JUST AGRICULTURE
multidisciplinary e-Newsletter

Exploring the Soil Microbiome: Key to Sustainable Agriculture

Renuka*[1] and Dhamni Patyal[2]
Renuka*[1], PhD. Scholar, Department of Soil Science and Agricultural Chemistry, SKUAST Kashmir
Dhamni Patyal[2], PhD. Scholar, Department of Agronomy, SKUAST Jammu

ARTICLE ID: 21

Current research priorities include reducing global warming, protecting the environment and increasing food production to meet global food demand. According to estimates by the Food and Agriculture Organization of the United Nations, global food production must be increased by 70 in order to feed the projected 10 billion people by 2050. For this reason, the global food supply must be increased sustainably, taking into account competition for natural resources especially land and wate and the need to operate an economy with limited carbon emissions. Sustainable agriculture is based on producing food with the lowest possible impact on the environment and the food chain through chemical residues. The plant body can be considered as a complex network of interconnected ecological niches harbouring a variety of microorganisms in the rhizosphere, surface tissues (rhizoplane and phylloplane) and internal tissues (endosphere), with which they engage in a wide range of beneficial, neutral and harmful interactions. Scientists have long been interested in studying the normal relationships of plants with their environment.

Introduction

The internal nutrient cycle in the soil is impaired by the heavy dependence on modern cultivation methods, the use of mineral fertilizers and the use of agrochemicals. The use of various mineral fertilizers and agrochemicals pollutes water systems, leads to contaminated runoff and harms beneficial insects, the soil microbiome and plants. It also contributes to climate change by altering rainfall and temperature patterns. The development of plant growth and soil fertility are crucial for sustainable agriculture and are influenced by the soil microbiota: the soil microbiome contributes to nutrient cycling through the decomposition of organic matter and ecosystem function (nutrient recycling and resistance to biotic and abiotic stress). Different microbiome groups are used in sustainable agriculture for plant protection through the use of biopesticides and bio fungicides as well as for nutrient uptake through rhizosphere,

JUST AGRICULTURE
multidisciplinary e-Newsletter

endophytic or phyllo spheric interaction in symbiotic/free-living processes. The conservation and sustainable use of natural resources such as soil and water are essential for plant productivity, human health and environmental safety. These resources are the main suppliers of minerals and nutrients. Sustainable agricultural practices reduce pollution, protect natural resources from soil and water degradation, and maintain biodiversity and soil health.

To meet human demand for food and fibre, sustainable agriculture integrates plant and animal products such as farmyard manure, crop residues, etc., while improving the environment and farmers' quality of life through the efficient use of non-renewable and on-farm resources. To minimize the use of off-farm resources such as agrochemicals, sustainability can be achieved through the use of animal manure and effective on-farm waste management practices. Techniques used in sustainable agriculture include conservation tillage, cover crops, agroforestry, intercropping, crop rotation, green manure and the use of biofertilizers.

Background

Lederberg and McCray originally used the term "microbiome" and defined it as a "collection of resident microorganisms inhabiting a particular host/environment" Microbes are used in agriculture as bio stimulants that mobilize locally available nutrients for plant uptake, as biocontrol agents and as biofertilizers. Due to their ability to multiply and sustain themselves, these bacteria are dynamic and do not need to be injected frequently. The location, the type of plant and the microbial community influence how effective and long-lasting microbial inoculants are in promoting plant development and improving soil resilience. Beneficial microbes can enhance plant growth and nutrient uptake through nitrogen fixation, siderophore production and other mechanisms such as solubilization of P, K and Zn. Plant microbiomes are therefore agriculturally important bioresources for agriculture.

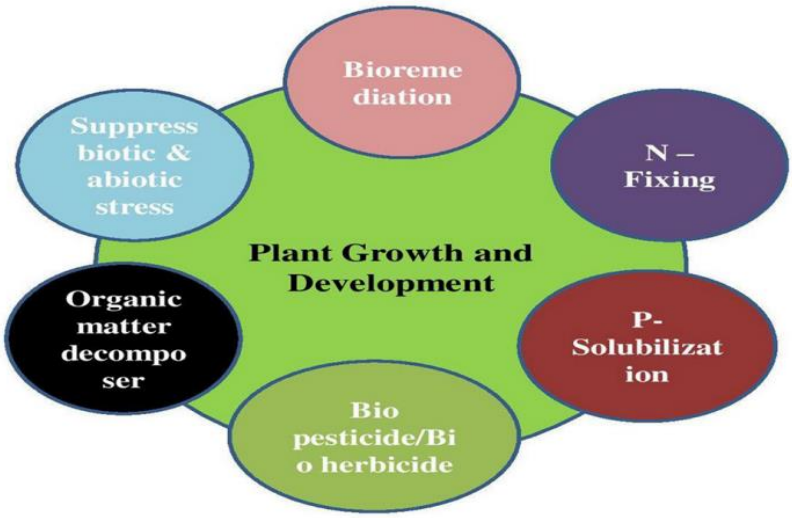
Role of microbes in soil health

Sustainably managed ecosystems are highly dependent on healthy soils, which are also an important factor for the health of the individual. The ability of soil to function as a vital living system, support plant and animal productivity, maintain or improve the quality of water and air, and promote plant and animal health is referred to as soil health. The condition and well-being of soils have a significant impact on energy security, climate change mitigation and global food and water security. In recent years, the worsening impacts of land use change,

JUST AGRICULTURE
multidisciplinary e-Newsletter

erosion, compaction and pesticide pollution on soils have drawn attention to the importance of preserving the ecological services provided by soils. As a result, there is a growing interest in the methods that as a result, interest in methods to maintain healthy soils is growing, and researchers are increasingly recognizing the need to understand and incorporate the importance of microbial communities in protecting and improving soil health. For example, to improve biodiversity and soil health, a number of studies have shown the benefits of crop diversification, reduced use of synthetic pesticides and mineral fertilisers, and intensive tillage. A wide range of processes, including nutrient cycling, organic matter dynamics, soil structure, carbon transformation and sequestration, can be influenced by the direct and indirect actions of soil microbial communities. Soil is the largest terrestrial carbon store, and an increasing number of studies indicate that microbial communities are crucial for soil carbon stability. Microbial biomass is not as labile as previously thought, and microbial material can be the source of finely divided, stable organic matter.

Microbial characteristics are critical to our understanding of soil carbon sequestration because they are linked to the stable carbon pool in soil, including microbial biomass, complexity and the existence of important microbial groups. In addition, soil microbes control the biogeochemical cycling of other elements such as iron, nitrogen, phosphorus and sulphur, which has a direct impact on all aspects of human health. While the literature emphasises the importance of physical and chemical indicators of soil health, not as much attention has been paid to soil biological indicators.



Role of micro biome in sustainable agriculture

JUST AGRICULTURE
multidisciplinary e-Newsletter

Components of sustainable agriculture

The soil microbiome contributes to nutrient cycling in ecosystems by helping to break down organic matter and promoting resilience to biotic and abiotic stress. In sustainable agriculture, different microbiome groups are used for plant protection through the use of biopesticides and biofungicides as well as for nutrient uptake through rhizospheric, endophytic or phyllospheric interaction in symbiotic/free-living processes. The conservation and utilisation of natural resources such as soil and water, which are the main suppliers of minerals, is essential for plant productivity, human health and a safe environment. Sustainable agricultural practices reduce pollution, protect natural resources from soil and water degradation, and maintain biodiversity and soil health. Sustainability can be achieved through the use of animal manure and good waste management to reduce the need for off-farm resources such as agrochemicals. Some of the sustainable agricultural factors that influence the soil microbiome are listed below:

Sustainable agricultural factors that affect the soil microbiome

Future challenges

A challenge for future research efforts is to protect and conserve the biodiversity of the rhizosphere and to explore its possible integration into agricultural soils. Microbial inoculants are currently used to solve several agronomic problems. However, there is still a lack of

JUST AGRICULTURE
multidisciplinary e-Newsletter

widespread acceptance, mainly due to inconsistent performance under different environmental conditions. Global interest in the microbiome has been reignited by the growing need for safer food and better nutrition, the development of research technologies and interest in sustainable agriculture. Politicians, environmentalists, ecologists, scientists, farmers and biologists are all interested in discussing the topic of sustainable agriculture, which makes it so important for today's farming practises. The widespread use of agrochemicals and mineral fertilizers has led to agricultural soils being contaminated today. A clear advantage over many other control agents and techniques is the use of the microbiome. A productive way to advance organic and sustainable agriculture would be to use microbial technologies.

Conclusion

Within the context of sustainable agriculture, the diversity and quantity of microorganisms found in the soil rhizosphere are the primary determinants of soil health. Plant composition, productivity, and sustainability are influenced by the variety and quantity of microorganisms present in the soil and rhizosphere. An incredibly appealing method that is non-transgenic and can be thought of as the extended plant genome is the deployment of microorganisms to increase agricultural output. Low-input, sustainable agriculture has a bright future because these bacteria may help restore soil health and productivity. Our knowledge of how production practices and environmental factors impact the physical, biological, and chemical stability and dynamics of the soil–rhizosphere–plant systems, as well as their impact on short- or long-term sustainability, needs to be further enhanced through improved assessment of soil health indicators.