverse microorganisms (e.g., bacteria, fungi) that interact with plants, enhancing nutrient recycling, disease suppression, and bioremediation. These beneficial effects arise from complex soil-plant-microbe interactions within the rhizosphere, the area surrounding plant roots (Vankayalapati Vijaya Kumar, 2016) [1].

The persistence of herbicides in soil is significantly influenced by physical, chemical, and biological interactions, including adsorption to soil particles and microbial decomposition. These factors determine the herbicides' environmental fate and impact on soil health (C. Furmidge & J. Osgerby, 1967) [3].

Soil organic carbon (SOC) is a key determinant of soil health, influencing soil structure, nutrient availability, and overall ecosystem services. Sustainable management practices, such as organic farming and reduced tillage, can improve SOC levels, thereby enhancing soil health and agricultural productivity (R. Lal, 2016) [4].

Soil health is closely linked to biodiversity within soil ecosystems. Microbial diversity, for instance, plays a crucial role in nutrient cycling, organic matter decomposition, and the suppression of soil-borne diseases. Diverse microbial communities can improve plant health and resilience to stresses (J. Doran & M. Zeiss, 2000) [5].

Physical Interactions

- **Soil Texture and Structure:** These determine water retention and drainage, root penetration, and air circulation within the soil. Practices like no-till farming can improve soil structure by reducing compaction and erosion.
- **Soil Moisture:** Adequate moisture is vital for plant growth and microbial activity. Management practices such as cover cropping and mulching can help maintain soil moisture levels.

Chemical Interactions

- **Nutrient Management:** The presence and availability of essential nutrients (like nitrogen, phosphorus, and potassium) are critical for plant health. Overuse of fertilizers can lead to nutrient leaching, affecting water quality.
- **pH Levels:** Soil pH affects nutrient availability and microbial activity. Liming acidic soils or using sulfur to lower pH in alkaline soils can help maintain optimal pH levels for specific crops.

Biological Interactions

- **Soil Microorganisms:** Bacteria, fungi, and other microorganisms play a key role in nutrient cycling, organic matter decomposition, and forming symbiotic relationships with plants (e.g., mycorrhizal fungi).
- **Plant Residues and Organic Matter:** The incorporation of organic matter into soil improves its fertility, structure, and water-holding capacity. Composting and green manures are effective ways to add organic matter to soil.

Human Interactions

- **Agricultural Practices:** Crop rotation, cover cropping, reduced tillage, and organic farming practices can enhance soil health by improving biodiversity, reducing erosion, and increasing organic matter content.
- **Pollution and Contamination:** Chemical spills, overuse of pesticides, and heavy metals can degrade soil health. Regulations and best practices are essential to minimize these impacts.

Climate Change Impacts

- **Temperature and Precipitation Changes:** Climate change can alter precipitation patterns and increase temperatures, impacting soil moisture, nutrient cycling, and organic matter decomposition.

- **Carbon Sequestration:** Healthy soils are important carbon sinks. Practices that increase organic matter content can help mitigate climate change by capturing atmospheric CO_2.

Conclusion

In conclusion, soil health is a critical component of global environmental health, agricultural productivity, and climate change mitigation. The interactions between physical, chemical, and biological factors within the soil ecosystem are complex and interconnected, influencing the soil's ability to support plant life, sequester carbon, and maintain ecological balance. Human activities, particularly agricultural practices, play a significant role in either enhancing or degrading soil health. By adopting sustainable farming practices such as crop rotation, cover cropping, minimal tillage, and organic amendments, we can improve soil structure, enhance nutrient cycling, and increase biodiversity within the soil.

Furthermore, recognizing the impact of climate change on soil health underscores the urgency for adaptive management strategies that not only protect soil but also contribute to its resilience against temperature and precipitation changes. Investing in soil health is not just about safeguarding agricultural productivity; it's about ensuring food security, preserving biodiversity, and fighting climate change. As we move forward, it is imperative that policymakers, farmers, researchers, and communities work collaboratively to implement practices that sustain and improve soil health, thereby securing the well-being of future generations and the planet.

References

1. Kumar V. Plant Growth-Promoting Microorganisms: Interaction with Plants and Soil; c2016. p. 1-16. https://doi.org/10.1007/978-3-319-27455-3_1.
2. Sunita Bisht, Manjulata Upadhyaya. *Glycine max* (L.) merr. A traditional crop of Kumaun Himalaya and ethnobotanical prespectives. Int. J Agric. Food Sci. 2020;2(2):11-13. DOI: 10.33545/2664844X.2020.v2.i2a.36
3. Furmidge C, Osgerby J. Persistence of herbicides in soil. Journal of the science of food and agriculture. 1967;18(7):269-73. https://doi.org/10.1002/JSFA.2740180701.
4. Lal R. Soil health and carbon management. Food and Energy Security. 2016;5:212-222. https://doi.org/10.1002/FES3.96.
5. Doran J, Zeiss M. Soil health and sustainability: managing the biotic component of soil quality. Applied Soil Ecology. 2000;15:3-11. https://doi.org/10.1016/S0929-1393(00)00067-6.
6. Babujia LC, Silva AP, Nakatani AS, Cantão ME, Vasconcelos AT, Visentainer JV, *et al*. Impact of long-term cropping of glyphosate-resistant transgenic soybean [*Glycine max* (L.) Merr.] on soil microbiome. Transgenic research. 2016 Aug;25:425-40.
7. Nakatani AS, Fernandes MF, De Souza RA, Da Silva AP, Dos Reis-Junior FB, Mendes IC, *et al*. Effects of the glyphosate-resistance gene and of herbicides applied to the soybean crop on soil microbial biomass and enzymes. Field Crops Research. 2014 Jun 1;162:20-9.
8. Widmer F. Assessing effects of transgenic crops on soil microbial communities. Green Gene Technology: Research in an Area of Social Conflict; c2007. p. 207-34.
9. Powell JR, Levy-Booth DJ, Gulden RH, Asbil WL, Campbell RG, Dunfield KE, *et al*. Effects of genetically modified, herbicide-tolerant crops and their management on soil food web properties and crop litter decomposition. Journal of Applied Ecology. 2009 Apr;46(2):388-96.