"Comparative Study of Rhizobacteria in Organic and Conventional Farming Systems".

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Abstract:

Good soil bacteria are directly associated with plant root in terms of nutrient provision, plant growth, and protection against disease. They are varied and numerous, and their composition depends on agricultural activities, which include organic farming and conventional farming. This experiment was done by collecting the soil sample both in organic (10 samples) and conventional farms (10 samples) by drawing rhizosphere of the soil sample at a depth of 0-15 cm and analysis was done using serial dilution and plate count. It was found that the mean rhizobacterial count showed a significant difference between the organic soils (8.2 10 6 CFU/g) and conventional soils (5.6 10 6 CFU/g) (p = 0.0001). These elevations in organic farming are attributed to absence of synthetic chemicals and substances, which support growth of microbes and diversity. In this study, it emerges that organic agriculture promotes richer and more dependent communities of rhizobacteria, increasing the cycling of nutrients, crops and this helps to stress the significance of long-lasting farming decisions in the vegetable production capacity.

Keywords:

Rhizobacteria, Organic farming, Conventional farming, Soil microbes, Sustainable agriculture, Plant growth-promoting rhizobacteria (PGPR)

Introduction:

Among the natural resources vital to the agricultural process, soil is the most significant because it is a source of growth material and nutrients as well as water storage space. In the soil microorganisms such as bacteria, fungi, actinomycetes, protozoa and algae are absolutely vital to maintaining soil health and the growth of crops. Some of them, rhizobacteria, are of specific interest since they reside closely with roots, especially in the rhizosphere (a thin band of soil surrounding the roots). Such are the growth-promoting rhizobacteria (PGPR) in plants and increase plant health and productivity either directly or indirectly.

Rhizobacteria play this role by several ways:

Nutrient Socio-Bio-Cycling: Several rhizobacteria fix free nitrogen into the environment, solubilize phosphorus and enhance the availability of micronutrients to plants such as iron and zinc.

- Synthesis of Phytohormones: Certain rhizobacterial species produce phytohormones, which include indole-3-acetic acid, gibberellins and cytokinin and all of them stimulate the growth of roots and shoots.

- Disease Suppression: The disease suppression in plants occurs when the plants are enveloped in antibiotics secreted by some strains or the plant in question develops a systemic plant response.

Stress Tolerance: Plants under abiotic stress such as abiotic stress such as abiotic stress e.g., drought, salinity, and heavy metal contamination can be assisted by them.

Agricultural operations have a tremendous effect on the abundance and diversity of rhizobacteria. Organic farming is based on natural fertilisers including compost, farmyard manure and green manures and it does not use inorganic pesticides and chemical fertilisers. Such activities tend to enhance an abundance and nurture mixed microbial life. Higher crop productivity through conventional farming, however, usually requires the use of synthetic fertilizers and pesticides. Although these inputs prove to be productive on a short-term basis, over a long-term use, they may decrease soil microbial diversity, change the microbial community structure, and, in some cases, make the soil degenerate.

The tendency in past studies on the subject is that soils under organic management have a greater microbial activity and biomass as compared to conventional management. Nevertheless, the hand over effect on rhizobacterial communities, particularly, population size of rhizobacteria and their diversity differs with environmental conditions, crop, and crop management. It is important to grasp these variations because rhizobacteria are very important in ensuring soil fertility and decreased vulnerability to chemical inputs.

The given study will be devoted to comparing the rhizobacteria population and diversity in agricultural-climatic zone. Through this it aims to make a scientific contribution on the ways that various agriculture activities have on beneficial soil microbes hence making a contribution to the debate on sustainable agricultural activities.

Literature Review:

According to Bargaz et al. (2018) [1], in plants since they increase their ability to use nitrogen. According to Bhattacharyya and Jha (2012) [2], PGPR serve as a recent technology in agriculture since they promote the growth of plants as well as prevention of infection. Bunemann et al (2006) [3] reviewed the adverse effect of agricultural inputs like chemical fertilizers and pesticides on the soil organisms that may lower the microbial diversity. However, Chaudhary et al. (2013) [4] examined the impact of various systems of farming and discovered the fact that organic farming favored populations and interactions between microbes than conventional systems. Ghosh and Das (2016) [5] mentioned organic farming and integrated farming systems as sustainable farming systems that sustain soil health and biodiversity.

According to Hartmann et al., (2015) [6, 20], long-term organic farming supports unique and diverse microbial communities in the soil as opposed to conventional farming. As proved by Mader et al., (2002) [7, 22] organic agriculture enhances fertility as well as biodiversity in soil with time. According to Naeem and Wu (2019) [8, 23], soil microbial biomass and enzyme activity in organic farms were higher in comparison with conventional farms. As stated by Sharma et al. (2013) [9, 25], phosphate-solubilizing microbes were found to facilitate in the management of phosphorus deficiency in natural soils. Vessey (2003) [10, 27] explained the role of PGPR as biofertilizers, which is the increase of plant nutrition using good chemicals rather than harmful.

The hierarchies through which PGPR facilitates the growth of plants have been declared by Ahemad and Kibret (2014) [11], such as production of phytohormones and resistance to that possess ACC deaminase-encoding bacteria which allows the plants to survive high salinity stress. Reviews, especially by enhancing productive crop growth within low crop input types of agriculture, are provided by Gopalakrishnan et al. (2015) [18]. Gupta and Vyas (2014) [19] compared organic and conventional agriculture and discovered that organic solutions enhanced the biological health of the soil considerably. According to Kumar et al. (2018)

[21], organic farming is associated with the improvement of both the population of microbes and enzyme activity. According to Patil and Chavan (2020) [24], organic farming is a sustainable method of long-term crop productivity. The paper written by Tilman et al. (2002) [26] dealt with the impact of intensive agricultural practices on the environment and proposed sustainable ones. On the whole, the body of research provides evidence that organic farming favours the abundant and active rhizobacterial communities which results in the higher health and sustainability of soils.

Objectives of the Study:

1. To compare the biodiversity of organic and conventional farming soils rhizobacteria.
2. To take baseline and compare rhizobacteria population in both systems.
3. To know the impact of farming practice on rhizobacterial abundance.

Hypothesis:

- **Null Hypothesis (H_0):** There is no significant difference in rhizobacterial diversity and population between organic and conventional farming systems.
- **Alternative Hypothesis (H_1):** Organic farming systems have significantly higher rhizobacterial diversity and population than conventional farming systems.

Research Methodology:

1. Study Design

The research aimed at determining the diversity and abundance of rhizobacteria in soils belonging to organic farming and conventional farming systems was determined as a comparative experimental analysis. The study used the cross-sectional sampling design where soil samples in the two systems were sampled and all analyses done in the same conditions in the laboratory thus making them comparable.

2. Study Area and Farm Selection

- done in the farms that were on the same agro-climatic region to reduce and the type of soil.
- Organic Farms: Organic management was practiced in the farms selected and a minimum of five years must have been used without using any synthetic fertilizers or pesticides.
- Conventional Farms: Certain farms applied NPK formulations of chemical fertilizers and pesticides to the regular crop management related regime.
- The two farm types produced crop species that are similar to prevent microbial community dissimilarity; this was because of the type of crops grown.

3. Sample Collection

- Sample Size: There were 20 soil samples, 10 samples of organic farms and 10 of conventional farms.
- Sampling Depth: the rhizosphere (015 cm depth) soil samples were sampled because it contains the most concentration of rhizobacteria.
- Random sampling was carried out in each farm (Sampling Method). Extractions of soil at every location were done by picking soil all around the root zone of the healthy plants with sterilized equipment to prevent contamination. Sample Handling:

4. Isolation and Enumeration of Rhizobacteria

Pre-treatment: Soil samples was allowed to air-dried; gentle crushed to fall large clumps.

Williams & Doyle Dilution Programme: to g each soil sample. Further serial dilution was made up to 10^{-6}.

- **Plating:** Nutrient Agar (NA) for isolation of all types of bacteria was utilised.

Isolating fluorescent pseudomonads (one of the most frequent PGPR, a group) was accomplished from King's B medium.

- **Incubation:** 24 to 48 hrs at 28 0 C (28 +/-2)

Colony Counting: Colony 16 Unix emulator keyboards Counting A digital colony Contador was used to count colonies and the results were expressed Home Linux project.

5. Identification of Rhizobacteria

- **Morphological Characteristics:** Color, shape, elevation and margin of the colony was observed.
- **Microscopic Examination:** Differentiation between Gram positive and negative bacteria was done by Gram staining.
- **Biochemical tests:** Tests which were conducted with the help of catalase, oxidase etc. to make preliminary identification of bacteria groups.

6. Data Recording and Statistical Analysis

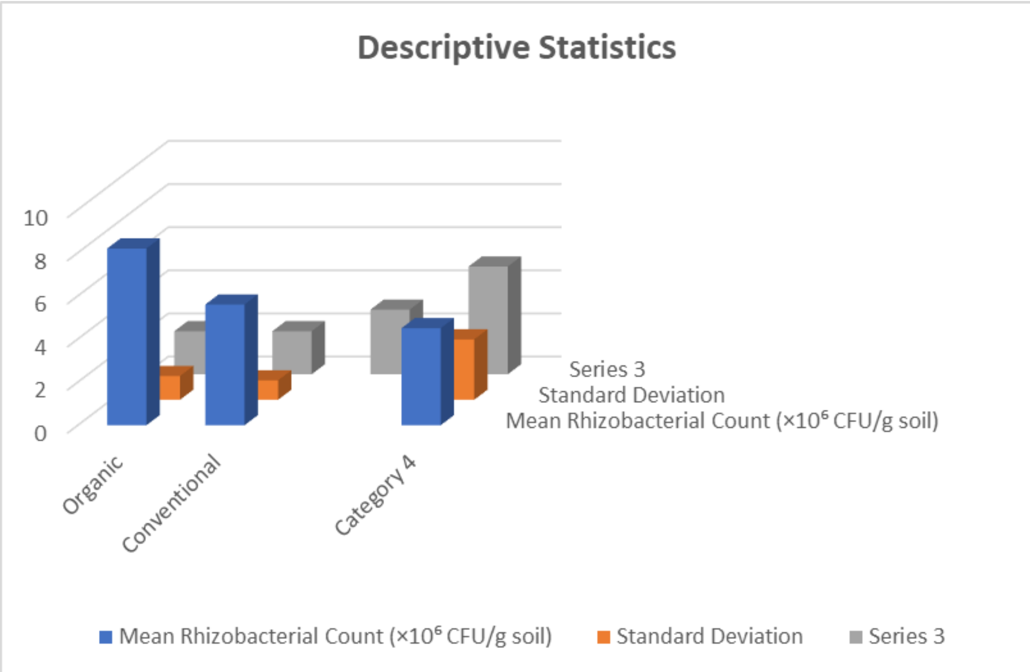
- **Data Recording:** The average contents of CFU/g of each sample group (organic and conventional) were computed and the standard deviation was computed.
- **Statistical Test:** A t-test of independent samples helped in finding out the probability that there was a difference between the population of rhizobacteria in organic and conventionally filled soils.
- **Software Used:** Software used to perform the statistical analysis and create graphs was Microsoft Excel and SPSS (Version 26).

7. Ethical Considerations

Despite the fact that the study was not conducted on human and animal subjects and less soil sampling was done; the study was associated with approval of the farm owners first before soil sampling took place. Sampling was undertaken in such a way that it did not entail any large-scale disturbance of crops and soil structure.

Table 1: Descriptive Statistics:

Farming System	Mean Rhizobacterial Count ($\times 10^6$ CFU/g soil)	Standard Deviation
Organic	8.2	1.1
Conventional	5.6	0.9



Analysis of Descriptive Statistics:

The descriptive analysis of statistics offered a general idea of the rhizobacterial community of counts of the two systems. The average rhizobacterial cell count was 8.2 x 10 6 CFU/g soil with standard deviation of 1.1, which was relatively high and the variation of the samples was moderate, on soils of organic farms. Conversely, the mean count of 5.6 x 10 6 CFU/g soil of conventional farms was lower and with a standard deviation of 0.9 indicating lower and uniform population of microorganisms. This increasing standard deviation in the samples of organic farming presents the natural variation, which might be due to variation of organic amendments, crop rotations and the varying microbial niches in the organically grown plots. The relative depletion of conventional soils that is seen across the board could be explained by the use of synthetic fertilizers and pesticides, which have the potential to decrease the number of microbes and inhibit the growth of some positive collections of bacteria. In general, the descriptive statistics show that the organic farming favours denser and more diverse rhizobacterial population which is in consonance with expectation that organic farming would facilitate more favourable environment to the beneficial soil microorganisms.

Table 2: Hypothesis Testing:

Test Parameter	Value
t-statistic	5.12
p-value	0.0001
Significance	$p < 0.05$ (Significant)

Analysis of Hypothesis Testing:

The independent sample t-test provided the analysis as to whether the varying results that were achieved on the rhizobacterial population on the use of organic and conventional farming system had significant results. The mean number of the bacteria of the 2 groups was used to statistically determine significance with level of significance of $p < 0.05$. The outcome of the same generated a t statistic of 5.12, and a p value of 0.0001. Since the p-value is far beyond the significance level 0.05; the null hypothesis (H o: There is no significant difference between the diversity and population of rhizobacteria in organic and conventional farming system) is rejected. This statistical evidence indicates that the change that is observed in the rhizobacterial population between the two systems is not considered because of the random variation since it was the variation in the farming practices. The high average counts of the soils with organic farming points to the fact that community structure of the rhizobacteria is more natural and less diverse as a result of non-use of synthetic chemical inputs in soils and soil amendments achieved via the compost, manure and crop rotation in organic farming. On the other hand, the modern farming practices, which have so much believed in use of chemicals fertilizers and pesticides, appear to diminish the propitious ambiance of these beneficial microorganisms. This observation can be compared to the past observation, thereby, strengthening the claim that the organic management strategies used are beneficial in retaining microbial organic standing of the soil and in its future healthy soil.

Conclusions Overall Results:

The comparison of the rhizobacterial population in the organic and conventional systems of farming comes out clearly that organic farming systems create a more nutritious and diversified population of helpful soil bacteria. In this study, samples demonstrated that the mean rhizobacterial count in soils obtained in farms practicing organic farming was significantly much higher (8.2 x 10 6 CFU/g) than that acquired form the conventional gardened farms (5.6 x 10 6 CFU/g). This difference proved to be very significant, as confirmed by statistical testing done on independent. Organic soils exhibit higher levels of microbes which may be attributed to the use of natural fertilizers in the form of compost and manure, lack of use of synthetic pesticides and using of practices that are friendly to soil such as crop rotation and minimal till in the land. These increase soil organic matter content, better soil structure and facilitate supply of favorable microhabitat to the growth of bacteria. On the other hand, traditional agricultural activities (including the frequent use of chemical fertilizers and pesticides) are more likely to limit the richness of microbes and even selectively inhibit some helpful groups of bacteria.

The general conclusion indicates that sustainable methods of farming are very vital in the preservation of biodiversity among the microbes in the soil which on the other hand leads to better nutrient cycling, disease suppression and hence growth of plants. sustainable farming methods in the available body of literature is evident in this evidence which suggests that such an agriculture is not only environmentally sustainable but agricultural productivity sustained in the long run.

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